Reflective Practice in Paramedic Head Injury Management: Exploring the Need for Quality Improvement and Implementation in Clinical Practice.

A Nexus Analysis of Clinical Decision-Making and Reflective Insights.

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Preface and Acknowledgements

This thesis is dedicated to my three Sons, Ryan, Hugo, and Zachary; anything is possible boys, dream big, follow your heart, and reach for the stars!

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Glossary

Term	Description
Advanced Clinical Practitioner or ACP	A highly skilled healthcare professional who operates autonomously at an advanced level in the assessment, diagnoses, and treating of patients. As well as leading in research, audit, education, and management activities within healthcare.
Ambulance Service Clinical Performance Indicators or CPIs	Quantitative metrics used to assess the quality, effectiveness, and efficiency of ambulance services in responding to emergency calls and managing patient care.
Ambulance Service Key Performance Indicators or KPIs	Metrics used to measure and evaluate the performance and effectiveness of ambulance operations.
BM	'Boehringer Mannheim' is an out-of-date term that is used to refer to blood glucose levels but actually stands for the original manufacturer of the blood glucose test strips.
Conversational Analysis	An approach to studying social interaction and talk-in-interaction, rooted in sociology and linguistics.
Cerebral blood flow velocity	The speed at which blood travels through the vessels supplying the brain with oxygen and nutrients.
Cerebral Perfusion Pressure or CPP	The net pressure gradient that drives oxygen delivery to cerebral tissue defined as the difference between mean atrial pressure and intracranial pressure.
Critical Care Paramedic or CCP	Advanced level paramedic with specialist training in managing critically ill or injured patients.
Computer mediated discourse analysis	A research methodology that examines communication occurring through computer-mediated platforms.
College of Paramedics	The recognised professional body for paramedics in the United Kingdom.
Cerebral perfusion pressure or CPP	Net pressure gradient that facilitates the flow of blood into the brain, defined as the difference between mean atrial pressure and the intracranial pressure.
CRASH-3	A significant clinical trial aimed at assessing the efficacy and safety of tranexamic acid (TXA) in patients with traumatic brain injury.
CT Scan or Computed Tomography Scan	A diagnostic imaging procedure that uses X-ray technology and computer processing to create detailed cross-sectional images of the body.
Direct or New/Novel Oral Anticoagulant (DOAC) or (NOAC)	A class of medications used to prevent and treat blood clots. Unlike traditional anticoagulants, DOACs or NOACs work by directly inhibiting specific clotting factors in the blood.
End tidal CO2 or ETCO2	The partial pressure of carbon dioxide at the end of an exhaled breath.
Glasgow Coma Scale or GCS	Neurological scale used to assess and quantify the level of consciousness in a patient.
Health Care Professional Council or HCPC	Regulatory body responsible for overseeing and ensuring the competence and conduct of healthcare and care professionals in the UK.
Hypothetico-deductive-reasoning	A form of logical reasoning commonly used in scientific inquiry.
HOTT Algorithm	Traumatic Cardiac Arrest Resuscitation protocol.
Intracranial Pressure or ICP	The pressure exerted by fluids, primarily cerebrospinal fluid (CSF), inside the skull and on the brain tissue.
iCPG	Digital application designed by to offer easy access to JRCALC guidelines.

i-Gel	Supraglottic airway management device designed for use in anaesthesia and resuscitation procedures.
IHCD	The Institute of Health and Care Development focuses on academic and vocational qualifications and testing in the healthcare sector.
Impedance Threshold Device or ITD	A medical device original designed for use in CPR to enhance circulation and increase blood via the creation of negative pressure in the chest thus promoting greater venous return to the heart during chest recoil.
JRCALC or Joint Royal Colleges Ambulance Liaison Committee	An organisation responsible for developing and reviewing clinical guidelines tailored for paramedics in the UK.
Mean Arterial Pressure or MAP	Average pressure in a patients arteries during on cardiac cycle calculated using a formula that considers both systolic and diastolic blood pressure.
Mediated Discourse Analysis	A specialised framework within linguistic discourse analysis pioneered by Ron Scollon and Suzanne Scollon, focusing on understanding communication in various social contexts.
Major Trauma Centre	Specialised hospital equipped to provide comprehensive care for patients with severe and life-threatening injuries.
NICE or National Institute for Health and Care Excellence	A body in the UK that produces evidence-based recommendations, evaluates cost-effectiveness, and ensure quality of care.
Nasal Pharyngeal Airway	A flexible tube inserted into a patients nostril to establish or maintain an open airway.
Newly Qualified Paramedic or NQP	A paramedic who has recently completed their formal education but who often then complete a period of preceptorship or a consolidation programme where their level of autonomous practice may be restricted.
Oral pharyngeal Airway	A medical device used to maintain or open the airway by preventing the tongue from obstructing the upper airway passages.
Partial pressure of carbon dioxide or PaCO2	A measurement of the pressure exerted by carbon dioxide dissolved in arterial blood.
Patient Group Directions or PGD	A legal framework that permits certain registered healthcare professionals to supply and/or administer specified medications to a predefined group of patients without the need for individual prescriptions.
Paramedic Practitioner or Specialist Paramedic	An enhanced paramedic with additional training and skills usually in the field of minor injuries and illness.
Quality Improvement or QI	Systematic efforts aimed at enhancing various aspects of healthcare delivery to achieve better outcomes for patients.
Rapid Sequence Intubation or RSI	The rapid administration of induction agents and neuromuscular blocking agents to induce immediate unconsciousness and paralysis, facilitating the insertion of an endotracheal tube into the trachea.
Supraglottic Airway Devices	A medical device positioned above the glottis and form a seal with the pharynx allowing for ventilation and oxygenation within the need for endotracheal intubation.
Arterial Oxygen Saturation Level or SaO2	The percentage of haemoglobin in arterial blood that is saturated with oxygen.
Trauma Unit	Specialised unit within a hospital that provides immediate care to patients with severe traumatic injuries including stabilisation for ongoing transfer to a major trauma centre if required.

Abbreviation List

Abbreviation		Abbreviation	
#	fracture	ICH	Intracranial Haemorrhage
A(c)BCDE	Airway (c-spine), Breathing, Circulation, Disability, Environment / Exposure	ICP	Intracranial Pressure
A&E	Accident & Emergency Department	ICU	Intensive Care Unit
AACE	Association of Ambulance Chief Executives	iCPG	Integrated Clinical Practice Guidelines
ABC	Airway, Breathing, Circulation	IHCD	Institute of Health and Care Development
ACF	Antecubital fossa	Imp	Impression
ACP	Advanced Clinical Practitioner	IT	Information Technology
ADL's	Activities of Daily Living	ITD	Impedance Threshold Device
AEMT	Association of Emergency Medical Technicians	ITLS	International Trauma Support
AF	Atrial Fibrillation	ITPR	Intrathoracic pressure regulator
AIMS	Alcohol Intoxication Management Services	ITU	Intensive Therapy Unit
AIP	Ambulance Improvement Programme	IV	Intravenous
AKI	Acute Kidney Injury	JRCALC	Joint Royal Colleges Ambulance Liaison Committee
AmbSYS	Ambulance System Indicators	JVD	Jugular Vein Pressure
AMI	Acute Myocardial Infarction	KC	Knowledge construction
AMTS	Abbreviated mental test score	KO	Knocked Out
ASHICE	Age, Sex, History, Injuries/Illness, Condition, ETA	KPI	Key Performance Indicator
ATLS	Advanced Trauma Life Support	KVO	Keep Vein Open
ATNC	Advanced Trauma Nurse Course	LBNP	Lower-body negative pressure
BASIC	British Association for Immediate Care	LF	Low frequency
BM	Boehringer Mannheim	LOC	Loss of consciousness
BME	Black and Minority Ethnic	LP	Lumbar Puncture
BMI	Body Mass Index	MAP	Mean Arterial Pressure
BP	Blood Pressure	MDA	Mediated Discourse Analysis
BPA	British Paramedic Association	MDT	Multi-disciplinary Team
BPJ	British Paramedic Journal	MeSH	Medical Subject Headings
BPM	Beats per minute	MIU	Minor injury Unit
BTEC	Business and Technology Education Council	MRI	Magnetic Resonance Imaging
BTF	Brain Trauma Foundation	MSK	Muscular Skeletal System
BTS	British Thoracic Society	MSNA	Muscle sympathetic nerve activity
BVM	Bag Valve Mask	MTC	Major Trauma Centre
C-spine	Cervical Spine	NABME	National Ambulance Black and Minority Ethnic Group

CA	Conversational Analysis	NHSI	NHS England and NHS Improvement
CABCDE	Catastrophic Haemorrhage, Airway, Breathing, Circulation, Disability, Exposure / Environment	NICE	National Institute for Health and Care Excellence
CALNAS	Culture and Leadership Network for Ambulance Services	NMBA	Neuromuscular blocking agent
CASP	Critical Appraisal Skills Programme	NOAC	New or Novel Anticoagulant
CBFV	Cerebral blood flow velocity	NOF	Neck of Femur
CCP	Critical Care Paramedic	NPA	Nasal Pharyngal Airway
CDA	Critical Discourse Analysis	NQP	Newly Qualified Paramedic
CFS	Clinical Frailty Score	NRAC	Non-registered Ambulance Clinician
CI	Confidence Interval	ODP	Operating department practitioner
CMDA	Computer mediated discourse analysis	ONSD	Ocular Nerve Sheath Diameter
CO2	Carbon Dioxide	OP	Oral phalangeal Airway
CoP	College of Paramedics	OT	Occupational Therapist
CPD	Continued Professional Development	OTC	Over the counter
CPG	Clinical Practice Guideline	PaCO2	Partial pressure of carbon dioxide
CPI	Clinical Performance Indicator	PALM	Pharmacologically Assisted Laryngeal Mask
CPP	Cerebral perfusion pressure	ParaCRU	Paramedic Critical Research Unit
CPR	Cardiopulmonary Resuscitation	PEEP	Paramedic Evidence based Education Project
CPSM	Council for Professions Supplementary to Medicine	PGD	Patient Group Directions
CRANE	Cardiac, respiratory, Abdominal, Neuro, Exposure / Environment assessments	PHTLS	Pre-hospital Trauma Life Support
CRT	Capillary refill time	PMH	Previous Medical History
CSF	Cerebrospinal Fluid	POC	Package of Care
CT	Computed Tomography (Scan)	POCUS	Point of care ultrasound
CTBI	Chronic Traumatic Brain Injury	PP	Paramedic Practitioner
CVE	Cerebral Vascular Event	PPV	Positive predictive value
CVP	Central Venous Pressure	PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
DBP	Diastolic Blood Pressure	PRN	Latin "pro re nata" meaning "When necessary"
DHx	Drug or medication history	Pt	Patient
DOAC	Direct Oral Anticoagulant	QAA	Quality Assurance Agency
DoH	Department of Health	QI	Quality Improvement
DSI	Delayed Sequence Intubation	QIC	Quality Improvement Collaborative
EBCD	Experienced-based co-design	QIF	Quality implementation framework
EBM	Evidence Based Medicine	RAP	Right arterial pressure
EBP	Evidence Based Practice	RCT	Randomised controlled trial

ECG	Electrocardiogram	ROC	Receiver Operator Characteristics
ED	Emergency Department	ROM	Range of Movement
EENTd	Eyes, Ears, Nose, Throat and Dental	RoS	Review of Systems
EICP	Elevated Intracranial Pressure	RSI	Rapid Sequence Intubation
EM	Emergency Medicine	SAD	Supraglottic Airway Devices
EPs	Emergency Physicians	SANS	Spaceflight associated neuro-ocular syndrome
ETCO2	End tidal CO2	SaO2	Arterial Oxygen Saturation Level
EtOH	Ethyl alcohol	Sats	Saturation (oxygen saturation level)
F1	Foundation Year 1 Doctor	SBP	Systolic Blood Pressure
F2	Foundation Year 2 Doctor	SD	Standard Deviation
F2F	Face to face	SDEC	Same Day Emergency Care
FAST	Face, arms, speech, Test, or alcohol screening test	SECAmb	Southeast Coast Ambulance Service NHS Foundation Trust
FdSc	Foundation Degree in Science	SP	Specialist Paramedic
FOAMed	Free Open Access Medical Education	SPO2	Serum Pressure 02 levels
GCS	Glasgow Coma Scale	SPR	Subject perceived rating
GI	Gastric Intestinal System	SST	Squat-to-stand test
GRADE	Grading of Recommendations Assessment, Development and Evaluation	STEMI	ST elevation myocardial infarct
GU	Gynae - Urinary System	SV	Stroke Volume (Cardiac)
HART	Hazardous Area Response Team	SWAST	Southwestern Ambulance Service Trust
HCA	Health Care Assistant	tACP	Trainee Advanced Clinical Practitioner)
HCP	Health Care Professional	TBI	Traumatic Brain Injury
HCPC	Health Care Professional Council	TNC	Trauma Nursing Course
HDR	Hypothetico-deductive-reasoning	TPR	Total peripheral resistance
HEE	Health Education England	TRIAD	Triangulation of Reflective Improvement Activities and Dissemination
HEMS	Helicopter Emergency Medical Services	Tu	Trauma Unit
HIRT	Head Injury Retrieval Trial	TXA	Tranexamic Acid
HOTT	Hypovolaemia, oxygenation, tension pneumothorax / tamponade	ULEAC	University of London Examinations and Assessments Council
HPC	Health Professions Council	US	Ultrasound
HR	Heart Rate	UTI	Urinary Tract Infection
Hx	History	WHO	World Health Organisation

Abstract

Objective

Head injuries, a leading cause of death and disability (NICE, 2023) demand swift identification and intervention due to the 20% mortality rate associated with elevated intracranial pressure (ICP) (Fakhry *et al.*, 2004). The lack of specific pre-hospital guidance and ICP monitoring poses challenges. Recognising the need for change in clinical practice, paramedic professions must assess the feasibility of implementing evidence-based medicine for improved pre-hospital head injury patient outcomes (Institue for Health Improvement, 2019).

This research has used a 3-phased design to answer the overall research question:

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

Methods

This research has used Mediated Discourse Analysis, a specific form of discourse analysis, whereby 'discourse', 'agency' and 'practice' are mediated into a 'nexus of practice'. Unlike some other of forms of discourse analysis, MDA focuses on discourse 'in' action as opposed to discourse 'as' action, in doing so researchers aim to enable the various discourse into practical application (Scollon, 2001c). The overall aim of this thesis was achieved through three phases, comprising of the analysis of 12 semi structured interviews, analysis of 10 written reflections in practice and analysis of transcripts from 4 online case studies involving 94 participants with post case study questionnaires.

Results

Key findings reveal that paramedics face challenges in implementing best practices due to issues such as outdated guidelines, conflicting recommendations, and the complexity of clinical decision-making. Reflective practice is identified as a critical tool for enhancing clinical skills and fostering a culture of continuous improvement. The study introduces the "What, Why, How, QI" model of reflection and the TRIAD

Model (Triangulation of Reflective Improvement Activities and Dissemination) to support reflective practice and QI initiatives.

Conclusion

The research concludes that both introducing changes into clinical practice and changing how paramedics practice are necessary to improve the assessment and management of head injury patients. Recommendations include enhancing clinical guidelines, promoting continuous professional development, fostering a reflective culture, and addressing barriers to implementation. The findings contribute to the broader field of paramedicine and healthcare, offering valuable insights and practical frameworks for improving patient care in the pre-hospital setting.

Contents

List of Figures and Tables

Chapter 1 - Introduction

“While all changes do not lead to improvement, all improvement requires change” (Institue for Health Improvement, 2019).

1.1 Introduction to the thesis

To address these research aims and answer the research question, the work within this thesis has utilised mediated discourse analysis (MDA) to analyse the data collected in the qualitative phases. The application of mediated discourse analysis supported an exploration of the use of discourse type within in each phase, as well as the content within that discourse. The innovative use of MDA in paramedic practice within this thesis has resulted in the discussion of the practice of ‘the assessment and management of head injury patients by paramedics in the pre-hospital setting’ via an understanding of the mediated means, mediated actions, and chains of actions within this practice. Moreover, the research has allowed for exploration of how these chains of actions overlap with other practices to form a nexus of practice, referred to as ‘paramedic practice’ and how this nexus becomes part of the wider ‘QI and Implementation Science in Paramedicine’ community of practice’.

This introduction chapter will include an overview of research paradigm, as seen in Table 1, which will be elaborated in the reflexive account of the researcher is subsection 1.3.

Table 1 - Paradigm Framework

Paradigm	**Interpretivist / constructivist**
Ontology	**Constructivism**
Epistemology	**Interpretivist**
Methodology	**Mediated Discourse Theory**
Methods	**Qualitative data collection and Nexus Analysis**

The research design process, as seen in figure 1, was an iterative process, starting with the systematic review of ICP targeted therapy in pre-hospital head injury patients, through to the initial scoping of quality improvement and implementation science theory and leading to the subsequent design of each phase of the research.

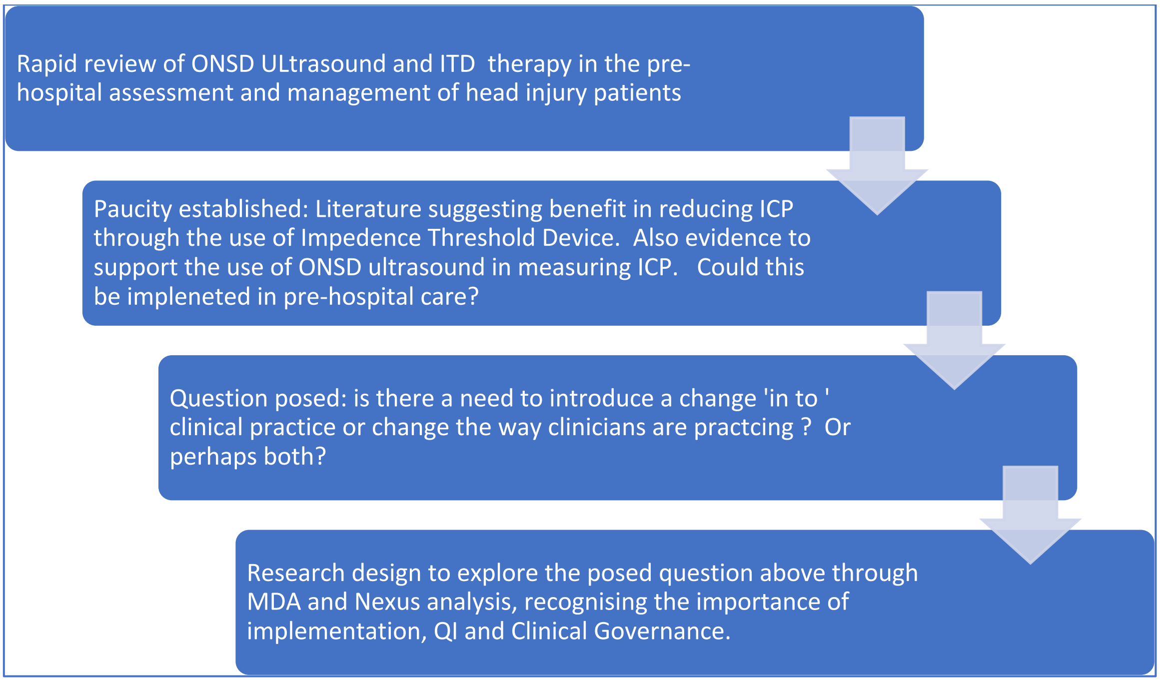


Figure 1 - Research design process.

This introduction will provide a comprehensive overview of the research paradigm and design, including the theoretical frameworks and methodologies employed. It will outline the research questions and aims and explain the significance of reflexivity in the research process. Additionally, the introduction will present background information on head injury assessment and management in paramedic practice, as well as the clinical guidelines and best practices that inform this study. Finally, it will set the stage for subsequent chapters by detailing the structure of the thesis and the key areas of focus.

1.2 Research Questions and Aims

The research question underpinning this thesis is:

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

To answer this question the thesis has the following overall aims:

1. Establish **What** treatment and assessment paramedics are currently providing in the management of head injury patients.
2. Understand **Why** paramedics are making the decision they are, in relation to the assessment and management of head injury patients.
3. Understand **How** paramedics are engaging with reflective practices and how this relates to their decision making.
4. Establish if reflective practice can contribute to healthcare quality improvement and implementation science **(QI)**.

These aims were achieved through a 3 phased qualitative design:

- **Phase 1** - Through 'reflective before-action conversation':
    - a) Explore paramedic decision making relating to head injury patients and,
    - b) Establish their reaction to suggested innovation or quality improvement.
- **Phase 2** – Examine paramedic decision making relating to head injury patients, through 'written on-action reflection'.
- **Phase 3** – Evaluate paramedic peer decision making relating to the assessment and management of head injury patients, through 'social media case study conversations and reflection 'in-action'.

1.3 Reflexivity

Through reflexive practice I have been able to explore and understand my role in the research (Finlay, 2002). As ethnography is contextual, it is argued that reflexivity is an important element. As such, the importance of the researchers understanding of this context in the design and conducting of the research is recognised (Lichterman, 2015).

My journey as a paramedic has profoundly influenced the trajectory of my research. Initially, my interest was sparked by the potential of the ResQpod, a device aimed at improving survival outcomes in cardiac arrest patients. Inspired by extensive animal research, I envisioned a clinical trial within the ambulance service to evaluate its efficacy in a real-world setting. However, upon discovering that a similar trial was already underway, I faced a pivotal moment of reflection and redirection.
Determined to contribute meaningfully to paramedic practice, I delved deeper into the literature on Impedance Threshold Devices (ITD) and their potential to reduce intracranial pressure (ICP). This exploration led me to consider the broader implications for head injury management in pre-hospital care, an area where I felt paramedics could offer more targeted interventions beyond standard observations and transportation.
My initial research approach was firmly rooted in objectivist ontology and positivist epistemology, focusing on quantitative methods to test hypotheses related to ITD and ONSD (Optic Nerve Sheath Diameter) measurements. However, as I engaged more deeply with the literature on change management, quality improvement, and the culture of paramedicine, I recognised the value of qualitative methods in capturing the nuanced experiences and perspectives of paramedics.
This realisation marked a significant shift in my philosophical stance towards a constructivist ontology and interpretivist epistemology. Reflecting on my own clinical experiences as a paramedic, I recognised the potential power of reflective practice in shaping clinical decision-making and improving patient care. This led me to design a multi-phased research approach that captured the reflective processes I had undergone and sought to explore these processes with other paramedics.
The final research design incorporated semi-structured interviews, written reflections, and modified ‘talk aloud’ case studies, allowing for a comprehensive exploration of

paramedics' experiences and reflections. This methodological evolution was driven by my belief that understanding the reflections and insights of paramedics could inform more effective clinical practices and interventions.

Reflecting on my journey, I recognised that my initial research ideas were shaped by my personal experiences and reflections as a paramedic. To ensure that my study was grounded in the collective experiences of the paramedic community, I sought to engage my peers in a collaborative reflective process. By incorporating their insights and experiences, I aimed to create a more robust and inclusive foundation for future research and practice improvements.

The methodological framework of my research was further refined through the application of Mediated Discourse Theory (MDT) and Nexus Analysis. These approaches allowed me to explore the intersections of practice, discourse, and technology within paramedic practice. The use of virtual ethnography and computer-mediated discourse analysis provided a rich, multi-faceted understanding of how paramedics interact with and reflect on their clinical experiences.

In summary, my research journey has been characterised by a dynamic interplay between personal reflection and collaborative inquiry. This reflexive approach has allowed me to navigate the complexities of paramedic practice and contribute to the ongoing dialogue on quality improvement and implementation in pre-hospital care. By embracing a multi-phased design grounded in reflective practice, I have been able to capture a holistic view of paramedic practice, ultimately aiming to enhance patient care through informed, reflective practice.

1.4 Background Information

1.4.1 Head injury assessment and management in Paramedic Practice and the wider healthcare setting

Head injury is the most common cause of death and disability in people aged 1-40 years of age in the United Kingdom (NICE, 2023). A Traumatic Brain Injury (TBI) is defined as an acquired brain injury resulting from either a blow or jolt to the head (NIH, 2023). Severe brain injury has previously been categorised using the Glasgow Coma Scale (GCS) and originally recognised as a GCS score between 3 and 8 (Teasdale and Jennett, 1974), however more recent research suggests that GCS should not be relied upon for categorisation of severe brain injury as the patient's condition may be rapidly evolving and therefore a higher GCS may create a false sense of security (Fitzgerald *et al.*, 2022). Several studies have utilised focused studies to extrapolate data and estimate global TBI incidence relating to population (Feigin *et al.*, 2013; Dewan *et al.*, 2019). These studies estimated either 790 incidences per 100,000 population, or 50 million TBI's each year, including all severities (Feigin *et al.*, 2013). Another study estimated 939 incidences per 100,000 population with an estimated 5.48 million severe TBI's annually (Dewan *et al.*, 2019).

1.4.2 Background to Head injury clinical guidance

Head injury guidance over the years can be categorised by documentation of three management approaches encompassing the various treatment options. The three management approaches are referred to as Intracranial Pressure (ICP) targeted therapy, Cerebral Perfusion Pressure (CPP) targeted therapy and the Lund concept. The ICP targeted therapy aims to reduce intracranial pressure thereby increasing cerebral blood flow, thus reducing cerebral ischemia and brain oedema, the traditional approach, as documented in 1993, can be seen in Table 2 (Miller, Piper and Dearden, 1993). CPP Targeted Therapy concentrates on increasing the cerebral perfusion pressure. The Lund concept, the traditional approach, also aims to reduce ICP, by reducing microvascular pressures and reducing osmosis through the damaged blood brain barrier thus preventing or reducing cerebral oedema, as documented in the 1990's and can be found in Table 2 (Rosner, Rosner and Johnson, 1995; Eker, Asgeirisson and Grande, 1998; Grande, Asgeirisson and Nordstorm, 1997).

Table 2 – Origins of Head Injury management approaches

Treatment	ICP Targeted Therapy	CPP Targeted Therapy	Lund Concept
Head Position	Elevation 15-30˚	Flat	Flat
Sedation	Morphine plus lorazepam	None	Low dose thiopental
Treatment of systemic hypertension	Treat systolic blood pressure > 160 mm Hg using labetalol	No	Metoprolol plus clonidine
Nutritional Support	Yes, avoid hyperglycemia	No	Yes, avoid hyperglycemia
Neuromuscular Blockade	Yes	Yes	No
CSF Drainage	Yes	Yes	No
Osmotherapy	Yes	Yes	No
Barbiturate Coma	Yes	No	No

It is important to work through the conflicting advice within these three management approaches as studies have shown that the implementation of clear Clinical Practice Guidelines (CPGs) in the management of head injury patients can have a substantial positive impact on their overall recover, length of hospital stay, as well as associated costs (Fakhry *et al.*, 2004; Vukic *et al.*, 1999; Hesdorffer, Ghajar and Lacono, 2002; Arabi *et al.*, 2010).

The Lund concept is limited in its effectiveness due to requiring a particular patient type; those with damage to the blood brain barrier and a loss of pressure autoregulation (Eker, Asgeirisson and Grande, 1998). Such a specific patient group is extremely difficult to establish in a pre-hospital environment and therefore the Lund concept is unlikely to be appropriate as a generic CPGs for head injury patients. Although some studies have reported successful outcomes with the Lund concept most treatment strategies will concentrate on a form of ICP or CPP targeted therapy, as a result a recent Cochrane review, which compared the Lund concept with these more conventional regimes (Eker, Asgeirisson and Grande, 1998). The review highlighted an issue with the quality of evidence available, particularly centered on a lack of randomised controlled trials, thus the review concluded that there is insufficient evidence to support the use of the Lund concept in the treatment of traumatic brain injury (Muzevic and Splavski, 2013). With the removal of the Lund concept, the traditional methods of ICP and CPP therapies; whilst agreeing on neuromuscular blockade, CSF drainage and osmotherapy, conflict over the advice for barbiturate coma, nutritional support, treatment of systemic hypertension, sedation, and head position remained.

When considering an approach to the treatment and management of a head injury patient is it adventitious to consider the effects of such treatment from a holistic perspective. TBI patients may present as multi-trauma patients with other system involvement and as such treatments must complement each other where possible but even in the absence of an acute insult on another physiological system, a TBI patient may experience non-neurological systemic complications of neurological origin and thus the treatment advocated for TBI patients must take into account potential impact on such recognised complications (Zygun, 2005). A theme starts to emerge with significant contributions to TBI research in the 1990's and the area of systemic complications is no exception (Piek *et al.*, 1992). Fortunately, a more recent, prospective observational study of 209 patients was conducted; the finding of which reported an 89% occurrence of at least one non-neurological organ system dysfunction in patients studied, thus supportive of (Piek *et al.*, 1992) recognition over a decade earlier. It was also noted that there was a correlation between those with systemic complications, in hospital mortality, and long-term neurological outcomes in survivors (Zygun *et al.*, 2005).

The CPP therapy approach has been noted to adversely affect non-neurological organ function. As a result of the prevalence of non-neurological systematic complications in head injury patients, the CPP approach is arguably not appropriate as a holistic patient management approach (Rosner, Rosner and Johnson, 1995). Although treating head injury patients poses additional complexities, the presence of non-neurological systemic complications allows for the identification of patterns of symptoms associated with severe head injuries. Specifically, the observation of a 'Cushing's triad,' which includes bradycardia, hypertension, and an irregular breathing pattern. This recognition enables the provisional diagnosis of such injuries, especially in the pre-hospital environment (Fodstad, Kelly and Buchfelder, 2006).

Most neuronal damage in severe head injury does not occur immediately but rather over a period of hours or even days after the original injury has occurred (Chesnut *et* *al.*, 1993). An increase in ICP is a serious clinical condition often associated with neurologic injuries or defects and is recognised as one of the main causes of cerebral oedema, the most severe consequence of severe brain injury (Leinonen, Vanninen and Rauramaa, 2018). The transfer of intrathoracic pressures in the closed cranium has been recognised for some time; however, the mechanism of the immediate pressure transfer is not fully understood. The Scottish anatomist Monro first described intracranial pressure in 1783 (Mokri, 2001), which has been developed by several anatomists and physiologists until Cushing in 1926 expanded on previous descriptions to state that with an intact skull, the volume of the brain, blood, and CSF is constant; and an increase in one component will cause a decrease in one or both of the other components (Cushing, 1926). Elevated ICP is frequently evident following head trauma or may arise due to conditions such as intracranial tumours, hydrocephalus or subdural hematoma (Lencean and Adam, 2013). Increased or elevated ICP, also known as intracranial hypertension, is defined as a cerebrospinal fluid pressure of >20mmHg (Hightower, Chin and Heiner, 2012). The circulatory system is responsible for maintaining optimal CPP, given the following equation:

$$CPP = MAP - ICP \text{ where } MAP = (1/3 \text{ systolic BP}) + (2/3 \text{ diastolic BP}).$$

Thus, one major goal of ICP monitoring is to prevent reduction in CPP, therefore preventing cerebral ischemia, neurological damage and possibly death (Reilly and Bullock, 2005). With elevated ICP being associated with a mortality rate of approximately 20%, early identification of the condition is critical to ensuring swift initiation of appropriate management and therapies and relies on techniques to accurately monitor ICP and rapidly alert clinicians to elevations in ICP (Fakhry *et al.*, 2004). Early diagnosis and prompt treatment can avert patient deterioration and prevent potentially devastating neurological damage and minimise poor patient outcomes (Vahedi, Hofmeijer and Juettler, 2007).

1.4.3 Paramedic guidance on head injury assessment and management

The Head Injury clinical guidelines produced by the National Institute for Health and Care Excellence (NICE) refer to The Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidelines as one of six standards which should be embodied in the initial assessment on scene of adults sustaining a head injury (NICE, 2014a). Paramedic specific pre-hospital guidelines in the UK are produced by JRCALC in partnership with The Association of Ambulance Chief Executives (AACE) (Joint Royal Colleges Ambulance Liaison Committee, 2021a).

The other five standards within the NICE guidelines (NICE, 2014a) are:

- Trauma Nursing Course (TNC)
- Advanced Trauma Nurse Course (ATNC)
- Pre-hospital Trauma Life Support course (PHTLS)
- International Trauma Support course (ITLS)
- Advanced Trauma Life Support (ATLS) course / European Trauma course.

The researcher has attempted to summarise the points emphasised within the NICE head injury guidelines (NICE, 2014a) in Table 3 below. This is to enable comparison and discussion with other guidelines and thesis data analysis in later chapters. There is very little specific pre-hospital guidance on assessment and treatment, other than signposting to the limited information within the sources listed above, as seen in column one of Table 3. The table allows for a comparison of the pre-hospital guidance with a summary of the assessment guidance for emergency departments and investigations in column 2. Finally, the table also summarises the guidance for transfer, admission, observation, and discharge.

Table 3 - Summary of emphasis within NICE (2014) Head Injury Guidelines

Management at the scene and transport to hospital	Assessment in emergency department	Investigations, transfer, admission, observation, and discharge
GCS	Stabilise ABC	Specific guidance on imaging decisions
Full C-spine Immobilisation where appropriate	Risk factors for CT head and spine imaging	Specific guidance investigating cervical spine injuries
Major trauma – treat greatest threat to life	Emphasis on decision making relating to GCS findings	Specific guidance on CT scan for patients on anticoagulant treatment
Pre-alert to receiving hospital	Involvement of anesthetist or critical care physician for airway management	Criteria for admission
Diversion to Trauma or specialist hospital unit	Management of pain to prevent increased ICP, (including fracture splintage, catheterisation of full bladder) with small opiate doses.	Guidance of transfer to neurology
	Use a head injury proforma (examples provided)	Guidance on observation criteria and timings
	Discuss 'significant' imaging abnormalities with Neurosurgical department.	Guidance for discharge and follow up advice

At the point of this thesis being concluded, the last published version of NICE head injury guidelines was 2014, at which time subsequent published research is suggestive of potential changes to improve the pre-hospital assessment and management of head injuries and increased ICP, including:

- A de-emphasis of rigid collars with the recognition that they do not provide immobility, however, do cause harm to the patient such as increased ICP (Davies, Deakin and Wilson, 1996; Mobbs, Stoodley and Fuller, 2002; Stone, Tubridy and Curran, 2010; Connor *et al.*, 2015; Leigh, 2017; Thompson *et al.*, 2021; Bazaie *et al.*, 2022)
- Impedance threshold device therapy in reduction of ICP (Hansen *et al.*, 2021; Hosznyak, 2016; Kiehna *et al.*, 2013).

However, the 2014 NICE Head injury guidelines have been amended in 2019 regards anticoagulated patients, and in 2017 to remove outdated research recommendations. However, there remain several research recommendations, in the NICE head injury guidelines (NICE, 2014a), in the following area:

- Using CT scans as decision making tools in the diagnosis and management of head injury patients
- Significance of antiplatelet and anticoagulant drugs in risk factors of head injury patients
- Using biomarkers to diagnose brain injury.
- Predictors of long-term sequelae following head injury

The assessment and treatment of increased ICP in the pre-hospital environment are limited for the paramedic clinician, as can be seen in the 2020 updated JRCALC 'head injury assessment and management algorithm' in Figure 2 below (Joint Royal Colleges Ambulance Liaison Committee, 2020). The data collection of this thesis spanned the 2016 and 2019 versions of JRCALC guidelines, there were no changes in the head injury and assessment algorithm within this time, however there has subsequently been an update in 2020 which now includes the use of Tranexamic Acid as a result of the CRASH 3 trial (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; Joint Royal Colleges Ambulance Liaison Committee, 2020; Cap, 2019).

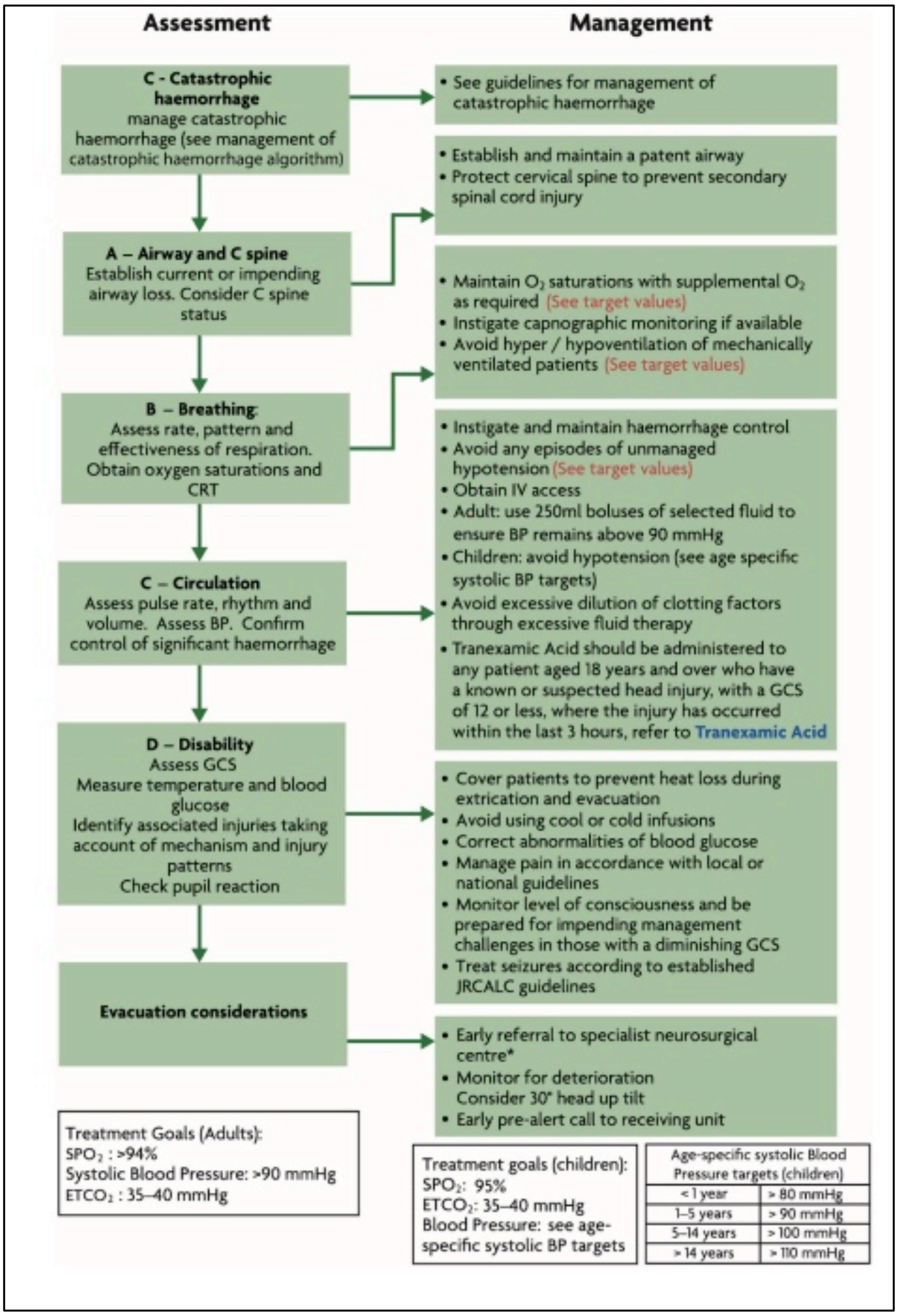


Figure 2 - JRCALC 2019 Head Injury Algorithm (with 2020 Crash 3 Trial TXA Addition) (Joint Royal Colleges Ambulance Liaison Committee 2020).

As can be seen from the JRCALC head injury algorithm and emphasis within the NICE head injury guidelines, options for establishing and monitoring ICP in the pre-hospital environment are limited to clinical observations within an ‘ABCDE’ clinical observations approach; in particular using the GCS scale, pupil assessment and observing for a Cushing’s triad (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; NICE, 2014a; Fodstad, Kelly and Buchfelder, 2006).

1.4.4 Research with the potential to change paramedic head injury clinical practice.

However recent research suggests that pre-hospital ‘traditional clinical signs’ as discussed above, are not reliable and may therefor lead to patients being under triaged and subsequently under treated (ter Avest *et al.*, 2020). Thus, the recommendation was made for further research in this area to identify more accurate clinical observations or non-invasive techniques to assess for increased ICP in the pre-hospital setting (ter Avest *et al.*, 2020). Moreover, a range of both invasive and non-invasive techniques are available for monitoring ICP, the more common of which can be found in Table 4 (Asiedua *et al.*, 2014).

Table 4 - Invasive and non-invasive options to monitor ICP.

Non-Invasive	Invasive
Transcranial Doppler	Ventriculostomy
Tympanic membrane displacement	Micro-transducers
Optic nerve sheath diameter ultrasound	
CT scan /MRI	
Fundoscopy	

In monitoring elevated intracranial pressure (ICP), intracranial catheter placement is commonly recommended, despite limited level 1 evidence from randomised controlled trials (Levitt, Joshua and Kim, 2013; Hartl and Philip, 2013; Mattei, 2013). Notably, changes in optic nerve sheath diameter (ONSD) rapidly occur after an ICP increase, making ONSD measurement a highly sensitive, early intervention for ICP estimation. This technique has the potential for detecting acute and hyper-acute ICP increases in hospital or pre-hospital settings, especially for critically ill patients (Frumin, 2014; Major, Girling and Boyle, 2011). While invasive methods, despite being less economical and posing higher risks, are currently routine due to their superior accuracy (Roboel *et al.*, 2012), recent research aims to promote non-invasive ICP monitoring, emphasising ONSD measurement's potential benefits (Asiedua *et al.*, 2014). Ultrasound measurement of ONSD is considered to have potential as a non-invasive methods for ICP monitoring, supported by reviews in 2011 (Rosenberg *et al.*, 2011), and a 2020 meta-analysis (Lee, Kim and Yun, 2020).

The options for the reduction of increased ICP and maintaining CCP are limited in ambulance service clinical practice (NICE, 2014a; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019). A comparison across other pre-hospital guidelines also identified the same limited options (Geeraerts *et al.*, 2018; Hoogmartens *et al.*, 2014; Carney *et al.*, 2017; Badjatia *et al.*, 2008). These options are summarised as:

- Pain management
- SPO2, BP and ETCO2 target treatment goals
- Recent addition of TXA administration
- 30-degree head elevation where achievable
- Hyperosmolar drugs / Mannitol (if local guidelines permit for clinical grade)
- Sedation (if local guidelines permit for clinical grade)

However, despite the current limitations there may be future potential for a change in practice after two human trials have been conducted using Impedance threshold device (ITD) therapy for the management of increased CCP. However, neither were in pre-hospital care and studies were very limited in their design and size (Kiehna *et al.*, 2013; Hansen *et al.*, 2021).

Despite research suggesting potential improvements in the assessment and management of head injury patients which could impact on clinical practice (Handley, Gorukanti and Cattamanchi, 2016), a recent scoping review has recognised that not all evidence based guidance in emergency medicine, and in particular head trauma is implemented in clinical practice (Tavender *et al.*, 2014). Therefore, any proposed changes to practice resulting from this thesis must consider implementation strategies.

Therefore, it is important to understand improvement science, specifically quality improvement in healthcare and the role of the clinician, in order to fully understand the required change to clinical practice (Koczwara *et al.*, 2018; Jones, Vaux and Olsson-Brown, 2019). Moreover, it is also important to understand implementation science before introducing any proposed evidence in to practice, to understand enablers and barriers to such an implementation. Thus forecasting the uptake of new practices among clinicians, as well as the uptake and ‘compliance’ or concordance’ with existing evidence based practice, as although change is necessary for improvement, not every change results in improvement (Damschroder *et al.*, 2009; Institue for Health Improvement, 2019).

Improvement and Implementation Sciences have differing components, objectives, theories, methodologies, and history (Koczwara *et al.*, 2018). Improvement Science takes a pragmatic approach and originates from industry with a focus on improving elements of productivity such as safety, quality and value at a system level, through the identification of poor performance (Davidoff *et al.*, 2015). Whereas implementation science has philosophical underpinnings within the behavioral sciences and focuses on the uptake of evidence into evidence-based practice (Handley, Gorukanti and Cattamanchi, 2016). Although differing in their focus, the two sciences seem to complement each other with an overlapping objective to 'identify issues with quality and achieve improvement'. However despite the apparent connection, the two sciences are only seen to work together sporadically and occasionally within healthcare and as such there is still opportunity for these separate disciplines to become more interconnected in order to achieve the full benefit's within healthcare from this suggested synergistic approach (Koczwara *et al.*, 2018).

In recognition of the statement that *"While all changes do not lead to improvement, all improvement requires change"* (Institue for Health Improvement, 2019) and in order to improve the assessment and management of pre-hospital head injury patients, the question is "do we need to introduce a change 'into' clinical practice or change how we clinically practice?"

1.4.5 Importance of the Research Area

Head injury is the most common cause of death and disability in people aged 1-40 years in the United Kingdom (NICE, 2023). Traumatic Brain Injury (TBI) results from a blow or jolt to the head and can lead to severe, long-term consequences (NIH, 2023). Despite advancements in medical care, the pre-hospital assessment and management of head injuries by paramedics remain critical areas needing improvement.

The incidence of TBI is significant, with studies estimating 790 incidences per 100,000 population, or 50 million TBIs annually, including all severities (Feigin *et al.*, 2013). Severe TBIs, characterised by a Glasgow Coma Scale (GCS) score between 3 and 8, can lead to substantial morbidity and mortality (Teasdale and Jennett, 1974). Recent research suggests that GCS alone may not be reliable for categorising severe brain injuries, as patients' conditions can rapidly evolve (Fitzgerald *et al.*, 2022).

1.4.6 Current Best Practices in Head Injury Management

Current best practices in the management of head injuries emphasise the importance of early and accurate assessment, stabilisation, and appropriate referral. These practices are guided by established clinical guidelines and evidence-based protocols to ensure optimal patient outcomes.

1.4.6.1 Stabilisation and Initial Assessment

- **Airway, Breathing, and Circulation (ABCs)**: Ensuring the patient's airway is clear, breathing is adequate, and circulation is stable is the priority. This includes the use of advanced airway management techniques if necessary (NICE, 2014a).
- **Glasgow Coma Scale (GCS)**: Regular assessment using the GCS to monitor levels of consciousness, which may also help determine the severity of the head injury and guiding further management (NICE, 2014a). However, recent research suggests that GCS alone may not be reliable for categorizing severe brain injuries, as patients' conditions can rapidly evolve (Fitzgerald *et al.*, 2022).
- **Full Cervical Spine Immobilisation**: Initially, full cervical spine immobilisation is recommended where appropriate to prevent further injury, although recent evidence suggests a de-emphasis on rigid collars due to potential harm such as increased intracranial pressure (ICP) (Davies, Deakin and Wilson, 1996; Mobbs, Stoodley and Fuller, 2002).

1.4.6.2 Imaging and Diagnosis

- **Computed Tomography (CT) Scans**: Early CT scans are crucial for patients with risk factors such as anticoagulant use, signs of skull fracture, or a GCS score of less than 15 attributed to head injury, to identify intracranial haemorrhages, fractures, and other critical findings (NICE, 2014a).
- **Risk Factors for Imaging**: Specific guidance on imaging decisions based on risk factors, including the use of CT scans for patients on anticoagulant treatment and those with cervical spine injuries (NICE, 2014a).

1.4.6.3 Monitoring and Management

- **Intracranial Pressure (ICP) Monitoring**: Monitoring ICP is advantageous, where achievable, in patients with severe head injuries. Techniques include invasive methods like ventriculostomy and non-invasive methods such as optic nerve sheath diameter (ONSD) ultrasound (Rosenberg *et al.*, 2011; Lee, Kim and Yun, 2020).
- **Cerebral Perfusion Pressure (CPP)**: Maintaining optimal CPP is critical to prevent cerebral ischemia. This involves managing mean arterial pressure (MAP) and ICP to ensure adequate cerebral blood flow (Reilly and Bullock, 2005).

1.4.6.4 Pain Management and Sedation

- **Pain Management**: Effective pain management is crucial to prevent secondary brain injury. This includes the use of small doses of opiates and other analgesics to manage pain without significantly affecting the patient's neurological status (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; NICE, 2014a).
- **Sedation**: Sedation may be used to manage agitation and prevent further injury, but it should be carefully monitored to avoid adverse effects on ICP and CPP (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019).

1.4.6.5 Advanced Interventions

- **Impedance Threshold Device (ITD) Therapy**: Recent research suggests that ITD therapy may help in reducing ICP and improving CPP in head injury patients. However, further studies are needed to establish its efficacy in the pre-hospital setting (Kiehna *et al.*, 2013; Hansen *et al.*, 2021).

- **Tranexamic Acid (TXA)**: The use of TXA has been incorporated into guidelines following the CRASH-3 trial, which demonstrated its effectiveness in reducing mortality in patients with traumatic brain injury (Joint Royal Colleges Ambulance Liaison Committee, 2020).

1.4.6.6 Guidelines and Protocols

- **NICE Guidelines**: The National Institute for Health and Care Excellence (NICE) provides comprehensive guidelines for the assessment and management of head injuries, including recommendations for imaging, monitoring, and treatment (NICE, 2014a).

- **JRCALC Guidelines**: The Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidelines offer specific pre-hospital guidance for paramedics, emphasising the importance of clinical observations and the use of protocols to guide treatment decisions (Joint Royal Colleges Ambulance Liaison Committee, 2021a).

These best practices provide a framework for paramedics and other healthcare professionals to deliver evidence-based care to head injury patients, ensuring timely and appropriate interventions to improve patient outcomes.

1.5 Theoretical Framework

This theoretical framework will consider quality improvement and implementation science to understand the implications throughout the research analysis and discussion of findings as this research aims to understand how reflective practice can contribute to understanding the need for quality improvement and implementation. However, the research design has been guided by mediated discourse theory, also discussed in this subsection.

1.5.1 Mediated Discourse Theory

Mediated discourse theory (MDT), developed by *(Scollon, 2001c)* through his work in mediated discourse analysis, has three main principles.

1. **Principle of Social Action**: Discourse is most effectively understood as social actions rather than systems of representation, thought, or values. (Scollon, 2001c)
2. **Principle of Communication**: The term 'social' in 'social action' signifies a shared system of meaning. For an action to be social, it must be communicated. (Scollon, 2001c)
3. **Principle of History**: The term 'social' also implies 'historical,' indicating that shared meaning arises from a common history or past. (Scollon, 2001c)

MDT is recognised as sharing these theoretical principles with interactional sociolinguistics, linguistic anthropology, critical discourse analysis, new literacy studies, socio-cultural psychology, and sociology of language and practice theory. However, distinct from these other theories MDT focuses on the mediated action as the unified unit of analysis and thus creating a central theoretical position. MDT like Activity Theory, formulated by Russian cultural psychologist Lev Vygotsky, recognises that all social actions are mediated through identified means or tools, whereas Mediated discourse analysis focuses on the role of discourse in mediating these social actions. Moreover, specific to MDT is the focus on analysing ‘real-time’ social actions through the recognition of their intersection between practice, discourse, technology and analysis (Scollon, 2001c).

1.5.2 Introducing Quality Improvement

The term 'Improvement Science' emerged in order to describe research into the effectiveness of methods used within quality improvement (The Health Foundation, 2011a; Chatfield, 2020). Quality Improvement has a much longer history which is thought to have originated back in the early 1900's with W. Edwards Deming credited as the 'father' of quality improvement, specifically as a result of his work leading to the creation of the 14 principles of quality improvement, now recognised as the foundation for all work within improvement science (The Health Foundation, 2011a; Evans, 2020b).

Quality improvement is the systematic approach to identifying improvements in processes (Swanwick and Vaux, 2020b). Several models exist within Quality Improvement and a few key models have been suggested as transferable to healthcare quality improvement; such as lean methodology, model for improvement, six sigma and experienced-based co-design (EBCD) (Evans, 2020b).
Despite quality improvement having a specific 'healthcare' focus in recent years, contributed too through improvement science, there is still a recognised motivation among staff to act when services are thought to be insufficient or varying from others, without necessarily first considering the evidence, effectiveness, risk or cost of proposed changes and as such the end result can lead to the opposite effects intended thus further negatively impact on productivity and quality of services delivered (Marshall, Pronovost and Dixon-Woods, 2013; Swanwick and Vaux, 2020a).

1.5.3 Quality Improvement in Healthcare

To explore quality improvement in healthcare (QI), it is first necessary to understand what is meant by the term 'quality' and the history of, and theories within quality improvement. Quality is a term open to interpretation and is used in varying degrees within everyday language to either describe a set of desirable characteristics sometimes referred to as qualities or a person, object or event, or to declare the excellence of an object or event perhaps using a scale or against a set of aims, or simply the use of the term quality as an alternative to excellence (Swanwick and Vaux, 2020b). However, the term quality required further exploration relating to its common pre-fix use within process and change management. The resulting commonly used pre-fix terms are ‘Quality control’ used to describe the comparison of performance through internal benchmarks and standards, ‘Quality Assurance’ used to evaluate performance against external standards through means such as audit and finally ‘Quality Improvement’ used to describe systematic processes for improvement of quality, first described as the Total quality Management (TQM) approach (Swanwick and Vaux, 2020a; Alghamdi, 2018).

The Institute of Medicine defined six dimensions of quality, seen in Table 5, which can be viewed as aims or objectives by which quality can be achieved and measured (Institute of Medicine, 1990).

Table 5 - Institute of Medicine’s 6 dimensions of quality

Safe (avoid harm to patients from care that is intended to help them)
Timely (Reducing waits and harmful delays)
Effective (Evidence bases services producing a clear benefit)
Efficient (Avoiding waste)
Person-centered (Care which respects patients’ needs and preferences)
Equitable (Consistent quality regardless of patient characteristics)

These six dimensions are not a stand-alone list and similarities can be found in definitions and lists from other organisations, including NHS England and the World Health Organisation (WHO), both of which have a clear focus on healthcare being patient or person focused in a timely, efficient, effective and safe manner (NHS England, 2016; WHO, 2016). The dimensions and focus of the NHS, WHO and the Institute of Medicine do not however provide ‘aims and objectives’ to achieve quality. However the ‘No needless’ framework, created as an adaptation of the six dimensions of quality, lists five clearer objectives which could be used as a measure of performance or statement of objectives (Institute for Innovation and Improvement, 2005). The five objectives within this ‘No needless’ framework can be found in Table 6 below.

Table 6 - No Needless Framework

1. No needless deaths
2. No needless pain or suffering
3. No helplessness in those served or serving
4. No unwanted waiting
5. No one left out

QI in healthcare has a patient centered focus on achieving a safe, equitable, efficient, timely and safe service (The Health Foundation, 2013), however it is noted that not all healthcare services achieve these objectives, which on occasion leads to poor or even unsafe practice, with levels of harm reaching as high as 25% of patient admissions or interactions, with patients receiving only half of the appropriate care for their general condition (The Health Foundation, 2011b) (Francis, 2013). Contributing factors for poor patient outcomes have been categorised into three main sections; Human Factors, Clinical Complexity, and System Failures (Weingart *et al.*, 2000). Leading improvement within the NHS requires a general change in mindset to move away from reactive problem solving, managing patient volume, rewarding high performers, and managing individual who are poor performers, towards a focus on improving overall processes and systems, managing variability in systems, and dealing with chronic problems underpinning poor performance. Therefore, there remains the need to move away from firefighting to continuous improvement (NHS Institute for Innovation and Improvement, 2005).

A foundation for all improvement activities can be captured in a four-part model developed in 2002 by a health and social care working group across the NHS (Penny, 2003). The four parts are:

1. Involving users, carers, staff, and public
2. Process and systems thinking.
3. Personal and organisational development
4. Making it a habit: initiating, sustaining, and spreading.

The first part of this model has an emphasis on listening to the experiences and needs of staff and using a variety of techniques to bring these voices forward

(Penny, 2003), the Health Foundation support the concept that all staff have a role to play in continuous improvement of healthcare services (The Health Foundation, 2013).

Within QI, models such as lean methodology, model for improvement, six sigma and EBCD have proven to be transferable to healthcare and used with great success or were created specifically with healthcare in mind. However, these models vary in emphasis within overall QI process and the level of model knowledge and training required to utilise them (Swanwick and Vaux, 2020a).

1.5.4 Quality Improvement in the Ambulance Service

"Why settle for being the best ambulance service in your patch when we could be the best ambulance service in the world?" Erin Payne, Head of Quality Improvement Yorkshire Ambulance Service (Oates and Baines, 2019).

Many of the NHS ambulance trusts have a published Quality or QI strategy, thus suggesting this is recognised as an area of importance. However, as suggested in their varying titles and subsequent content, the main purpose of many of these documents is focused on the measurement of quality as opposed to the process of quality improvement (East of England Ambulance Service, 2018; London Ambulance Service, 2018; Yorkshire Ambulance Service, 2018; North West Ambulance Service, 2018; Welsh Ambulance Service, 2015; East Midlands Ambulance Service, 2020; South Western Ambulance Service, 2017; Isle of Wight NHS Trust, 2020; North East Ambulance Service, 2017).

Despite the previous mentioned publications suggesting some strategic focus on quality and QI within many of the UK ambulance trusts, the challenge emerges in bridging the gap between 'islands of innovation' and in this case linking separate services together in order to share innovation and spread change (Oates and Baines, 2019). However, this challenge can be met, as there is evidence to support the effectiveness of Quality Improvement Collaborative (QIC) within healthcare settings. However most examples of the work of QIC's do not include extensive details of QI or implementation process so it is difficult to fully understand the criteria their success may be based upon (Wells *et al.*, 2018).

In 2018, NHS England announced plans to fund a 12-month ambulance improvement programme, which led to the development of 'Project A', delivered in partnership by The Association of Ambulance Chief Executives (AACE) and NHS Horizons. In designing 'Project A', the project team recognised the power of staff contribution to quality improvement and asked themselves the following:

"How could we speed up and broaden improvement if we worked with frontline teams and patients to identify and implement new ways of working that would add up to large scale change?" (AACE, 2018b).

In part, the answer to this question came through a technique in 'quality improvement' known as 'Accelerated design' or 'accelerated experienced based co-design' (Tollyfield, 2014; AACE, 2018b) The concept behind accelerated design is to gather together a group of individuals in one room based on the 'right principles', in this case, right people, to gather the right data, using the right process. In creating these events, it is suggested organisations can achieve several months of quality improvement activity in as little as one day, this principle within Project A is illustrated within Figure 3 below (AACE, 2018b).

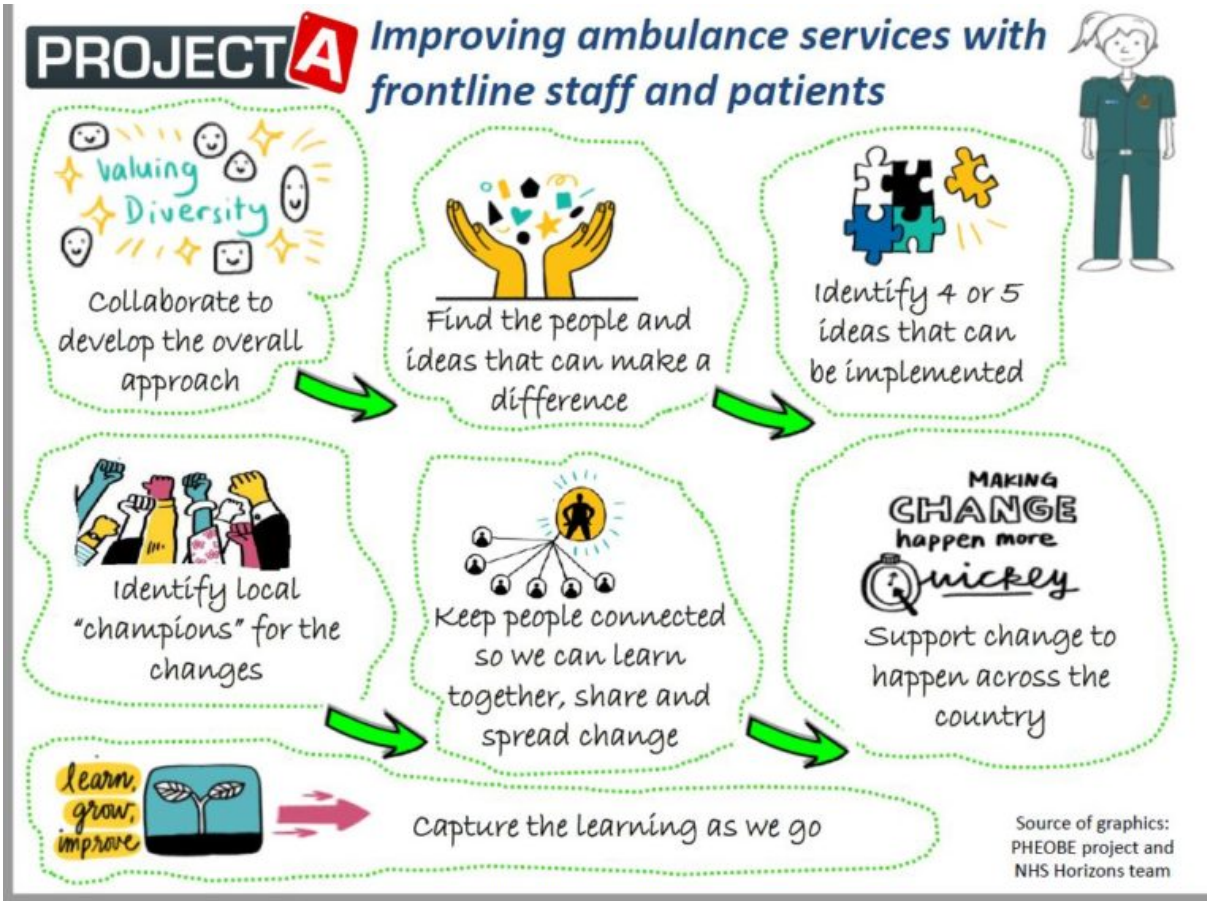


Figure 3 - Project A Concept (Improving Ambulance Services with frontline staff and patient (AACE, 2018b).

On the 28th of June 2018, an accelerated design event was held for Project A which generated 500 Quality Improvement ideas. The project then moved on to step two, which was led by a panel of experts over a two-day innovation burst event, which thematically analysed the initial ideas in order to prioritise subcategories of work which could be carried forward as shown in Figure 4 below (AACE, 2018a).

Figure 4 - Project A (Six ideas for progression)(AACE 2018a).

Shortly after the success of Project A, in 2019, the Ambulance Q project was launched aimed at enhancing and accelerating improvement across ambulance service boundaries. This project recognised the benefit of sharing experiences within ambulance service QI and aimed to raise awareness and engagement in QI across services and to establish UK-wide collaborative working to share improvement initiatives and tackle shared challenges (Turnbell-Ross, 2020). Building on the successful work of Project A and approved funding for project Ambulance Q, coupled with a desire to continue to network and share between leaders, the Ambulance Quality Improvement Network was founded in 2019 with support from NHS Horizons and representation from ambulance services across the UK (Oates and Baines, 2019). However, despite the successful funding application for project Ambulance Q, the project was paused in the very early stages due to the Covid-19 pandemic, with plans for project re-design in the future (Turnbell-Ross, 2020). Although the Ambulance Q project was not specifically related to Head Injuries, there are potential lessons to learn from the design of the method / process which could be utilised in the improvement of Head Injury Assessment and Management in pre-hospital care.

1.5.5 Evidence of the Need for Improvement

Current guidelines and practices for managing head injuries in the pre-hospital setting are inconsistent and often not fully adhered to. For example, the use of rigid collars, which do not provide effective immobilisation and can increase intracranial pressure (ICP), is still prevalent despite evidence suggesting harm (Davies, Deakin and Wilson, 1996; Mobbs, Stoodley and Fuller, 2002; Stone, Tubridy and Curran, 2010; Connor *et al.*, 2015; Leigh, 2017; Thompson *et al.*, 2021; Bazaie *et al.*, 2022).

Moreover, traditional clinical signs used by paramedics to assess head injuries, such as GCS and pupil assessment, are not always reliable and can lead to under-triage and under-treatment of patients (ter Avest *et al.*, 2020). This highlights the need for more accurate and non-invasive techniques to assess ICP in the pre-hospital setting.

1.5.6 Implementation Science in Healthcare

There is evidence to suggest that only two thirds of health improvement initiatives are successfully implemented and lead to the desired outcomes, as such there is a recognised need for these improvement initiatives to be co-designed and implemented with patients, stakeholders and staff in order to create a sustainable change (The Health Foundation, 2013).

A systematic review and meta-analysis of published literature between 1980 and 2011, was conducted in order to establish the reasons for failed organisational change (Mosadeghrad, 2014). The main findings are captured in Figure 5 below. This meta-analysis is then complemented by a systematic meta-review completed in 2020, which identifies common barrier in the implementation of clinical practice guidelines, a summary of those findings can be found in Table 7, adapted from the published article (Correa *et al.*, 2020).

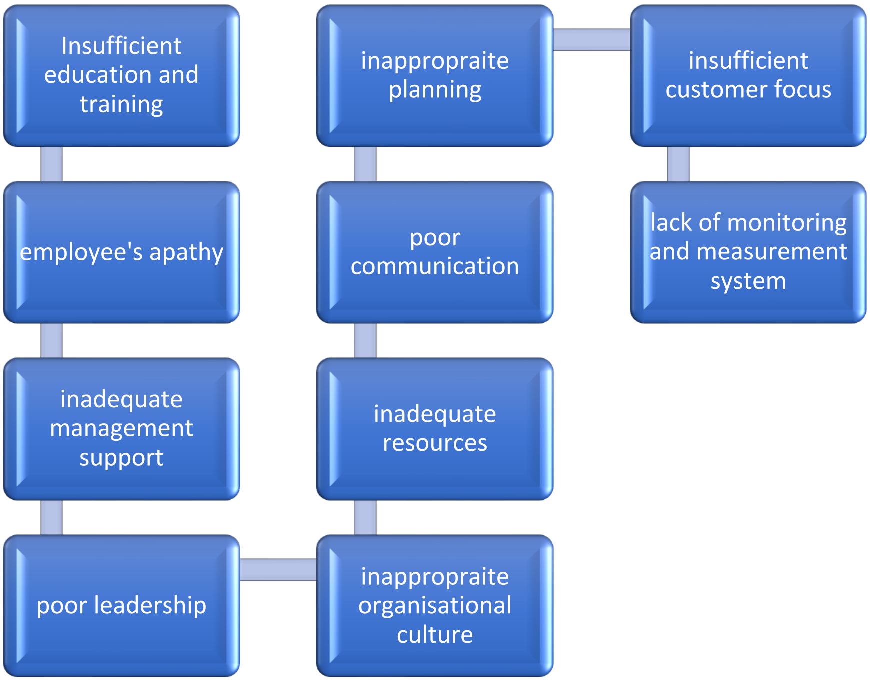


Figure 5 - Reasons for failed organisational change (Mosadeghrad 2014)

Table 7 - Common barriers to implementing clinical practice guidelines (Correa et al 2020)

Contexts	Barriers
Political and social context	• Difficulties in prioritising the health problem • Lack of access to information, lack of mechanisms and systems to support storing of information
Health organisational system context	• Lack of protocols and processes that clearly define the roles within the institution to implement guidelines • Additional workload • Difficulty accessing health services • Difficulties with availability of medicines • Deficiency in staff continuous education • Deficiencies in the referral of patients to services • Lack of skill and specialist knowledge within services • Insufficient support from institutions • High turnover of staff that prevents a continuous training process • Limitations of infrastructure • Lack of availability of interpreters in services • Lack of access to information, lack of mechanisms and systems to support storing of information
Guideline's context	• Lack of awareness of the existence of guidelines and clarity of guidelines • Beliefs that the guidelines evidence is incorrect or not enough to be reported • Beliefs that CPG is too rigid, may not always be practical and cannot be applied on a day-to-day • Guidelines restrict clinical judgment and challenge professional autonomy and limits treatment options
Health professional context	• Greater confidence in clinical experience than in guidelines recommendations • Lack of effective communication, research and self-learning skills • Resistance to change caused by disagreement with the recommendations of the CPG, doubts about the efficacy of interventions and clinical outcomes • Physician's reluctance to use CPG because of patient factors, self-belief or fear of complications • Little familiarity with guideline recommendations • Negative attitudes of physicians towards the implementation of the guideline or to EBM • Lack of autonomy and authority • Belief that intervention was not part of their role
Patient context	• Language and literacy problems • Lack of motivation, compliance, and knowledge to follow the recommendations • Patient comorbidities, mobility problems, polypharmacy, and self-empowerment capacity • Patients' financial situation and occupational status • Depression, anxiety, and fear

However, research conducted by the Health Foundation in 2015, recognised there was a gap between staff's awareness and knowledge of 'things' which needed to be changed, and their ability to influence or implement that change. The main barriers to successful change are explained in the roadmap developed by the Health Foundation and also depicted in Figure 6 below (Allcock *et al.*, 2015).

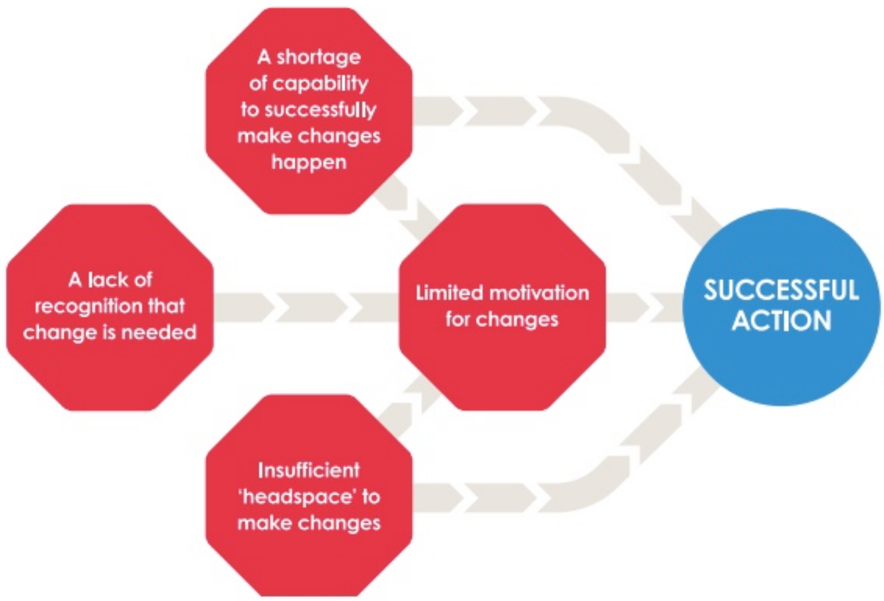


Figure 6 - Four barriers to making change in the NHS (The Health Foundation 2015)

However, the recognition of barriers to successful change is only advantageous if used to inform change through an implementation strategy. One of the main reasons for the gap between research and evidence-based practice is the lack of an implementation strategy including known barriers and enablers (Bach-Mortensen, Lange and Montgomery, 2018; Correa *et al.*, 2020). Implementation science seeks to identify reasons why evidence may or may not be translated into practice and provide the methodology and strategies needed to for successful uptake (Handley, Gorukanti and Cattamanchi, 2016). The gap between research findings and evidence-based practice has largely been due to the paucity in implementation science evidence (Proctor *et al.*, 2009), however this new field of science is now becoming more established and strategies more widely understood, specifically within the healthcare sector (Handley, Gorukanti and Cattamanchi, 2016).

1.5.7 Relating Clinical Governance to QI and Implementation Science

In order to fully explore continuous Quality Improvement in Healthcare, it is important to understand clinical governance, as among other objectives, clinical governance was designed as the main vehicle for achieving continuous QI within healthcare settings (Scally and Donaldson, 1998). However, as this sub section will demonstrate, there is a possible overlap of QI and Implementation Science within clinical governance and thus an important framework for consideration within this thesis.

The most widely used, cited, and recognised definition of Clinical Governance is found below:

> *A framework through which NHS organisations are accountable for continually improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence in clinical care will flourish. (Scally and Donaldson, 1998)*

The clinical governance framework at inception in 1998, focused on seven pillars or components. More recently the framework has been conceptualised as more of an 'umbrella' term which encompasses the pre-existing seven pillars but also features an expansion on the pillar previously titled 'openness' to cover the broader subject of organisational environment features such as strategic capacity and capability, cultural behaviour, leadership and teamwork (Marley, 2016; Public Health England, 2021). An adaptation of the original pillars to depict the transition of 'openness' to 'organisational environment' can be seen in Figure 7 below. Although the Organisational Environment would be considered part of 'Implementation Science' (Damschroder *et al.*, 2009), it is noted that organisational environment and culture are now recognised within clinical governance and as such there is a clear hybrid within clinical governance of both quality improvement, as noted in the definition of Clinical Governance, and implementation science as noted here.

Figure 7 – Adapted Pillars of Clinical Governance

This perceived overlap of ‘culture’ featuring within both improvement and implementation science, could be explained by the concept of ‘Continuous quality improvement’. Rather than a single change process, ‘Continuous Quality Improvement’ is a philosophy of change applied to a whole organisation, embedded within culture, leadership, and evidence base decision making (The Health Foundation, 2013).

Moreover, the overlap in clinical governance between improvement and implementation science can also be noted through the exploration of Evidence Based Practice (EBP). The ‘Research and development’ and ‘clinical effectiveness’ elements within Clinical Governance, form to create EBP and thus this subject is a component of improvement science. However barriers to clinicians introducing evidenced based practice into their decision making processes is an integral part of the newly emerging field of research referred to as ‘implementation science’ (Sadeghi-Bazargani, Tabrizi and Azami-Aghdash, 2014; Bauer *et al.*, 2015).

Although clinical effectiveness is originally listed as an individual pillar, it could be argued that clinical effectiveness is the embodiment of successful clinical governance through the implementation of research findings, education to disseminate research and safe practice and the application of risk management (NHS Executive, 1996). In achieving this, clinical effectiveness is in essence providing the right care in the right way to the right patient at the right time; a healthcare methodology known as ‘right care’ (DOH, 2004; NHS England, 2018b). As the ‘right care’ methodology looks to streamline the implementation of clinical practice to eliminate waste and error, thus only achieving the aims of ‘right care’, 'right time', 'right place', it could be argued that this methodology is strongly aligned with 'Lean Methodology' originating within industry but now successfully implemented within healthcare (Bicheno, 2008; Poksinska, 2010; Gupta and Jain, 2013). Arguable therefore EBP, the implementation of research findings into practice, is a key element of clinical effectiveness and as such both clinical effectiveness and EBP could be seen as the connecting factors between clinical improvement and implementation practices (Dawes *et al.*, 2005; Curran *et al.*, 2012). In 2015 The Health Foundation published a report titled 'Constructive Comfort: accelerating change in the NHS'. This report aimed to identify key factors needed for implementing change within the NHS and identify barriers to achieving this. As a result of this work the report highlighted seven factors for successful change in the NHS. Although not directly described as a synergy between improvement and implementation science, the seven factors show a hybrid of both disciplines, as can be seen from Figure 8 below (Allcock *et al.*, 2015).

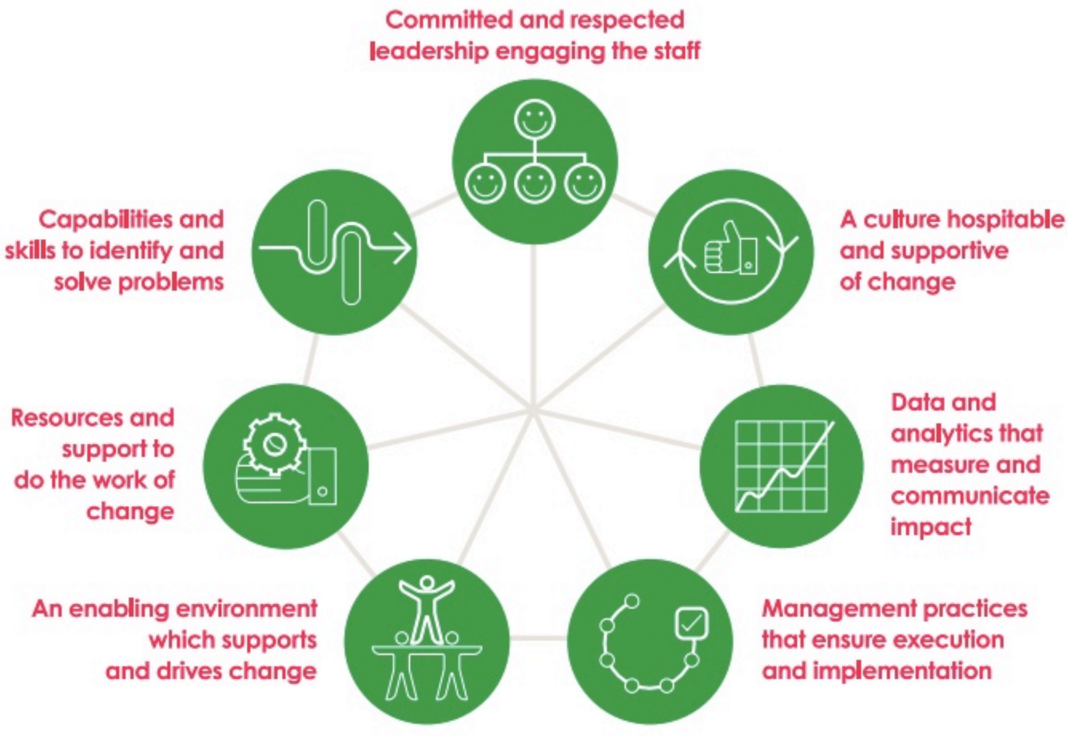


Figure 8 – Seven factors for successful change in the NHS (The Health Foundation 2015)

Implementation science expands on the pre-existing 'research and development' and 'education and training' pillar of clinical governance, to specifically address the methods of implementing research and evidence into evidence based clinical practice, thus improving clinical effectiveness and quality of care (Bauer *et al.*, 2015). Implementation science could therefore be argued as an extension of the clinical governance framework to achieve EBP. Moreover in 2012 a blended 'clinical effectiveness and implementation science' hybrid design was proposed in order to achieve a more productive implementation strategy, quicker gains and more useful information for decision makers in healthcare (Bauer *et al.*, 2015).

1.5.8 Clarifying Improvement and Implementation

In this thesis, improvement and implementation are used to address different aspects of enhancing paramedic practice in the assessment and management of head injuries.

Improvement Science (ImpS) focuses on increasing the adoption of existing evidence-based practices. This involves identifying current best practices and ensuring they are consistently applied in clinical settings. For example, improving the adherence to guidelines for head injury management, such as the use of appropriate immobilisation techniques and accurate assessment methods.

Implementation Science (ImpR), on the other hand, is concerned with introducing new evidence into practice. This involves evaluating new interventions or technologies and integrating them into clinical workflows. For instance, exploring the potential of new non-invasive techniques for assessing intracranial pressure (ICP) in the pre-hospital setting.

The research aims to address both aspects:

- **Increasing the Adoption of Existing Evidence**: By understanding the barriers to compliance with current guidelines and developing strategies to enhance adherence among paramedics.
- **Introducing New Evidence**: By evaluating the feasibility and effectiveness of new assessment tools and techniques, such as the use of optic nerve sheath diameter (ONSD) ultrasound for ICP estimation.

The phrase "in to" clinical practice refers to the introduction of new evidence, while "how paramedics practice" pertains to the adoption of existing guidelines and evidence. This distinction is crucial for understanding the dual focus of the research on both improving current practices and integrating new innovations.

1.6 Methodological Background

1.6.1 Ethnography and Virtual Ethnography

Ethnography is a recognised branch of anthropology. With origins in the late ninetieth century in cultural and social anthropology, the discipline expanded into sociology and other social sciences towards the end of twentieth century, in particular with the recognition of medical ethnography in the 1950's (Brewer, 2000; Rashid, Caine and Goez, 2015).
Ethnography has been acknowledged as a suitable methodology for identifying issues within healthcare, including paramedicine, in a natural context to allow for the study of organisations and group cultures. (Cooper, Endacott and Chapman, 2009). Unlike the more traditional forms of ethnography where the researcher will observe participants in their natural setting, i.e. 'during a clinical shift' where individuals are co-located, this PhD research has utilised a modified online ethnographic approach with a particular link to institutional ethnography. This allowed for the exploration of a healthcare system to allow for improvement in performance (Rowland, Manogram and Bourgeault, 2019).

Virtual ethnography, also known as cyber-ethnography, webnography or online ethnography, allows for the study of a culture or community through online social interaction (Dominguez *et al.*, 2007; Wang and Liu, 2021). It is important however to note the difference between virtual ethnography, which is understood as the ethnography of virtual space, and digital ethnography which is the use of digital tools to aid research through data collection and analyses (Hine, 2000; Beaulieu, 2004; Murthy, 2008; Puri, 2007). Social media is an important and ever-growing platform for professional interaction and CPD within healthcare (Batt, 2014; Richardson *et al.*, 2016; Higginson, 2017; Nelmes, 2012; Ventola, 2014; Chan and Leung, 2018), as previously discussed in Chapter 2, and as such both virtual and digital ethnography are relevant to understand the online world as a source of knowledge and interaction among healthcare professionals.

Early virtual-ethnographic researchers, such as Turkle and Stone, observed how individuals displayed an alternative personality online verses their offline worlds and this form of research was thought to lead to an understanding of how the internet would significantly change society (Robinson and Schulz, 2011; Turkle, 1995; Stone, 1991). However, it is noted that online research poses risk associated with individuals creating false personas therefore creating inaccurate results (Markham and Buchanan, 2012). Nevertheless, as the internet became more mainstream, this new approach to ethnography was seen as a recognised adaption of the more traditional methodology in order to study society through an alternative setting (Robinson and Schulz, 2011; Cora *et al.*, 2009). Subsequently Netnography started to become a more recognised term used specifically to express the concept of research activities focusing on the study of social interactions within digital communication texts (Kozinets, Dolbec and Earley, 2014). Netnography was first developed in 1995 by Robert Kozinets, a marketing professor, to analyse discussions online between Star Trek fans. Rather than interactions with participants as would be seen in anthropology, Netnography techniques set out to collect naturally occurring online communications which are then subjected to interpretive analysis, thus enabling the study of the interactions within a cultural setting (Kozinets, 1998; Kozinets, 2015). Moreover, computer mediated discourse analysis (CMDA) first conceptualised by Herring in 1994, aims to focus specifically on language use over networked devices, utilising a mediated discourse analysis approach (Herring, 2004; Herring, 2019). The concept on CMDA later developed into a methodological toolkit focusing on the analysis of ‘structure, meaning, interaction management and social behaviour’ within both the micro and macro level of online interactive exchanges (Herring, 2019).

Exploration of cultural practices and influences is now recognised as an important step in quality improvement process in order to bridge the pre-existing gap in analysis of stand-alone ethnographic studies and data collection for QI projects, this was recognised in a study in 2019 which developed a methodology specifically aimed at this combination approach termed ‘Quadangulation’ as shown in Figure 9 (Rodriguez and Hallas, 2019).

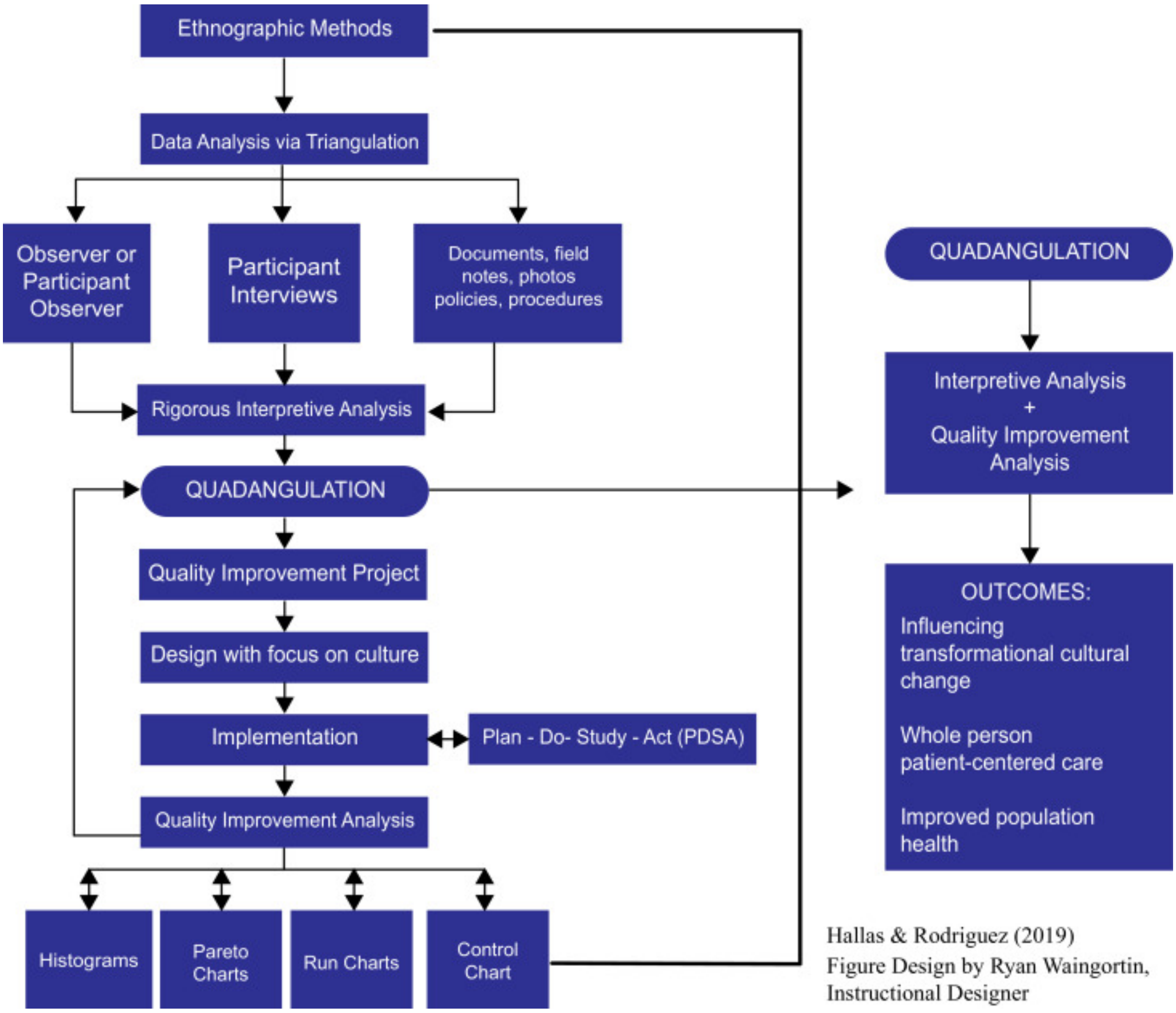


Figure 9 - Quadangulation Framework (Rodriguez and Hallas, 2019).

As with CMDA, the researcher has acknowledged the experiences of previous researchers within virtual ethnography but expanded this into the methodological theory of mediated discourse analysis in the design of this PhD research.

1.6.2 Mediated Discourse Analysis

Mediated discourse analysis (MDA) is therefore the specific form of discourse analysis within MDT, whereby discourse, agency and practice are mediated into a 'nexus of practice'. Unlike some other forms of discourse analysis, MDA focuses on discourse 'in' action as opposed to discourse 'as' action, in doing so researchers aim to enable the various discourse into practical application (Scollon, 2001c).

It has been suggested that MDA is a form of 'action research' as they share a philosophical and methodological approach applied within social science and both approaches are seen to immerse the researcher within the setting (Jones, Gold and Claxton, 2017; Scollon and de Saint-George, 2012). Action research attempts to simultaneously link data collection and analysis with change or problem solving in a collaborative approach, through the use of critical reflection enabling future predictions relating to organisational or personal change (Reason and Bradbury, 2013; Rowell *et al.*, 2015). However, unlike traditional 'action research', it is argued that MDA does not require additional research cycles given the rich nature of data collection and analysis within the nexus analysis approach (Jones, Gold and Claxton, 2017). Moreover, MDA has also been compared to Critical Discourse Analysis (CDA) focusing on the influence of wider social discourse on the individuals, and Conversational Analysis (CA) which more specifically explores linguistic construction (Scollon, 2001c; Scollon and de Saint-George, 2012). Although MDA also explores discourse in social practices, in contrast to CDA and CA the focus of MDA is on discourse as an action or tool in its own right, rather than as the outcome of an action and therefore could be argued as having greater capacity to explore how social practices are developed (Scollon, 2001c).

Exploration of cultural practices and influences is now recognised as an important step in quality improvement process in order to bridge the pre-existing gap in analysis of stand-alone ethnographic studies and data collection for QI projects, as such a study in 2019 has developed a methodology specifically aimed at this combination approach termed 'Quadangulation' as discussed further in section 1.6.2 (Rodriguez and Hallas, 2019).

The nexus analysis review in chapter 2 also explores the culture of paramedic practice, recognising the importance of social media and reflective practice, and the potential role both may play in quality improvement and change management within paramedic practice. Learning from past experience and incidents has previous been recognised within the aviation industry, and the analysis of data produced from the evaluation of such experiences has proven to be extremely useful in providing insight allowing for prevention of error and thus improvement in similar future events (Syed, 2015). In healthcare and paramedic practice, this type of data can be found in the form of reflections, professional development activities, supervision, debrief and audit. In recognition of the place for ‘learning from experience’ and ‘capturing the voice of staff’ in quality improvement, with a profession specific focus on reflective practice, the decision was made to adapt MDA and nexus analysis as the chosen methodology for this thesis.

MDA allowed the researcher to view reflection as an action as well as a form of discourse which could mediate action, rather than solely focusing on the linguistics within the text. In relation to this research the social actors are the paramedics and their associated clinical colleagues, the practice being investigated is ‘**the assessment and treatment of head injury patients**’. To analyse this practice and the mediated actions and chains of actions within, the data has been collected using reflective discourse ‘before’ ‘in’ and ‘on’ action.

Nexus analysis was used as the methodological approach to map and document the participants, social and mediated actions and resulting nexus and community of practice within this research. Nexus analysis follows three defined steps,(Scollon and Scollon, 2004b), through which the three phases were created:

1) **Engaging the nexus of practice.** The researcher was already engaged in the nexus of ‘paramedic practice’ as a registered paramedic. However, to better understand the practice of clinical decision making and reflection within paramedic practice, the researcher further engaged in the nexus of practice through a narrative review of literature, found in chapter 2, considering the following three areas of literature, ‘historical body’, ‘interaction order’ and ‘discourses in place’ as seen in Figure 10, and engagement in the nexus through the process of data collection. Further engagement in the nexus was then achieved through the three phases of research.

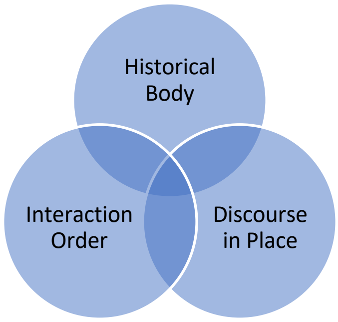


Figure 10 - Nexus analysis; areas of narrative focus to engage the nexus.

2) **Navigating the nexus of practice.** The researcher was able to analysis the discourse produced from the three individual phases utilising a modified MDA framework including content analysis and computer mediated discourse analysis.

3) **Changing the nexus of practice.** Finally, having navigated the nexus the researcher was able to make recommendations in the following areas:
   a. Contributions to nexus analysis and mediated discourse theory in relation to existing QI and Implementation frameworks.
   b. Contributions to theory and practice of clinical decision making and reflective practice.
   c. Contributions to QI and Implementation of clinical practice in head injury assessment and management and wider clinical paramedic practice.

1.6.3 Overview of Data Collection methods

MDA supports 'methodological interdiscursivity' through integration of various approaches to data collection and analysis. However the following four types of data are recommended within study design (Scollon and Scollon, 2004b).

1) Data that allows for exploration of what participants say they do.
2) Data that navigates analysis of member's interactions.
3) Data that allows for neutral observations.
4) Data that captures participants 'own experience'.

Measuring and analysing decision making can be achieved in several ways. These include the following two successfully utilised or commonly referred to methods; cognitive interviewing (including ‘think aloud’ protocols), and ‘active information search’ (Wolcott and Lobczowski, 2021; Shulte-Mecklenbeck, Kuhberger and Ranyard, 2011).

Taking into account the need to understand decision making in order to answer the ‘how’ and ‘why’ questions embedded within this thesis and to achieve a MDA methodology, a qualitative approach was deemed appropriate (Given, 2008; Scollon and Scollon, 2004b).

Qualitative research was first used in the early twentieth century by anthropologists and sociologists, with a subsequent growth in both the 1960’s and the 2000’s including methodologies such as ethnography and mediated discourse analysis (Holloway, 1997; Denzin and Lincoln, 2005; Scollon and de Saint-George, 2012). More recently, qualitative research is becoming recognised and more frequently utilised as a research paradigm amongst health-care professionals, (Green and Thorogood, 2017; Morse, 2012). This may be as it aids in the understanding of the phenomenon under study in the cultural setting within which the study is taking place, providing an understanding of health behaviors and lived experiences, thus helping to address the research aims and answer the research question in a way quantitative research may not (Renjith *et al.*, 2021; Al-Busaidi, 2008).

Qualitative data were collected in this PhD by applying four different methods across three phases. These methods included semi structured interviews, submission of written reflections, modified ‘talk out loud’ case studies and short questionnaires, as seen in Figure 11. All four qualitative methods in this research align to the process of reflection, ‘before action’, ‘in-action’, and ‘on-action’, and thus allow for the exploration of experiences through a reflective lens (Munby, 1989; Leijen *et al.*, 2014; Eraut, 1995; Loughran, 2009; Stephenson, Cronin and Whitehead, 2020).

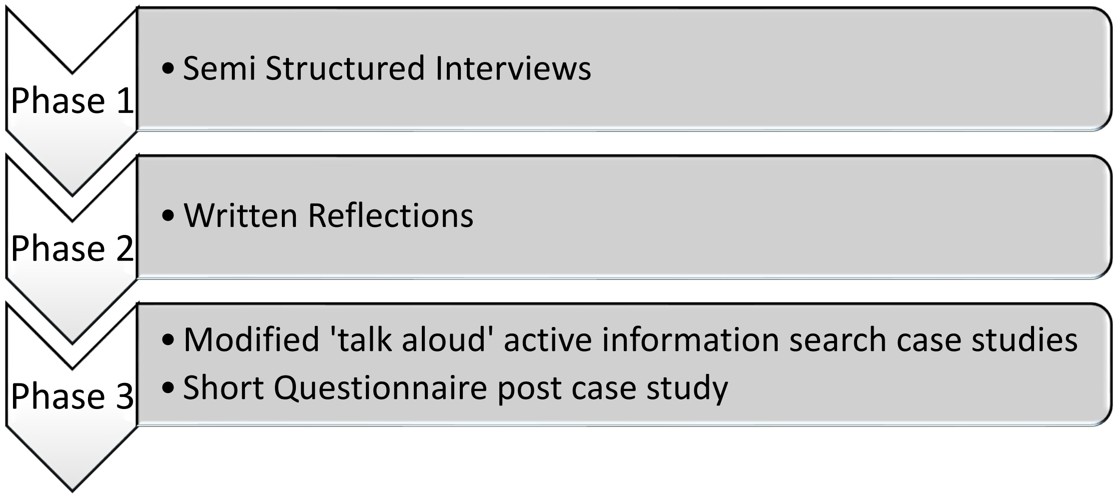


Figure 11 - Methods within multi-phased design.

To achieve the research aims and answer the research question the researcher used a combination of qualitative methods across the three phases as detailed below. These phases developed with an emergent design as the phase before was either in progress or complete. All phases are modeled on a form of reflection found within paramedic practice.

Phase 1 – Semi Structured interviews aimed at utilising **reflection 'before action**' to explore the current assessment and management of head injury patients amongst paramedics, where this knowledge comes from and perceptions, influences and attitudes regards change in practice and continuing professional development in this area.

Phase 2 – Phase 1 was initially analysed before phase 2 was conducted. This allowed for the adaptation of phase 2 considering the phase 1 findings. It was apparent from phase 1 that different aspects of head injury assessment and management held differing levels of importance to individual clinicians as did the focus areas of perceived challenges or difficulties. As such phase 2 was designed to utilise **reflection 'on action'** to allow for a greater exploration through analysis of paramedic reflections on head injury patient cases they had previously experienced.

Phase 3 – This phase utilises 'problem-based learning' to further explore paramedic thoughts on head injury assessment and management through a form of reflection **'in action'**. Once again, phase 2 was initially analysed before phase 2 was conducted. Having recruited both phase-1 and phase-2 participants through social media and having heard in phase 1 how social media influences continuing professional development, phase-3 was designed to further explore how social media plays a part in clinical practice relating to head injury assessment and management. This phase analyses how paramedics interact with four fictional head injury case studies in a 'closed' social media group setting within an open conversation amongst peers.

1.6.4 Problem Statement

The exact nature of the problem this thesis seeks to address is the potential inconsistent adoption of evidence-based practices in the assessment and management of head injuries by paramedics. There is a need to introduce changes into clinical practice or modify how paramedics practice to improve patient outcomes. This research aims to explore these issues through a multi-phased qualitative design, utilising mediated discourse analysis (MDA) and Nexus Analysis to understand paramedic decision-making and reflective practices.

1.7 Thesis Structure

This thesis is organised into eight chapters:

- **Chapter 1: Introduction** – Introduces the research problem, objectives, and significance of the study.
- **Chapter 2: Engaging the Paramedic Practice Nexus: A literature Review** – Reviews relevant literature, providing a theoretical foundation for the research.
- **Chapter 3: Ocular Nerve Sheath Diameter ultrasound and Impedance Threshold Device Therapy in the Assessment and Management of Increased Intracranial Pressure: A Systematic Review** – Presents a systematic review of ONSD ultrasound and impedance threshold device therapy.
- **Chapter 4: Methods** – Outlines the research design, data collection, and analysis methods.
- **Chapter 5: Analysis Framework** – Discusses the analytical framework used in the research.

- **Chapter 6: Findings** – Presents the findings related to current practices, decision-making processes, and reflective discourse.
- **Chapter 7: Discussion** – Interprets the findings, offering insights into quality improvement and implementation science.
- **Chapter 8: Conclusion** – Summarises key findings, contributions to knowledge, and recommendations for future research.

Chapter 2 – Engaging the paramedic practice nexus: A literature review.

There are three recognised steps within nexus analysis. One of these steps being ‘engaging the nexus’ (Scollon and Scollon, 2004b). Within this PhD study the engagement within the nexus has been both ‘pre’ and ‘during’ data collection, to allow for a focused methodology design and subsequent collection of data pertinent to the nexus under investigation.

Mediated action is the result of the coming together in any space or time of both ‘social action’ and the mediated means required to achieve that mediated action, this is known as the site of engagement, as depicted in figure 12 below.

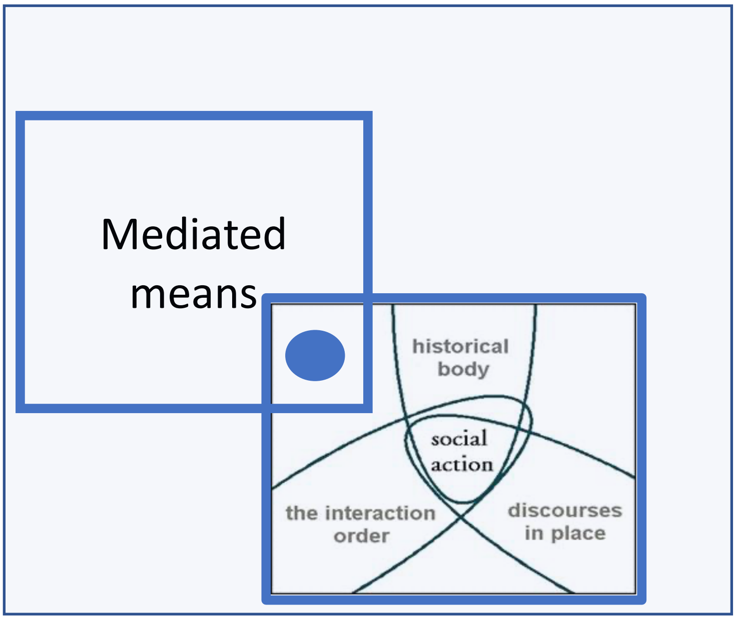


Figure 12 – Mediated Action Site of Engagement

As can be seen in figure 12 above, the social action within the site of engagement has three essential components. Thus ‘social action’ is recognised as the intersection between the ‘*historical body’* of the individual participating in the mediated action, the ‘*interaction order*’ of individuals engaging in or present within a mediated action and the ‘*discourses in place’* to enable a mediated action or mediational means (Scollon and Scollon, 2004b). Understanding the three essential components of social action through nexus analysis is important to later transfer this knowledge into any further analysis of the sites of engagement of any mediated action, subsequent chain of actions, resulting practice and eventually a greater understanding of the overall nexus and community of practice.

Therefore, to explore the nexus of 'Paramedic Practice, this chapter is sub divided into the pre data collection analysis of those previously discussed three components of social action, utilising the following structure:

- 4.1 Historical body
- 4.2 Interaction Order
- 4.3 Discourse in place.

2.1 Historical body

The concept of the historical body in nexus analysis is closely related to (Bourdieu, 1977) concept of 'habitus' (socially engrained habits, behaviors or skills). The historical body recognises that a participant's behaviour within a social action will be influenced by their previous experiences relating to the scene and any internalisation of discourses because of habit and practice (Scollon and Scollon, 2004b; Lane, 2014). Whereas the concept of 'habitus' acknowledges that dispositions may be shared by people with similar background or experiences, the concept of 'historical body' recognises that individuals participation in the social action is impacted by their unique interpretation of such previous experiences and discourses (Scollon and Scollon, 2004b; Lizardo, 2004). To explore the historical body within the paramedic profession, this sub section will analyse a brief history of the profession and structure of the NHS ambulance services (2.1.1) education and training (2.1.2) and technology within paramedic practice (2.1.3) all of which have seen significant changes and developments in recent history.

2.1.1 A Brief history of the paramedic profession and structure of the NHS Ambulance Services

To explore the physical structure of the NHS Ambulance Service model and to subsequently understand the overall organisational structure, it is first important to gain a broad understanding of the history of the paramedic profession in the UK.

In 1946, as a result of the National Health Service Act, it became the statutory responsibility of local county and borough councils to provide emergency ambulance services to their population, however this service could be sub-contracted if deemed appropriate (HMSO, 1946). The next significant piece of legislation to see change in the overall structure of UK Ambulance Trusts was published in 1973 during which time there were 142 existing Ambulance services in England and Wales. However, because of the National Health Service Reorganisation Act 1973, ambulance services were transferred from local borough / county council control to government control as part of the National Health Service (NHS). As a result of this reorganisation the services were consolidated from the original 143 to 53 regional or health authority ambulance services (College of Paramedics, 2020f; HMSO, 1979). Within the 1970's the Ambulance Service was also starting to see some significant changes in staff training and the start of an extended role later to develop into the role of the paramedic. This began with regional programmes, overseen with examinations and registration by the Association of Emergency Medical Technicians (AEMT), with Brighton delivering the first 'extended training course in 1971, including skills such as defibrillation, IV drug therapy and endotracheal intubation (College of Paramedics, 2020f; Briggs *et al.*, 1976). However the issues with costing, length, and structure of the courses, prevented the NHS from overseeing this as a national delivery and standard until 1985 when a national training programme was introduced by the Department of Health for 'extended trained' ambulance staff to convert to the new qualification, with the courses continuing the following year for all ambulance service personnel (College of Paramedics, 2020f).

Another significant restructure of NHS Ambulance Trusts was seen in 1990 under the provision of the National Health Service and Community Act. This change in structure saw the Ambulance services in England at this point in time reduce from 53 regional health authority services to 31 individual trusts (HMSO, 1990). As with previous decades there were also changes happening in training and education and the 1990's saw the move of paramedic education into higher education. Initially this provision of higher education was delivered as a distance learning conversion degree with Charles Sturt University in Australia and 40 paramedics from Northumbria Ambulance Service were enrolled, later graduating in 1997 with a Bachelor of Health Sciences degree (Lord, 2003). However only a year earlier in 1996, the first undergraduate degree in the UK was approved and delivered as a part-time programme for qualified paramedics at the University of Hertfordshire, two years later the same university was successful in having the first full-time paramedic degree programme approved (College of Paramedics, 2020f; University of Hertfordshire, 2017b). At the close of an important decade for the profession, paramedics voted ‘Yes’ in a ballot, to become a state registered profession (College of Paramedics, 2020f)

In 2000, only one year after voting ‘yes’ to become state registered, the next decade started with the requirement for paramedics to be state registered with the Council for Professions Supplementary to Medicine (CPSM) (College of Paramedics, 2020f; HPC, 2012). As the only profession registered by the CPSM, without the voice of a professional body, there then came the demand for the formation of such as movement (Whitmore and Furber, 2006). As a result Richard Lane and Stephen Dolphin, with support from Essex Ambulance Service, established the British Paramedic Association (BPA) in 2001 (College of Paramedics, 2020f; Furber, 2005). Later in this decade the profession saw a change in their registration and the professional body structure; the CPSM was replaced by the HPC in 2003 (later known as HCPC) resulting in the term ‘paramedic’ becoming a protecting title (College of Paramedics, 2020f; HPC, 2012). A year after the change in registration, the professional body also had a significant historical event with the change of name from ‘The British Paramedic Association’ to ‘The College of Paramedics’, a professional body which has continued to grow and develop the profession in numerous ways and registering as a charitable company in 2015 (Charity Commission For England and Wales, 2020; College of Paramedics, 2020f).

The early part of this decade also saw educational advancements, namely the first paramedic graduates with a BSc (Hons) in Paramedic Science in 2001 and the expansion of the higher education offer from the University of Hertfordshire in 2002, to now include the first UK Paramedic Foundation Degree (College of Paramedics, 2020f; Catterall, 2012). These further changes in education also led to the Quality Assurance Agency (QAA), releasing the first Bench mark statement for higher education in paramedic science in 2004 (College of Paramedics, 2020f; QAA, 2019). This benchmark was not the only document of significance to guide the content of the curriculum, as the COP complimented the QAA statement when they published the first version of the Curriculum Guidance and Competence Framework, then titled the ‘Curriculum Framework for Ambulance Education in 2006’; moreover, this framework also included the first career guidance for progressing into specialist, advanced and consultant roles, as seen in Figure 13 (College of Paramedics, 2020f; BPA, 2006).

Figure 13- British Paramedic Career Framework 2006 (BPA, 2006).

Structurally there had also been some significant changes by the mid 2000's, the most significant being the reduction of UK Ambulance Trusts from the pre-existing 31 individual trusts to 14 larger NHS trusts, as a result of the 'Taking healthcare to the Patient' report in 2005 and subsequent re-structures (Bradley, 2005). Of these 14 newly formed trusts, 11 trusts provided provision within England as can be seen in Table 8.

Table 8 - Post 2006 UK Ambulance Service Trusts

Ambulance Service	Year Established
East Midlands	1999
East of England	2006
Isle of Wight	2012
London	1965
Northeast	2006
Northwest	2006
South Central	2006
Southeast Coast	2006
Southwestern	2006
West Midlands	2006
Yorkshire	2006
Northern Ireland	1995
Scotland	1995
Wales	1998

Also important for the history of the structure of the profession, was the first employment or secondment of paramedics in 2002, within NHS Minor Injury Units (MIU) or GP Surgeries (College of Paramedics, 2020f). This expansion in the breadth of paramedic roles was closely followed in 2005 by the appointment of Andy Newton as the first Honorary Consultant Paramedic (College of Paramedics, 2020f).

As the profession moved from the later part of the 2000's to the 2010's, further developments in the profession were noted, many of which were guided by the COP but also influenced by the publication of the Paramedic Evidence based Education Project (PEEP) by the National Allied Health Professional Advisory Board in 2013. The PEEP stated the need for a greater standardisation of paramedic education, a fair access to funding for such education and an increase in the threshold for entry to the profession (College of Paramedics, 2020f; Lovegrove and Davis, 2013).

Importantly the HPC recognised the importance of continued professional development (CPD) in this decade and made this a requirement for renewal of registration in 2007. Nine years later in 2016, the COP were able to launch the British Paramedic Journal (BPJ) supporting the dissemination of profession specific research and CPD (College of Paramedics, 2020f; JPP, 2021).

In more recent times, specialist and advanced roles have emerged within pre-hospital paramedic practice, in an effort to meet ever increasing demands for the assessment and treatment of non-life threatening patient presentations requiring care within primary care, community and social care settings as opposed to an Emergency Department (NHS England, 2013). In recognition of the expanding breadth and depth of career options and roles in the paramedic profession, the COP launched their Career Framework in 2015 followed by their Post-Graduate Curriculum Guidance in 2018 (College of Paramedics, 2020f; College of Paramedics, 2018b; College of Paramedics, 2015). A significant advancement for the profession was seen in 2018 when Paramedics joined the list of health care professions able to qualify as Independent Prescribers with 430 paramedics having qualified as independent prescribers by February 2020 (College of Paramedics, 2020f; NHS England, 2018a; Best and Taylor, 2021). It was anticipated that this landmark event would create new pathways for patients to receive care, however this is not yet being fully realised, although it is noted that there is greater scope to achieve this with further recruitment of paramedics outside of the ambulance service into services such as NHS 111 (Best and Taylor, 2021). However arguably this move of workforce will make it more difficult for the ambulance service to provide a 'see and treat' service in the future if advanced paramedics are not retained in the service; a genuine risk associated with a mismatch of paramedic capabilities and opportunities within the ambulance service to use this skill set (Newton, Hunt and Williams, 2020). That same year, in 2018, the profession also saw the entry to HCPC registration raised to BSc Honours level, a recognition of how far the profession has developed over the past 50 years (College of Paramedics, 2020f; HCPC, 2018).

2.1.2 Education and Training

Education and training are strongly identified as key components to achieving clinical governance. For clinicians to remain current with their clinical practice, there is a clear need for their education to continue beyond initial undergraduate education, both to avoid skill and knowledge decay, build on the foundations of knowledge and to acknowledge that previous education may soon become out of date with the emergence of new research findings (Collin, Van Der Heijden and Lewis, 2012; McMahon, 2017; Dymoc and Tyler, 2018). There is therefore an expectation within professional and regulatory bodies, that clinicians will engage in Continuous Profession Development and evidence this when required (HCPC, 2021a; College of Paramedics, 2019b; HCPC, 2021c; Royal College of Nursing, 2021).

Paramedicine is still relatively new within Higher Education. In fact, the term ‘Paramedic’ and the profession as we recognise it today has, it could be argued, as having a short history in comparison to some other Health Care Professions (Royal College of Nursing, 2024; College of Paramedics, 2020f; GMC, 2022; Richardson *et al.*, 2015). Traditionally Paramedicine was considered a vocational career (College of Paramedics, 2008); however, contemporary discussion had supported the need for ambulance service training to evolve and move into Higher Education (College of Paramedics, 2008; Association of Chief Ambulance Officers, 2011; Department of Health, 2005).

Some of the more recent advancements within Paramedicine have centered on the autonomy of providing clinical care, from the diagnostic process through to treatment and discharge. In recognition of the change in pre-hospital care, from being seen as the ‘transport wing’ of the NHS to clinicians in their own right, Paramedics became part of the Health Professions Council (HPC) register shortly after their formation in 2002; now known as the Heath and Care Professions Council (HCPC, 2021b). Paramedics and Operating Department Practitioners (ODP’s) were an exception to the rule as all other professions on the register had a minimum academic requirement of a bachelor’s degree with honors. Paramedicine and ODP’s however were set at Diploma level; this was, in the most part, due to Paramedic education sitting outside of Higher Education (HCPC, 2018; National Careers Service, 2020). The vocational course provided ‘in house’ by Ambulance Services was created and regulated by the Institute of Health and Care Development (IHCD). The IHCD is a division of EXCEL which was formed through an amalgamation of the Business and Technology Education Council (BTEC) and the University of London Examinations and Assessments Council (ULEAC). BTEC and ULEAC has an established history in further education and whilst the IHCD Paramedic course was seen as being effective for teaching more surface learning task orientated skills which may have been suitable at the time of development, it later became recognised that the course was not allowing for more critical reasoning skills to be developed or deep learning with true understanding of the subject matter (Emms and Armitage, 2010). There was also the issue of the Paramedic curriculum growing in terms of the amount of knowledge required to meet the expectations of the profession and needs of the general public (Petter, 2012). In 2005 the Department of Health (DOH) in a publication titled ‘Taking Healthcare to the patient: Transforming NHS Ambulance Services’, recognised that in order to make advancements in diagnosing, treating and discharging patients within Paramedicine, a move towards more recognised competencies and higher education would be necessary (Department of Health, 2005). Within four years of the aforementioned DOH report being published the Paramedic profession had over 20 institutes offering Higher Education Paramedic Courses (Gregory, 2009). It is now possible to graduate with a pre-registration paramedic MSc for those already holding another healthcare registration, with the University of West London being the first to accredit such a programme (Univeristy of West London, 2019). Moreover, it is also possible to obtain a dual registration MSc in both nursing and paramedicine, showing how much education in paramedic practice has evolved to the present day (Edge Hill University, 2022).

2.1.3 Technology within Paramedic Practice and NHS Ambulance Services

As paramedic practice has changed over the centuries so has the technology supporting this practice. As well as the consideration of education needed to support the use of new technology within clinical practice, the main challenge behind technological advances throughout the past 50 years, and still present in today’s pre-hospital paramedic practice, is the ability to transfer healthcare technology to an out of hospital environment with issues such as storage space due to size and / or weight issues, power supply, internet connection, license for use, purchase or maintenance costs and the age and reliability of the vehicle to cope with extra demands (NHS Improvement, 2019; Carter, 2019). However, these challenges are being defeated increasingly, as technology improves, and ambulance services vehicles specifications are standardised and regulated (NHS Improvement, 2019; Hunt, 2013). One of the most recent technology advancements within a road ambulance, is seen in the first UK specialist Stroke Ambulance, providing mobile CT Scans / contrast, carotid ultrasound, blood and culture tests and thrombolysis among other interventions and investigations; advancements which may not have been thought possible only a few years earlier when most ambulances had little or no diagnostic imaging technology (Stannard, 2021; East of England Ambulance Service, 2020; Ebinger *et al.*, 2015). However, it is important to ensure advancements in technology are implemented in practice where they can enhance patient care and not at the detriment of clinical outcomes where implementation is simply because the technology allows for the advancement. Not all hospital based interventions or investigations may be advantageous in the pre-hospital environment and thus trials of such groundbreaking initiatives are useful in demonstrating improved clinical performance indicators, as demonstrated in the Mobile Stoke Unit trials mentioned above, through the reduction of thrombolysis time from 72 to 42 minutes (East Suffolk and North Essex NHS Foundation Trust, 2019). Although bringing diagnostic imaging and testing to the patient is an advancement in pre-hospital technology, there are alternative options to reduce the time from first contact to definitive intervention through the use of smaller and more readily available technology, such as the use of iPad tablets and telemedicine; however the pre-mentioned issues of connectivity reliability will need to be improved before the use of telemedicine can be fully relied upon (NHS England and NHS Improvement South East, 2020). Moreover, it is estimated that the use of telemedicine could save £300m in reduced ambulance dispatches and Emergency Department attendances and as such investments are currently being made in this area of technology advancement, including a project to ensure wearable devices with telemetry capability are made widely available to paramedic staff in the future (London Loves Business, 2020).

2.1.4 Analysis of Current Best Practices in Head Injury Management

Current best practices in head injury management are guided by established clinical guidelines and evidence-based protocols. This section provides a detailed analysis of these practices, comparing different guidelines and discussing their implications for paramedic practice.

2.1.4.1 Stabilisation and Initial Assessment

The initial assessment and stabilisation of head injury patients are critical steps in pre-hospital care. The NICE guidelines emphasise the importance of the ABCs (Airway, Breathing, and Circulation) to ensure the patient's airway is clear, breathing is adequate, and circulation is stable (NICE, 2014a). Advanced airway management techniques may be necessary to maintain airway patency and prevent hypoxia.
The Glasgow Coma Scale (GCS) is a widely used tool for assessing the level of consciousness in head injury patients. It helps determine the severity of the injury and guides further management. However, recent research suggests that GCS alone may not be reliable for categorising severe brain injuries, as patients' conditions can rapidly evolve (Fitzgerald *et al.*, 2022; Teasdale and Jennett, 1974).

2.1.4.2 Imaging and Diagnosis

Early imaging, particularly CT scans, is crucial for patients with risk factors such as anticoagulant use, signs of skull fracture, or a GCS score of less than 15 attributed to head injury. CT scans help identify intracranial haemorrhages, fractures, and other critical findings, enabling timely intervention (NICE, 2014a).

2.1.4.3 Monitoring and Management

Monitoring intracranial pressure (ICP) is advised in patients with severe head injuries. Techniques include invasive methods like ventriculostomy and non-invasive methods such as optic nerve sheath diameter (ONSD) ultrasound (Rosenberg *et al.*, 2011; Lee, Kim and Yun, 2020). Maintaining optimal cerebral perfusion pressure (CPP) is critical to prevent cerebral ischemia, involving the management of mean arterial pressure (MAP) and ICP (Reilly and Bullock, 2005).

2.1.4.4 Pain Management and Sedation

Effective pain management is crucial to prevent secondary brain injury. This includes the use of small doses of opiates and other analgesics to manage pain without significantly affecting the patient's neurological status (NICE, 2014a; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief

Executives, 2019). Sedation may be used to manage agitation and prevent further injury, but it should be carefully monitored to avoid adverse effects on ICP and CPP (NICE, 2014a; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019).

2.1.4.5 Advanced Interventions

Recent research suggests that impedance threshold device (ITD) therapy may help in reducing ICP and improving CPP in head injury patients. However, further studies are needed to establish its efficacy in the pre-hospital setting (Kiehna *et al.*, 2013; Hansen *et al.*, 2021). The use of tranexamic acid (TXA) has been incorporated into guidelines following the CRASH-3 trial, which demonstrated its effectiveness in reducing mortality in patients with traumatic brain injury (Joint Royal Colleges Ambulance Liaison Committee, 2020).

2.1.4.6 Guidelines and Protocols

The NICE guidelines provide comprehensive recommendations for the assessment and management of head injuries, including imaging, monitoring, and treatment (NICE, 2014a). The JRCALC guidelines offer specific pre-hospital guidance for paramedics, emphasising the importance of clinical observations and the use of protocols to guide treatment decisions (Joint Royal Colleges Ambulance Liaison Committee, 2021a).

2.1.4.7 Implications for Paramedic Practice

The implementation of these best practices in paramedic practice requires continuous education and training to ensure adherence to guidelines. Paramedics must be equipped with the knowledge and skills to perform advanced airway management, conduct thorough primary and secondary assessments, and make informed decisions regarding imaging and interventions. Additionally, the integration of new technologies and therapies, such as ITD and TXA, into pre-hospital care protocols may further enhance patient outcomes.

2.1.4.8 Conclusion

By analysing and comparing current best practices in head injury management, this section highlights the importance of evidence-based guidelines and their implications for paramedic practice. Continuous education, training, and the integration of new technologies are essential to improve the assessment and management of head injury patients in the pre-hospital setting.

2.2 Interaction order

Interaction order was first described by sociologist Erving Goffman, however, further work by R Scollon has allowed for interaction order to become recognised as the social and cultural setting in which the individual finds themselves when interacting with or interpreting the discourse in place (Goffman, 1983; Scollon and Scollon, 2003b). The analysis of the interaction order allows for a better understanding of how social and cultural settings may impact on the use of discourse and the resulting social action as a result of adherence to historically or culturally defined roles or rules of interaction (Hult, 2016; Multas and Hirvonen, 2019). For example, the interaction with clinical guidelines or interpretation of such clinical guidelines may vary dependent on whether the reading of such discourse is in silo, with peers, in an educational setting or during the delivery of clinical care to aid decision making. To explore interaction order within the ambulance service, this sub section will analyse organisational culture (2.2.1) and social structure (2.2.2).

2.2.1 Organisational Culture within the Paramedic Profession and NHS Ambulance Services

Organisational Culture was first introduced as a concept in 1951 by Dr Elliot Jaques after he published his case study findings in a book titled ‘The Changing Culture of a Factory’. The case study focused on the social life of an industry community and the description and analysis of the corporate group behaviour over two years (Hatch and Cunliffe, 2013; Jaques, 1951; Kummerow and Kirby, 2014). There are various definitions and explanations of organisational culture, which in essence can be summarised as, a set of shared assumptions, beliefs or values which contribute to shared behaviour or norms within an organisation (Ravasi and Schultz, 2006; Flamholtz and Randle, 2014) which serves therefore as the customary way of thinking or doing things (Jaques, 1951) that not only exists in practice but are also taught to newcomers (Schein, 2004), perceived by some as the corporate or organisation's 'personality' (Flamholtz and Randle, 2011).

Moreover, Deal and Kennedy in 1982 and subsequently Schein and Kotter in 1992, recognised that organisational cultures may have many co-existing and sometimes conflicting sub-cultures at company and team level (Schein, 1992; Deal and Kennedy, 2000; Kotter and Heskett, 1992). Regarding Paramedicine in the UK, there are arguably multiple subcultures, within the various ambulance trusts. However, there is also the potential for one overarching organisational culture developed over the history of the profession and unified through a joint sense of professional identity, recognised as important in health settings in order to create practice boundaries and reduce confusion within multi-professional teams (Brown, Crawford and Darongkamas, 2008). This professional identity can be defined as a shared set of knowledge, beliefs, attitudes, skills and values among members of a profession (Adams *et al.*, 2006). It is recognised that this professional identity is developed and re-defined over time with the influence of shared experiences and professional socialisation and starts as a student of the profession including any university experience, particularly in healthcare (Ashby, Adler and Herbert, 2016; Trede, Mackin and Bridges, 2012; Lasson *et al.*, 2016). This professional identity, within paramedicine, has been contributed to through core educational routes, familiar uniform with similarities across the UK, professional registration and other shared experiences or shared professional bodies, thus creating a society within the culture. Despite the progression of a profession's remit, flexibility and resilience being a necessity within healthcare and a point of celebration, the absence of a strong sense of professional identity can lead to a loss of professional boundaries and a sense of confusion within Multi-professional teams, and even the possibility of professions losing their identity and filling apparent gaps within service provision that may not be best suited to that particular profession (Turner and Knight, 2015; Matthews, Bialocerkowski and Molineux, 2019).

Alongside the impact of the College of Paramedics as an important contributor to professional identity, the professional body has also made a lasting contribution to capturing the story and history behind the profession's development (College of Paramedics, 2020f). Story telling is a key element to understanding an organisation or organisational culture as it captures the organisations 'narrative' thus creating an overall plot with characters, events and experiences inspired by real events expressing an organisations unique identity (Hatch and Cunliffe, 2013). As previously discussed, the ambulance service and paramedic profession have seen considerable development and change over the past 50 years and the work of the college of paramedics in preserving these stories is vital in future generations understanding this history (College of Paramedics, 2020f). It is important however to capture the stories of key individuals in the history of the profession, as well as factual timelines, such as Douglas Chamberlain for his contribution to the education of paramedics and thought of by many and the 'founding father' of the paramedic profession (Swindell, 2019), and Stephen Dolphin and Richard Lane for their work in founding the 'British Paramedic Association'(College of Paramedics, 2020f). It could also be argued that stories are being captured almost every day among the current workforce in the mode of professional reflections which could also form a rich narrative database within the paramedic profession (Murphy, Franz and Schlaerth, 2018). Moreover it is noted that the use of digital platforms have now enhanced the facilitation of story-telling in healthcare and expanded the scope of contributions to more easily include the story-telling of patients and service users as well as healthcare practitioners (Haigh and Hardy, 2011).

Alongside the college of paramedics, two other professional bodies are responsible for influencing the professional identity and culture of paramedicine in the United Kingdom, these are the HCPC and the Association of Ambulance Chief Executives (AACE) (HCPC, 2021b; HCPC, 2018; College of Paramedics, 2020f; AACE, 2011). However, any work by these organisations to develop the culture of the profession is also part of the wider NHS Culture which has been influenced recently by the publication of the NHS Peoples Plan and the NHS Long term plan. The full title of the NHS Peoples Plan is suggestive of the culture the NHS are trying to create and embed 'We are the NHS; People plan for 2020/21 – action for us all' with the report focusing on four key areas of 'people focus', 'belonging to the NHS', 'new ways of working' and 'growing for the future'(NHS England, 2019c; NHS England, 2020). However, these areas of focus also need to be looked at from a specific NHS Ambulance Service perspective to establish how this culture translates to this unique organisational environment.

In 2018 NHS England and NHS Improvement (NHSI) and the Ambulance Improvement Programme (AIP) supported the development of the 'Culture and Leadership Network for Ambulance Services' (CALNAS). This network reports, as a subgroup, to AACE (AACE, 2020b).
The formation of this network in 2019 was driven by three main influences, as listed below (Baines and Perera, 2020).

1) The strategic priorities of AACE, specifically Priority 3: *Strive to be an employer of choice,* with an underpinning theme of developing the culture of the ambulance service and Priority 6: *Promote the reputation of the sector,* with an underpinning theme of synergy to create a 'stronger together' ethos and to ensure the sector benefits from national programmes of work such as AIP.
2) The Ambulance Improvement Project known as 'Project A': A project delivered by NHS Horizons to improve ambulance services with frontline staff and patients, as previous discussed (AACE, 2018b).
3) Carter recommendations; with a focus on encouraging leadership at all levels, improving staff engagement, appraisals, and developing and embedding a enabling, supportive and appreciative culture (Carter, 2019).

The purpose of CALNAS is to ensure a national approach to creating a positive culture and overall improvement in the effectiveness of leadership within the sector, with the aim of enabling a move to a '*just culture'* within NHS Ambulance Services.

A just culture could be described as a 'no blame' culture, promoting 'openness', given that it has a system focus, which rather than punishing an individual who is deemed to be 'to blame' or at fault for a mistake, the 'just culture' aims to identify the issue within the system that led to that error or mistake (Catino, 2008; Baierlein, 2019). There is however still an emphasis on identifying willful 'wrong' behaviour which is dealt with through the appropriate disciplinary routes but where no knowing or willful under or poor performance has taken place, the just culture is designed to work with individuals who report issues or errors, in order to provide training if necessary and address system issues where needed, so learning can take place from each event (NHS Improvement, 2018; Behn, 2018). This approach to system thinking can create the opposite to a so called 'blame culture' by encouraging staff to participate in reflection, report issues in performance and systems where identified, and contribute to an overall safety culture within organisations (Khatri, 2009). Just cultures have been applied successfully within industry, aviation and healthcare, with the NHS recently publishing their own specific 'Just Culture' guide (Groeneweg, 2018; Harvey and Sotardi, 2017; Boyson, 2013; Balk, Stroeve and Bossenbroek, 2011; NHS Improvement, 2018).

There are three areas of focus within the CALNAS vision for a 'just culture', these are: a culture that promotes learning, a focus on quality improvement and leadership which is inclusive, compassionate, empowering, engaging and collaborative. In order to achieve this vision the network strives to identify opportunity for the sharing of, and collaboration on, new ideas and concepts pertaining to productivity and quality improvement, as well as the co-procurement of external leadership and organisational development (Baines and Perera, 2020).

2.2.2 Social Structure within the Paramedic Profession

Within social sciences, the term 'Social Structure' has been utilised since the 1920's with Philosopher Karl Marx credited with one of the earliest and most comprehensive theories regards this concept, 'The Marxian Class Theory' (Parkin, 1979; Andrew, 1983). At a very generic level, social structure can be defined as attempting to identify institutionalised norms within society groups and their individual members, defining the relationships present within groups of society and establishing the influence of patterns of behaviour on the social system and vice versa (Nadel, 2004). However, there are various subcategories of social science, firstly the sub divide of Macro and Micro structures allowing for the analysis of large groups across society such as political party structures, down to the more micro level of individual relationships within smaller units such as family (Amzat and Abdullahi, 2021) and secondly the sub categories of institutional or relational structures allowing for differentiating between expectations of behaviour between individuals and the relationships themselves (Lopez and Scott, 2000).

This subsection, therefore, will discuss some of the institutional and relational structures within NHS ambulance services, how these relationships may be formed, maintained, and contribute to organisational culture including subculture formation through smaller specific relationships addressing issues such as work based stress, burn out, minority group identity, career progression and peer-peer support networks.

The paramedic profession has many factors which could lead to the stress of paramedic employees, these include making difficult decisions under public scrutiny, in some cases being verbally and physically assaulted and the emotional stress's caused by difficult patient incidents such as trauma and death which may lead to post event psychological distress such as post-traumatic stress (Sterud, Ekeberg and Hem, 2006; Turner, 2018; Okeefe and Mason, 2010). However, in recent times work related stress in NHS Ambulance services can also be attributed to the change in structure and culture resulting from multiple transformation policies, alongside the introduction or revision of service delivery targets leading to perceived staff pressure to meet service response times and clinical performance outcomes (NHS England, 2019b; NHS England, 2019a; DOH, 2001; DOH, 2004; DOH, 2005). Moreover, these pressures are felt in a structure with less time between incidents for debriefing and social contact with colleagues in ambulance station crew rooms or 'stand-by points', combined with negative impacts of spending more time responding as a 'single response' as opposed to an ambulance crew comprising of two members of staff. The resulting impact of these work-related stresses are leading to an increase in staff sickness and 'burn-out' which in turn can present as a 'deadened conscience' and reduced level of compassion and care or an increase in staff leaving the service (Juthberg *et al.*, 2008). A recent study into resilience within paramedicine has noted management support, informal peer support and humour as important factors in building resilience to stresses within the service but recognises that due to shift work patterns and the demands on the service, these factors can be difficult to build into a working day or overall working practices (Clompus and Albarran, 2016). As recognised from the resilience study, it can be difficult for paramedics to find the time or ability to seek out informal peer support in a working day (Clompus and Albarran, 2016), however this type of support can be found in other forms within the wider profession, including the networking and sense of identity constructed through the professional body and social media forums (College of Paramedics, 2020f; College of Paramedics, 2009; Parameducate, 2016).

With the subject of ‘staff burn-out’ and ‘retention’ a cause for concern, resilience within the workforce has become a focus of interest and research. The notion of resilience as a dynamic process influenced both by internal and external factors in our personal and professional lives, has led to a greater understanding of how resilience can be nurtured within the external conditions of a social structure and not solely determined by the internal properties of the individual (Hunter and Warren, 2013; Luthar, Cicchetti and Becker, 2000). In the past decade, there has been a fluctuation in the overall number of paramedics employed within the United Kingdom (UK). At the start of the recent decade, there were approximately 20.5 thousand paramedics in employment within the UK, however by 2012 there had been a significant reduction in this number to approximately 17 thousand (Stewart, 2020). In 2018 there was a noted national shortage of paramedics with an estimated 1000 frontline vacancies across England, comprising of Paramedic and non-registered clinical roles. This shortage, thought to be contributing to ‘staff burn-out’, has led to an increase in the number of paramedics recruited into NHS England Ambulance Trusts from other countries, specifically Poland and Australia (Campbell, 2018), contributing to a rise again in paramedics employed in the UK to 18.7 thousand in 2020 (Stewart, 2020).

NHS Ambulance Trusts in the UK employed 164,720 members of staff in 2019, comprising of various clinical and non-clinical roles, of which some interesting demographics can be analysed to better under the social structure of the ambulance services and the paramedic profession. Of these 164,720 members of staff, 132,475 described their ethnicity as ‘white’, representing over 80% of the overall workforce. Recognising the small Black and Minority Ethnic (BME) representation in the workforce, The National Ambulance BME (NABME) group was formed in 2018, based on an initial initiative in London back in 2001, with an emphasis on promoting equality and equal opportunity for staff of all ethnic backgrounds within the service

(National Ambulance BME Forum, 2018). However, this is proving difficult with a low number of BME students recruited onto Paramedic degree programmes which may be influenced by the low number of visible BME staff already in the service, therefore a difficult culture to change (Farquharson *et al.*, 2017). Moreover, the history of the paramedic profession has always been male dominated and although this is changing, the breakdown of HCPC registered Paramedics in 2017 still showed a workforce comprising of a male majority with a figure of 15,466 compared to 9,496 females (HCPC, 2017).

The social structure provided through formal and informal professional relationships is quite specific within most ambulance services as historically this has been based on a pseudo military hierarchy and delivery model designed to meet service demands (Clompus and Albarran, 2016; Pollock, 2013; Newton, 2013). Until relatively recent times, the career trajectory of a Paramedic lay within the ambulance service, however with the recognition of the registered Paramedic status as an Allied Health Professional, the scope of career choices and progression has expanded into a more general NHS Career Framework. However, it is still commonplace for graduate paramedics to initially enter the ambulance service as 'newly qualified paramedics' and thus have at least some appreciation of the structure and culture within the service which could be argued as being built upon a modified military rank structure of career opportunities and lines of reporting and accountability (Newton, 2013; Pollock, 2013).

As previous noted, earlier in this chapter, there are now 11 NHS Ambulance Trusts providing services across England, all with a similar model and structure to meet the needs of the wider NHS and population through clinical commissioning frameworks (NHS England Centre Ambulance Team, 2018). The design of these services creates the very nature of teams and sub teams within each ambulance service, within which a particular culture may be present because of unique shared beliefs and actions. In particular common teams and subcultures may include services such as Air Ambulance Charities which are staffed by NHS Ambulance Service Paramedics, Hazardous Area Response Teams known as HART or Specialist Paramedics working with a specific focus on minor injury and illness which may include working in an environment other than the 'front line' provision of the service

(College of Paramedics, 2018b; Price, 2014; Dick, 2018; College of Paramedics, 2020e).

There are also many paramedics who progress in research and audit or education and management roles within the service, and as such are part of teams and subcultures specific to these departments. (College of Paramedics, 2018b; College of Paramedics, 2020e). A very successful Twitter hashtag was launched in 2017 '#notallparamedicsweargreen' to demonstrate the extent to which paramedics roles vary outside of the traditionally well-known public perception of paramedics wearing 'green' and working in the more well-known roles associated with working in 'front-line' ambulances (College of Paramedics, 2017). Within the ambulance service it is recognised that there may be issues around organisational and professional cultures and the differences in the way these subcultures are defined and behave. These differences are important to understand, given that the introduction of change within an organisation may be met with a strong professional culture, which may or may not support the implementation of such change thus the need to change cultures within the NHS as opposed to necessarily changing structures is a key consideration (Wankhade, Radcliffe and Heath, 2018).

Relationships between clinical specialty subcultures and teams can sometimes be seen as clinically hierarchical even if there is no official line of superiority and as such there can be a competitive nature or even strained relationships due to an elitist perception on either side, which ultimately can be seen as bullying in the workplace or the cause of clinical errors and subsequent patient harm (Green *et al.*, 2017). The contribution of pre-hospital teams from members outside of the ambulance service is also a contributing factor to these subcultures. However, the specifics of this multi-professional influence can be unique to each team or sub-culture which once again can lead to a perception of clinical hierarchy, an example of which may be the presence of Doctors within Air Ambulance Crews. This can lead to a much closer working relation with medical staff than is experienced by most 'road crews', creating a sub-culture specific to the team and workplace as opposed to the individual professions, which may be beneficial to the learning and development of those involved (Braithwaite *et al.*, 2016; Tasselli, 2015). However it is noted that provision and availability of medical staff for air ambulances may vary across the country and thus provides an example of how subcultures can vary from service to service despite being based on one NHS service or commissioning framework (Hyde *et al.*, 2012). As previous mentioned the ambulance service has a visual rank structure and although visual uniform markings or colours can be argued as important within healthcare, especially for identification among patients and within multi-professional teams, it can also be argued that the use of such visual markings can cause strained working relationships by reinforcing a hierarchical culture (Timmons and East, 2011).

The aforementioned progression of staff through various departments within the ambulance service is seen throughout the profession and not just limited to department structures within Ambulance Trusts, examples of which can be found within acute NHS trusts, primary care and community providers with paramedics in various senior and advanced roles (Clarke, 2019; Eaton *et al.*, 2020; College of Paramedics, 2020e; College of Paramedics, 2017). However it is important to note that not all paramedics who have left the ambulance service have 'abandoned' or wish to 'abandon' the organisation, many may choose to explore 'rotational' options where available, which has been proven to improve staff retention and patient care (Turner and Williams, 2018). Paramedic career development is recognised in the College of Paramedics Career Framework and depicted in the career development 'bullseye' as seen in Figure 14 (College of Paramedics, 2018b). This concept of four pillars of practice, consisting of Clinical, Leadership, Research and Education, is not however a concept specific to the paramedic profession but rather a framework originating from Nursing and now most well-known for its use in Advanced Clinical Practice Frameworks, in particular the HEE Multi-professional framework for advanced clinical practice in England (Henderson, 2021; Health Education England, 2017). Within this framework Advanced Practice is defined as a level of practice requiring competence across all four pillars as opposed to progression in just one chosen discipline, however the overarching pillar and focus should remain within clinical practice with a flexible approach on combination depending on workforce need, as seen in Figure 15, adapted from the East Midlands Advanced Practice Framework (Health Education England, 2017; Health Education East Midlands, 2014).

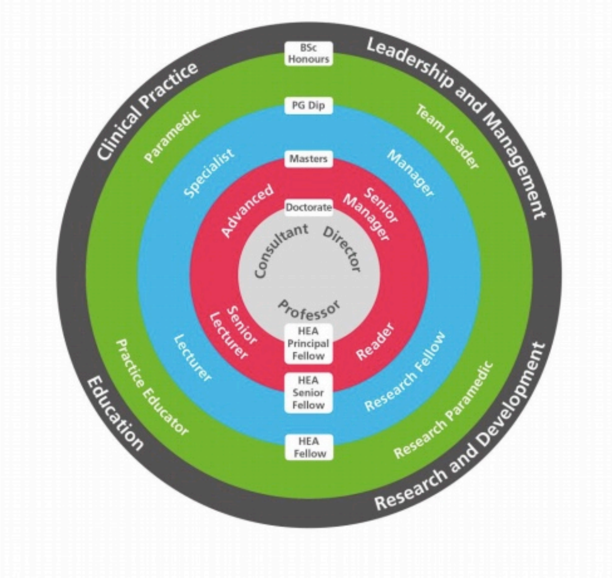


Figure 14 - College of Paramedics (2018), Paramedic Career Framework (College of Paramedics, 2018b)

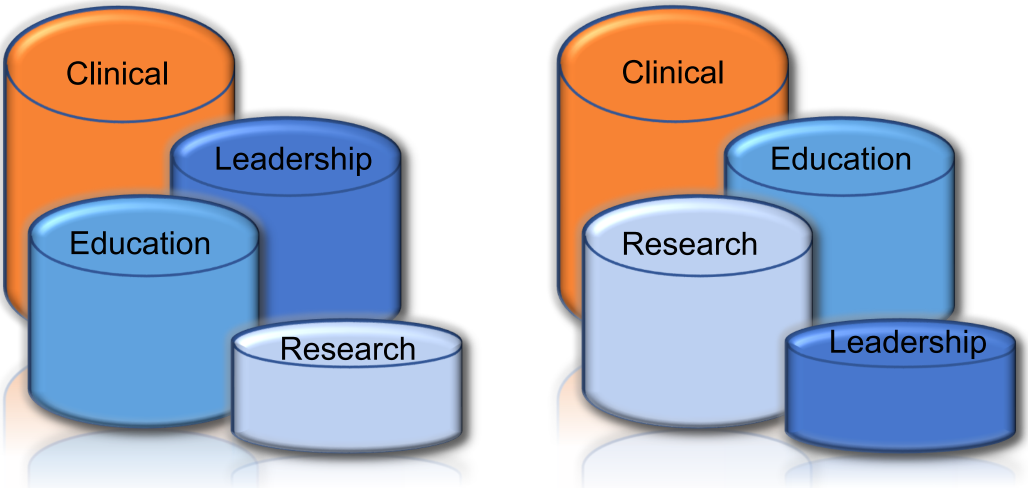


Figure 15 - Advanced Clinical Practice Pillars (Combination examples)

Despite the commonality with the College of paramedics Framework and the HEE Advanced Practice Framework, there is however an inconsistency in the message portrayed by the Paramedic Career Framework with regards to progression through clinical grades. As can be from the bullseye it is suggestive of Advanced Clinical Practice as a position of achievement senior to that of a specialist practitioner. The debate of where specialist or enhanced practice ends and Advanced Practice begins is not new (Leary and MacLaine, 2019; Cooper, McDowell and Raeside, 2019). However the HEE Advanced Clinical Practice Framework is clear that Advanced Practice is a level of clinical practice which can be achieved by a specialist or generalist practitioner and rather than viewing Advanced Practice on an axis with specialist practice, the axis should be between specialist and generalist, and novice and expert as seen in Figure 16 (Health Education England, 2017; Sabin, 2008; Benner, 1984).

Figure 16 - The Expert, Novice, Specialist and Advanced Axis (Sabin M 2008)

The potential misinterpretation of this hierarchical approach to clinical practice in paramedicine may be more specific to the ambulance service where 'specialist paramedic' is a commonly used title, with the title 'advanced practitioner' more commonly held by paramedics in roles within other healthcare settings. However, Critical Care Paramedics are now starting to use the title of Advanced Paramedic and as such the comparison and plotting of titles using the paramedic career framework may further ingrain the sub-cultures and elitist perceptions between clinicians. The work of HEE in the field of advanced clinical practice aims to address some of these inconsistencies in the use of titles, education standards and clinical governance through the framework, and a clear definition of advanced practice as seen in Figure 17 (Health Education England, 2017; Kindness *et al.*, 2019).

"Advanced clinical practice is delivered by experienced, registered health and care practitioners. It is a level of practice characterised by a high degree of autonomy and complex decision making. This is underpinned by a master's level award or equivalent that encompasses the four pillars of clinical practice, leadership and management, education, and research, with demonstration of core capabilities and area specific clinical competence. Advanced clinical practice embodies the ability to manage clinical care in partnership with individuals, families, and carers. It includes the analysis and synthesis of complex problems across a range of settings, enabling innovative solutions to enhance people's experience and improve outcomes".

Figure 17 - Advanced Clinical Practice HEE Definition (Health Education England 2017)

The work of HEE in this area also includes the introduction of 'the Centre of advanced practice' including a national educational standards at master's level, and a multitude of work stream projects with various professional bodies in order to create competency and capability frameworks including career roadmaps such as the Paramedic Roadmap for First Contact and Advanced Practitioners in Primary Care, thus ensuring progression from enhanced to advanced practice is a clear and governed process (NHS Employers, 2019; Health Education England, 2020a; Health Education England, 2021).

As discussed earlier in this section, the professional body is now the well-established 'college of paramedics' and has contributed various important guidance documents within the development of the profession while providing many other services to its members and the profession including a CPD platform and representation on various national forums and work streams. In the year 2020, the college represented almost 20,000 members across three tiers of membership which included associates, students and full members who have a Paramedic registration with the HCPC (College of Paramedics, 2020c). Continuing professional development has progressively moved into the virtual and online world and the College of Paramedics is an example of an influential organisation within the profession utilising such delivery (College of Paramedics, 2019a). However, the delivery of online CPD is not restricted to formal facilitation via professional or educational organisations and in fact the impact of social media on professional development is greater than traditional structured educational events. Social media may now be considered as a part of a profession or organisation's social structure and an overall contributor to the modern culture of the paramedic profession. As a recognition of the role of Twitter in the career of a paramedic, a reference guide was created by a paramedic researcher and educationalist explaining everything from 'what is twitter' through to 'how to use twitter for research and education' (Batt, 2014). Several paramedic specific sites exist for the social and professional networking of paramedics across social media platforms, many of which having a CPD focus, examples include @weparamedics which at the time of review has a followership of 7,391 (WeParamedics, 2012), also @paramedicsUK which is the Twitter handle for The College of Paramedics and at the time of review has a followership of 28.5 thousand, and a Twitter handle for most NHS ambulance services with some services having multiple handles including dedicated handles for research and education departments or individual specialist teams (College of Paramedics, 2009; London Ambulance Service, 2015).

The use of Twitter among healthcare professionals has also been proven to extend beyond networking and formal curriculum subject matter, to also include discussions on challenging issues such as sustainability and climate change from a profession perspective. One such discussion was seen to produce 996 tweets between 190 participants in one hour, a testament to the power of engagement and level of enthusiasm for such activities (Richardson *et al.*, 2016). The social media platform 'Facebook' also has several group pages aligned to paramedic social networking and CPD, examples include official pages designed by NHS ambulance trusts through to pages created by individuals and maintained on a voluntary basis such as 'Parameducate' a page designed for virtual peer education through case studies and other education material and at the time of review has 17.3 thousand members (Parameducate, 2016).

As a result of all Ambulance trusts now using social media on at least one platform, the Association of Ambulance Chief executives have now published ‘Best practice, benefits and guidance’ within these domains (Parameducate, 2016; AACE, 2019). As a result of the success of ‘Parameducate’ since its original launch through Facebook, the founders have now expanded the brand to include Twitter, YouTube, and branded products, further demonstrating the growth of these online communities (Parameducate, 2019; Parameducate Channel, 2017; Parameducate, 2016).

Although technology and social media is a driver for the profession, it must be used in a regulated and professional manner. In recent times there has become a trend within the profession known as ‘live tweeting’ where paramedics use Twitter to attempt to inform the public of the work conducted by paramedics within ‘front-line’ paramedic roles during a clinical shift (London Ambulance Service, 2015; Baron, 2017). Arguably this may be a practice influenced by successful ‘fly on the wall’ documentaries, such as ‘Ambulance’ a BBC One series or ‘Inside the Ambulance’ a W Channel series, both following NHS ambulance trust vehicles and staff in operation, thus creating a growing interest in the profession (South Central Ambulance Service, 2020; Owen J, 2021). However there have been concerns raised over the sharing of identifiable patient details in such posts and rather than creating a strong identity, and raising awareness of the profession, this use of social media has a danger of weakening the culture within the profession and damaging the social structure through this kind of unprofessional practice (Baron, 2017; London Ambulance Service, 2015). With the use of Twitter being recognised in healthcare as a professional platform for education, there is an argument that the professional use of such platforms should be included in higher education programmes as part of the promotion of engagement in social media as a form of professional development and to ensure appropriate and professional use (Higginson, 2017; Peck, 2014; Nelmes, 2012). A study in 2016 suggested that Nursing students benefitted from Twitter as an assessed component of their undergraduate degree, via greater awareness of digital professionalism, increased awareness of their profession and patient organisations, peer-peer support and networking and a sense of community within their profession (Jones *et al.*, 2016). However, a study comparing the incidence of professional conduct ‘fitness to practice' hearings in students receiving mandatory curriculum sessions on the use of social media, with those who did not, revealed no noticeable difference in outcome and thus the study supports the suggestion that the benefits to healthcare students engaging in social media for education, outweighs the possibility of associated inappropriate and unprofessional conduct (Jones *et al.*, 2021).

2.3 Discourse in place

'Discourse in place' refers to a wide range of discourses that may be present in a scene or social action either enabling or inhibiting actors to interact in that social action. The concept of 'discourses in place' may also be referred to as 'geosemiotics' within nexus analysis, as the subsequent analysis of mediated discourse in place allows for an understanding of key interfaces between semiotics and the physical world (Scollon and Scollon, 2003a; AL-Zydjaly, 2014). Therefore, the focus within nexus analysis is placed on those discourses which mediate action as a result of participants utilising them as a mediational means (Lane, 2014; Multas and Hirvonen, 2019). To explore discourses in place within the ambulance service, this sub section will analyse discourse relating to evidence-based practice (2.3.1), clinical decision making (2.3.2) research and development (2.3.3) information management and clinical audit (2.3.4) and reflective practice (2.3.5).

2.3.1 Evidence based practice.

Originating from Evidence based medicine (EBM), a concept first featuring in medical literature in 1991(Guyatt, 1991), Evidence Based Practice is defined through the following statement:

"Evidence-Based Practice requires that decisions about health care are based on the best available, current, valid, and relevant evidence. These decisions should be made by those receiving care, informed by the tacit and explicit knowledge of those providing care, within the context of available resources" (Dawes *et al.*, 2005, p. 1).

However, EBP is not only a concept enabled through elements of clinical governance such as education, research and clinical effectiveness, it is also a key feature of quality improvement as demonstrated in the 'IOWA Model of Evidence-based practice to promote quality care' (Titler *et al.*, 2001). In essence EBP alongside clinical decision making enables the implementation of quality improvement in healthcare, as without the transference of research to practice there would be no clinical effectiveness implementation among clinicians (Curran *et al.*, 2012). Moreover, identifying barriers to implementation of EBP could be adapted into a Continuous Quality Improvement framework (Solomons and Spross, 2010). Recognising research and clinical expertise as two elements are EBM or EBP are important, however a further recognised element is 'patient choice and values' (Dawes *et al.*, 2005; Sackett *et al.*, 1996) and as such, the patient could be considered as the final and most important stakeholder in achieving quality improvement within healthcare (Bastemeijer *et al.*, 2019).

The importance of patient choice and values within decision making was committed to in the NHS Constitution in 2009, and further recognised in the government paper 'Liberating the NHS: No decision about me, without me', however unfortunately not all staff feel able to fulfil this target within the restrictions or inefficiencies of the structure of the NHS or a perceived irrelevance, lack of need or patient want for such involvement (DOH, 2012; Buchanan, 2016; Coulter and Collins, 2011; DOH, 2009). Healthcare professionals are constantly making decisions whether regards a diagnosis, tests, treatment, or prevention. Their ability to make these decisions is based on their existing knowledge and the ability to recall and utilise this knowledge through the activation of cognitive processes, known as clinical reasoning. It is argued that professional competence is based on the ability to reason and therefore make appropriate clinical decisions, and paramedic practice is no exception (Schwartz and Elstein, 2008; Charlin, Tardif and Boshuizen, 2000; Norman, 2005). Paramedics are making sometimes difficult clinical and non-clinical decisions, that are not without risk and as such may be life changing for the patient and career changing for the paramedic (Poter *et al.*, 2007). These decisions are made all the more difficult as a result of the ever changing and developing role and profession, a changing patient demographic, and constraints on their paramedic practice as a result of organisational and logistically factors (McCann *et al.*, 2013).

2.3.2 Clinical Decision Making

Clinical decision making has been the subject of research now for several decades, originating with Elstein et al in in the late 1970’s (Elstein, Schulman and Sprafka, 1978; Norman, 2005). However, despite various research studies, it is still difficult to understand the cognitive process involved in clinical decisions, given its very nature as a cognitive event and thus difficult to measure or capture via many research methods. Given that some of the cognitive process is thought to perhaps be subconscious it is also difficult for the subject to describe, as they may not be fully aware of the decision-making process undertaken (Liljenstrom, 2022).

In the study of Human Problem Solving, it has long been argued that it is more important to understand how a person arrives at a decision than to understand the actual decision itself (Simon and Newell, 1971). Thus, understanding the cognitive processes undertaken during a clinical decision is key in the understanding of overall clinical decision making; albeit a clear challenge for the researcher (Schwartz and Elstein, 2008; Ilgen *et al.*, 2012; Epstein, 1999; Higgs and Jones, 2008; Eva, 2005).

Clinical decision making is often referred to within one of two categories termed as ‘heuristics’ or ‘Hypothetico-deductive-reasoning’ (HDR) this type of categorisation is explained in Johnathan Evans work on the science of reason , in which he expands on previously existing dual process theories to focus on human decision making (Manktelow, Over and Elqayam, 2011; Evans, 2020a). Evans dual process theory considers decision making as either heuristics or analytical in process, work later expanded upon by Daniel Kahneman in 2003 to describe type 1 and type 2 process’s where decisions are either made through an immediate intuitive process or in a longer more purposeful process of deliberation (Wason and Evans, 1975; Kahneman D, 2003). Heuristics recognises that some decision making may be felt to be based on ‘gut feeling’ or ‘instinct’, however HDR attempts to breakdown the decision-making process into various steps, thus allowing the clinician to understand their decision ‘in’ and ‘on’ reflection, and for colleague’s and service users to also benefit from an understanding of the decision-making process when required (Del Campo *et al.*, 2016; Gigerenzer and Gaissmaier, 2011; Buckingham, 2008; Pearson, 2013). The process of HDR is made up of ‘cue acquisition’, hypothesis generation’, ‘data interpretation and hypothesis testing’ and final decision making (Tanner *et al.*, 1987; Tariq, 2015). Within healthcare HRD is often achieved in a consultation model such as the Calgary-Cambridge consultation model allowing for the clinician to discuss the 'perceived problem' with the patient by 'taking a history', forming differential diagnoses, performing an examination or utlising investigations and suggesting a treatment plan (Kurtz, Silverman and Draper, 1998; Silverman, Kurtz and Draper, 1998). Moreover, this process should summarise with 'shared decision making' thus addressing patient health beliefs and therefore issues that may impact on compliance or concordance of agreed actions which may need to be revisited again if the course of action does not achieve the desired response (Main *et al.*, 2010; Kurtz *et al.*, 2003; Snowden and Marland, 2012).

In recent times, HDR has been adopted within healthcare to understand clinical decision making, however it had originated as a 'scientific method', utilised by scientists to create and test hypothesis (Lawson, 2015). The cognitive continuum as seen in Figure 18 below, attempts to create a comparison of techniques used to deduce differential hypothesis and diagnosis (Hamm, 1988), important components of the HDR process.

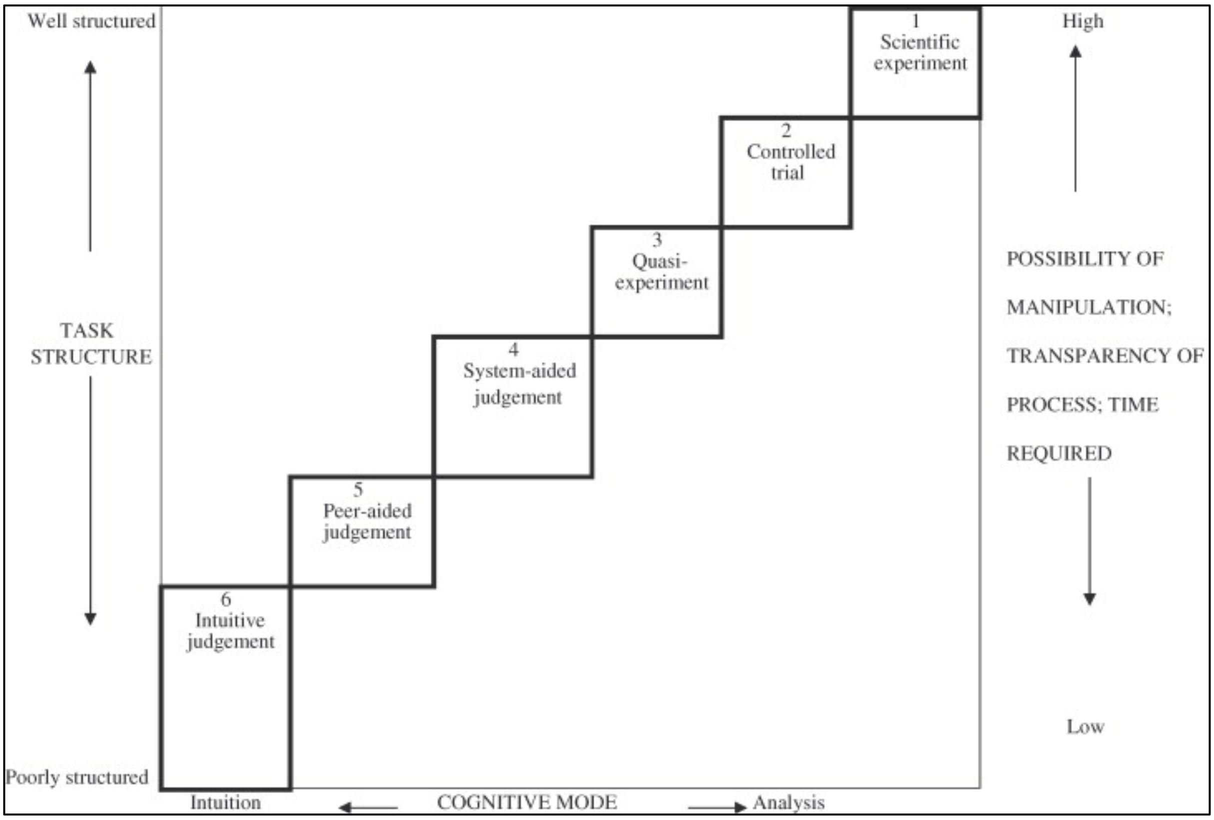


Figure 18 - Cognitive Continuum (Hamm 1988)

As the cognitive continuum depicts, the more analytical processes are thought to have the greater validity but require more time because of more complex processes (Dhami and Mumpower, 2018). The continuum is not designed to become a hierarchy of decision-making deductive processes, but rather a fluid spectrum which a clinician is recognised to move around dependent on the decision being made, the time pressures to make the required decision and the availability of resources required to move around the continuum (Custers, 2013; Gladstone, 2012). For example, a paramedic working in the historically traditional environment of a ‘frontline’ ambulance, would not have the necessary time, training, processes or equipment at their disposal to utilise steps 3, 2, or 1 but may benefit from the findings of such steps within previous research which is now available to them through clinical guidelines, protocols, or formularies, which would be considered step 2 (O’Hara *et al.*, 2015; Perona, Rahman and O’Meara, 2019; Mason and Nixon, 2013). Moreover, the emergency clinician may be pre-deposed to anchoring, availability or premature closure bias due to previous specific exposure, experience, and education (Hartigan *et al.*, 2020). Their differential diagnosis list may be based on clinical severity rather than likelihood, to manage the worst-case scenario first, referred to as ‘shot-gunning’ or ‘the ‘Casablanca strategy’ (aka rounding up the usual suspects) (Croskerry, 2011; Koivulahti, Tommila and Haavisto, 2020). This worst-case scenario may be treated based on clinical presentation as opposed to detailed and lengthily diagnostic testing (Klein, Orasanu and Calderwood, 1993). However, as paramedics move into roles outside of the ambulance service such as primary care, they may widen their use of the cognitive continuum as the types of decision they make will vary in terms or time pressure, the environment in which they work, the peer support available from senior clinicians and the availability of ‘point of care testing’ or referred diagnostic testing and patient review (AACE, 2020a; Eaton *et al.*, 2021; Blanchard *et al.*, 2019; Will, 2021).

Peer-aided judgement, ‘cross-checking’ or ‘double checking’ is common placed within healthcare and medicine, and where possible is encouraged, especially in emergency clinical decision making, as this maybe the highest a clinician can progress on the continuum in the restraints of time and access to diagnostic processes, however this may lead to specific forms of decision making bias such as ‘compromise’ (Will, 2021; Hewitt, Chreim and Forster, 2016; Kellett and Gottwald, 2014; Freund *et al.*, 2018). Within the ambulance service this peer-aided judgement, mentorship or clinical supervision may come from officially recognised practice educators or often peer to peer among varying grades, including those of specialist and advanced clinical roles (College of Paramedics, 2018b; Hodge, Swift and Wilson, 2018; College of Paramedics, 2020b). However this level of peer support is also possible from non-registered clinicians working alongside the paramedic such as ‘emergency medical technicians’ or ‘emergency support workers’, as it is recognised that experience is valuable in decision making and should not be prioritised by a perception of clinical hierarchy (Will, 2021; College of Paramedics, 2018b; NHS, 2020). With the use of telemetry and health informatics, the availability of medical peer-aided judgement is now more readily available and can be utilised in a more structured process (Kim *et al.*, 2020b).

The result of HDR is not always to reach a definitive diagnosis but to make a definitive decision (Hyoung, 2019). The definitive decision may be the need to refer a patient to an appropriate clinician or pathway, with a reduced number of differential diagnoses allowing for the transfer or referral of that patient to be conducted in a safe manner with possible treatment before the handover or referral is complete (Blodgett *et al.*, 2021; Oosterwold *et al.*, 2018; AACE, 2020a). The ability to continue to narrow down the list of differential hypotheses in order to eventually reach a definitive final diagnosis will be dependent on the clinician’s scope of practice from novice to expert and specialist to generalist (Benner, 1984). This process can be summed up as the ‘line of capability’ as depicted in Figure 19 (Collen, 2018).

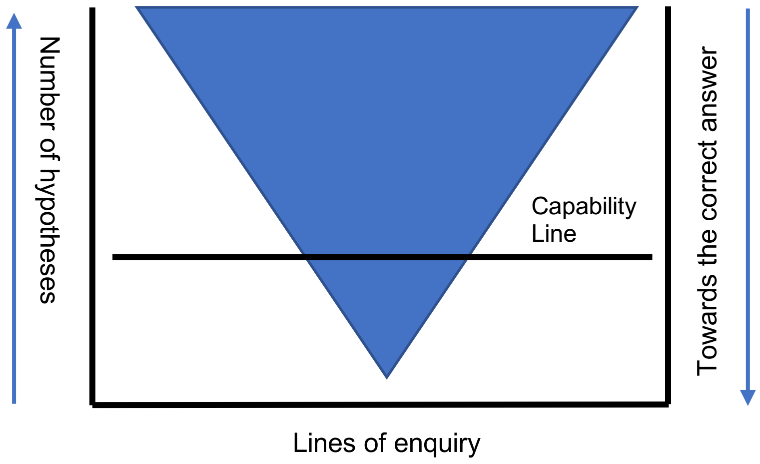


Figure 19- Line of Capability (Collen 2018)

As a paramedic within a traditional ambulance service, ‘front-line’ role, the clinician’s scope of practice maybe very generalist, even as a pre-hospital or critical care specialist, they are arguably still generalist albeit an ‘expert’ generalist in their scope of practice and as such the majority of their patients will still require ongoing referral (Benner, 1984; Collen, 2018). This level of autonomous practice and accountability for definitive diagnosis will vary and possibly increase among those paramedics working or seconded outside of the service or in rotational positions, given that the ability to recall and review patients or to order and interpret diagnostic test becomes more available within their scope of practice (Health Education England, 2021; Eaton *et al.*, 2020; Crouch and Brown, 2018).

As previous stated, the somewhat opposing category to HDR (Type 2 thinking), is Heuristics (Type 1 thinking), which attempts to capture decisions made on intuition or ‘gut instinct’, this is also sometimes recognised as, or referred to as, pattern recognition; in essence the more you are confronted with a similar situation the quicker you can make a decision based upon previous experience, or the more aided your decision making may be due to ‘fast & frugal’ decision aids (Tay, Ryan and Ryan, 2016; Marewski and Gigerenzer, 2012). This can either be argued as a sign of ‘expertise’ or as a form a decision-making bias which may possibly lead to decision making errors (Whelehan, Conlon and Ridgway, 2020). The success of heuristics is therefore dependent on hindsight and the reflection of previous decision making; this de-biasing of heuristics may be possible through simulation based training (Whelehan, Conlon and Ridgway, 2020; Altabbaa, Raven and Laberge, 2019). Heuristics or cognitive shortcutting is not specific to clinical decision making and can be seen in almost all forms of daily activity because of the learning process, for example the difference between the conscious and sub-conscious thought required to tie a shoelace or drive a car, from the first time this process is conducted through to the process in the hands of an expert. Moreover, the simplest decision is also thought to be the 'most likely', a concept referred to as 'Occam's Razor' (Wardrop, 2008). Much like the process of driving a car, cognitive shortcutting, in any form, can fail when assumptions are made, and decision-making error is increasingly likely when shortcutting or intuition is used when confounded by other human factors that may contribute to decision making bias or error (Kelly, 2020; Hartigan *et al.*, 2020).

Despite an understanding of clinical decision-making processes, through either heuristics or HDR, there are still decision-making errors or bias and the majority of these can be attributed to 'human factors. In previous years, there was a trend of comparison between healthcare and aviation 'human factor' management. This comparison was in part due to the aviation industry having successfully reduced passenger death's due to fatal crash events, whereas the NHS were experiencing an estimated 9000 patient deaths per year due to avoidable errors (Aviation Safety Network, 2020; Department of Health and Social Care, 2017). Although it is accepted that lessons can be learnt from the aviation industry regards the use of system aided judgement and team work in decision making, it is argued that passengers arrive at an airport happy and healthy in the majority, whereas patients often are at higher risk of death due to pre-disposing health conditions or risks associated with procedures and treatment, therefore a direct comparison, such as the death rate in the NHS equating to one plane crash each day in the UK with total fatality, may not be helpful (Collen, 2018). Recognising that human factors is an important part of clinical practice and learning lessons from personal experience as an airline pilot and the tragic loss of his wife during the anesthetic phase of a routine operation, Captain Martin Bromiley created the 'Clinical Human Factors Group'. This group aims to embed human factors science into many elements of health service, including design of services and procurement through to deliver of clinical care, through education and promotion. In doing so the group aim to encourage learning from mistakes through a just culture (Clinical Human Factors Group, 2020). Human factors in clinical decision making is recognised as the result of decision making bias, of which there are thought to be more than 100 bias variations mentioned within existing literature (Collen, 2018; Collen, 2017).

2.3.3 Research and development

As previously mentioned, system aided judgement is often the utilisation of clinical guidelines which are systematically developed and aim to disseminate research findings into a format intended for implementation within clinical practice in order to assist the clinician in clinical decision making (Institute of Medicine, 2011). In England, aside from clinical guidelines produced by NICE, there are specific pre-hospital paramedic practice guidelines, these are the JRCALC Clinical Guidelines which are produced by the Association of Ambulance Chief Executives (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; NICE, 2022).

Although acknowledged for their benefits, such as assistance with Quality Improvement projects, recognising a paucity in research and assisting the clinician in treatment recommendations, clinical guidelines can be criticised for a lack of transparent methodology, becoming out of date in only a few years and before the release of updated guidelines, and apparent bias aligned with the clinical experience and knowledge of the authors (Institute of Medicine, 2011; Woolf *et al.*, 1999; García *et al.*, 2014).

However clinical guidelines are not the only form of research dissemination and not normally the primary source of research publication. The dissemination of research findings through publication has historically been defined through a hierarchy of evidence, first referred to in EBM in 1979 in a report on the Periodic Health Examination (Hill, Frappier-Davignon and Morrison, 1979). This initial hierarchy of evidence had then been expanded on, over time, to take into account various diverse specialties and the subsequent questions being asked within that specialty hence the utilisation of the research findings; for example randomised controlled trials may not hold the same level of importance for clinicians working with prognosis forecasting verses clinicians interested in treatment outcomes (Burns, Rohrich and Chung, 2012). Despite noted variations, in 1995 Guyatt and Sackett published a pyramid of evidence to depict the generic hierarchy of evidence in clinical practice, several versions have existed over time, but all have served to show the perceived 'weaker' forms of evidence at the bottom, raising to perceived superior forms such as RCT's towards the top, as captured in Figure 20 (Murad *et al.*, 2016; Guyatt *et al.*, 1995).

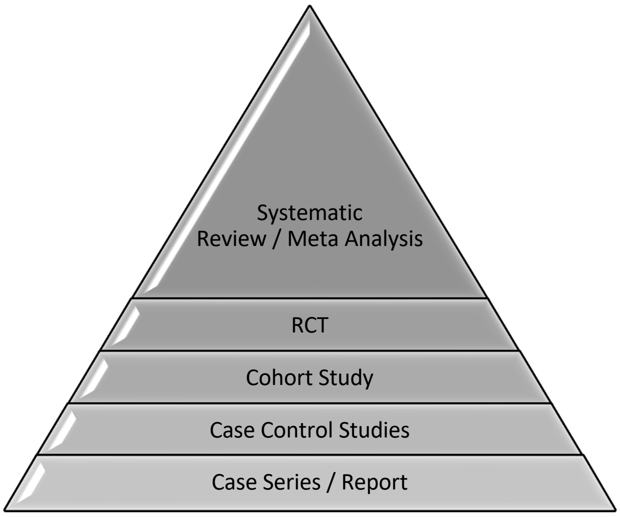


Figure 20 - Traditional Evidence Pyramid

This pyramid however, has seen suggested modifications in order to acknowledge that all systematic reviews and meta-analysis are not necessarily superior than their individual components further down in the pyramid, acknowledging the reliance on the quality of those component parts, for example it may be possible to have a meta-analysis of high risk data verses an RCT with low risk data findings (Murad *et al.*, 2016). Moreover, the alternative GRADE Approach (Grading of Recommendations Assessment, Development and Evaluation), as seen in Table 9, was subsequently created in the year 2000 and address's some of the criticisms of the pyramid hierarchy through its recognition of the importance of the quality as opposed to type of evidence (Schunemann *et al.*, 2003). However, it is noted that despite guidance for grading, as seen in Table 9, GRADE is subjective as opposed to the objective ranking system of the pyramid of evidence (Mustafa *et al.*, 2013).

Table 9 - GRADE Certainty Ratings

Certainty	Descriptor
High	The authors have a lot of confidence that the true effect is like the estimated effect
Moderate	The authors believe that the true effect is probably close to the estimated effect
Low	The true effect might be markedly different from the estimated effect
Very Low	The true effect is probably markedly different from the estimated effect

Table 10 - GRADE Rating Domains

Criteria to reduce confidence in certainty	Criteria to support certainty
Risk of bias	Large magnitude of effect
Imprecision	Dose-response gradient
Inconsistency	All residual confounding would decrease magnitude of effect (in situations with an effect)
Indirectness	
Publication bias	

For one of the younger Allied Health Professions, Paramedic Practice is becoming well established within research. Examples of this can be seen in work by the College of Paramedics through their research lead, their annual national research conference and The British Journal of Paramedic Practice, as well as the Paramedic Clinical Research Unit (ParaCRU), including collaborative PhD opportunities with the College of Paramedics, and the second professional practice journal 'The Journal of Paramedic Practice' (University of Hertfordshire, 2017a; College of Paramedics, 2021; College of Paramedics, 2020a; College of Paramedics, 2020d; JPP, 2021).

Before research can inform a change in clinical practice there is often the need for a feasibility study before commencement of a clinical trial. The feasibility study is an investment in ensuring the subsequent clinical research is of a 'good' quality and in doing so various elements are taking into account, including clinical particulars such as pharmaceutical or equipment specifics, but also the wider elements of the environment, staff and patient demographics; thus it is argued that a feasibility study is as much an art form as it is a science and needs to be specific to the organisation or environment within which it is to be conducted (Radjadhyaksha, 2010).

However not all research leading to a change in patient care or service delivery requires a clinical trial as changes may be more logistical or procedural. Within healthcare, changes are made almost daily in order to improve patient care, although not all are written as official research findings, in fact some are much more subtle but noticed by staff and patients none the less (The Health Foundation, 2011a). At the start of the century, research suggested that only a small minority of all evidence-based healthcare improvements were successfully adapted and implemented mainstream. Moreover, where this was achieved, data suggested that this took on average 17 years to implement from the initial pilot or trial and a common criticism of proposed 'change' within healthcare was the lack of research or evidence to support the change, perhaps contributing to the slow implementation (Grol, Baker and Moss, 2004; Balas and Boren, 2000; HM Treasury, 2006). With this recognised gap between research and practice, there was a desire between academics, researchers and healthcare managers to work closer together in order to achieve effective implementation of evidence-based research and practice (NIHR SDO, 2009; Brtunek, 2007; Leung and Bartunek, 2012; Rynes, Bartunek and Daft, 2001). This gap between research and practice has been at the center of the argument for a more synergized approach to improvement and implementation science within healthcare (Koczwara *et al.*, 2018; Curran *et al.*, 2012).

2.3.4 Information management and Clinical audit

Performance data collected and recorded for subsequent audit within UK Ambulance services could be argued as falling into two separate categories, firstly 'Key Performance Indicators' (KPIs) also known as System Indicators (AmbSYS) relating to response times of varying elements of service delivery and secondly 'Clinical Performance Indicators' (CPIs) relating to bundles of care in specific patient groups (Siriwardena *et al.*, 2010; NHS, 2022; NHS, 2019). Pre 2007, performance indicators were primarily focused on response times (8 and 19 min) also referred to by categories such as red, amber, green or category A, B, or C over the years; more recently referred to as category 1,2,3 and 4 and separate targets for call answering and specific 'stop clock' targets in targeted patient groups (Pons *et al.*, 2005; Siriwardena *et al.*, 2010; NHS, 2019; NHS, 2022). It has been argued that focusing solely on these metrics of performance has led to additional stress on ambulance personnel, can be costly and ineffective, and contribute to poor patient outcomes; furthermore these disadvantages are compounded by the argument that the measures lack a strong evidence base (Pons *et al.*, 2005; Bird *et al.*, 2005; Price, 2006; Campbell, Gratton and Salomone, 1994; Woollard, 2003).

In the absence of many validated clinical performance measures in the early 2000's, coupled with the results of a Delphi study recommending the creation of such performance measurements as a high priority for prehospital research, five CPIs were agreed and piloted within English Ambulance services between 2007 and 2008 (Moore, 1999; Siriwardena *et al.*, 2010; Snooks *et al.*, 2008). These piloted CPIs were in the areas of Stroke, ST elevation Myocardial Infarct (STEMI), Cardiac Arrest, Asthma and Hypoglycemia; chosen because of either high incidence, high associated cost or admission rates and the ability to compare performance across services (Siriwardena *et al.*, 2010). To achieve an audit of clinical performance which was both related to the evidence base and practical in terms of data available, the measures within each CPI were created based on existing nomenclature and aligned to well-established guidance rather than newly emerging research (Siriwardena *et al.*, 2010; Mainz, 2003). Post this initial pilot, ambulance services agreed to expand on the initial set of five CPIs to include areas such as trauma and focus on areas of clinical practice prioritised within patient care or considered to hold importance within stakeholder or professional opinion but where performance was perceived to differ between the services (Siriwardena *et al.*, 2010; Association of Chief Ambulance Officers, 2011). The health QI project which followed the initial pilot found cost associated with initiatives and conflicting time and demands on staff to be challenges associated with achieving improvements, however post the implementation of the Acute Myocardial Infarction (AMI) and Stroke CPIs, significant improvements were noted in patient care against the specific measurements included a recognised improvement in staff skills and knowledge (The Health Foundation, 2014; Siriwardena *et al.*, 2014).

Capturing data from patient records to report against CPI's has also changed over recent years. Historically ambulance service patient records were completed on paper and by hand which then needed to be scanned to facilitate audit processes, and where possible a carbon copy left with patients to assist in the sharing of records with other healthcare professionals should they interact with the patient soon after.

This approach caused potential data protection issues, created additional delays and complications with administrative processing and subsequently required the storage of large amounts of paper records (Porter *et al.*, 2020; Baird and Boak, 2016).

In recent years NHS Ambulance Trusts have transitioned across to digital solutions for patient record completion thus addressing some of these issues, allowing for an easier audit process which can be tailored to research needs in a timelier manner. However realising the full potential of electronic patient records will take more time and may require further work on the standardisation of clinical records structure, content and shared platforms in order to achieve potential benefits to the overall health system and audit outcomes. Moreover, the nature of pre-hospital work may mean that this technology can fail due to network signal availability and as such is yet to be a full proof system, thus still requiring the back up of paper record keeping (Porter *et al.*, 2018; Porter *et al.*, 2020; Health and Social Care Information Centre, 2014). As technology improves, so does the possibility of advancements in record completion and processing, such as 5G technology which may overcome several technical issues increasing reliability of IT resources in ambulance setting's, which will not only be limited to patient record keeping but also increase reliability and availability of telemetry systems allowing for the sharing of live patient data such as clinical observations and senior clinical advice (Kim *et al.*, 2020a). However, the advancement of 5G technology may bring with it issues over regulation, current widespread access to networks in remote areas and security over the transfer of patient data (Kim *et al.*, 2020a).

2.3.5 Reflective practice within Paramedicine

The concept of professional reflection was developed in the 19^{th} century in work by Donald Schon, in which he attempted to distinguish between reflection-on-action and reflection-in-action (Schon, 1983b; Schon, 1987). Reflection on action may arguably be used more commonly than reflection in-action, as 'in-action reflection' is the art of analysing the thoughts and action of the individual, by the individual while they are performing a task, thereby learning from their actions in the moment and being able to change their decisions, as a result, with instant effect (Greenwood, 1993). Reflection 'on-action' however, is the act of reflecting on events after they have occurred, in an effort to convert the recalled information into knowledge which can then be used in future decision making (Fitzgerald, 1994). Moreover this process is also thought to challenge the individuals beliefs and thoughts on theories and practices thus overall increasing knowledge and awareness for future events (Boulton and Delderfield, 2018).

Reflective practice is well established in healthcare and medicine as a tool for development, moreover it is a requirement by many professional bodies of their members and registrants including within the paramedic profession and as such it is embedded in many education programmes and professional guidance (HCPC, 2014; Academy of Medical Royal Colleges *et al.*, 2021; Mann, Gordon and MacLeod, 2007; NMC, 2019). Arguably reflective practice can happen in various formats, including guided reflection by a critical friend in conversation or personal quiet reflection, with no permanent record for future reference. However, a large amount of narrative and discourse is captured with an element of permanence in various forms, including the written reflection encouraged in professional practice and higher education and professional portfolio records, social media conversations, blogs and virtual case studies (Mak, Williams and Mackness, 2010; Fragkos, 2016). Debriefing within emergency services is also noted as a key activity for both personal learning, service development and staff welfare and thus the activity of both 'hot' and 'cold' structured debriefs can be seen as a form of both personal and team reflection (Snowdon, 2021).

With appropriate guidance and time to reflect, the practitioner has the ability to utilise the varying forms of reflection to firstly identify future learning needs through the critical reflection of past experiences (Schon, 1983a; Boud, Keogh and Walker, 1985), secondly engage in personal reflection through exploration of their beliefs, values and attitudes and how this fits within the professional culture and finally build a bank of knowledge through previous experiences which they are then able to link to future events, thus increasing self-awareness and professional practice (Bandura, 1986; Mann, Gordon and MacLeod, 2007; Epstein, 1999). Moreover the content of professional reflections have been recognised as a powerful source of narrative within medical professions, thus capturing the history and culture of the profession through story-telling (Murphy, Franz and Schlaerth, 2018; Haigh and Hardy, 2011). Reflecting on experiences in healthcare however is not limited to healthcare professionals and the ever expanding popularity and accessibility to digital platforms has enabled healthcare users to contribute their stories through personal reflective accounts (Haigh and Hardy, 2011). Recognising the importance of service users experiences and professional reflection, there is also now a platform to bring together these stories and enable joint learning through the power of shared experiences (Care Opinion CIC, 2021; Smith, 2018).

Various written reflective structures have been encouraged within healthcare professional practice, offering benefits such as a clear structure with a clear beginning and end to the reflective event. However the nature of such a structure may imply that all steps need to be followed, moreover the models available to clinicians may not necessarily fit every situation for which reflection would be advantageous, or may be deemed over simplified or complex (Smart, 2011; Hobbs, 2007). Some of the more well-known models in healthcare include the ERA Cycle (Jasper, 2013), Driscoll's 'what', 'so what', 'now what' model, utilising a three question approach based on earlier work by Terry Borton in the 1970's (Borton, 1970; Driscoll, 2007), Kolb's experiential learning cycle (Kolb, 1984) and Gibb's reflective cycle (Gibbs, 1998), as shown in comparison within Figure 21.

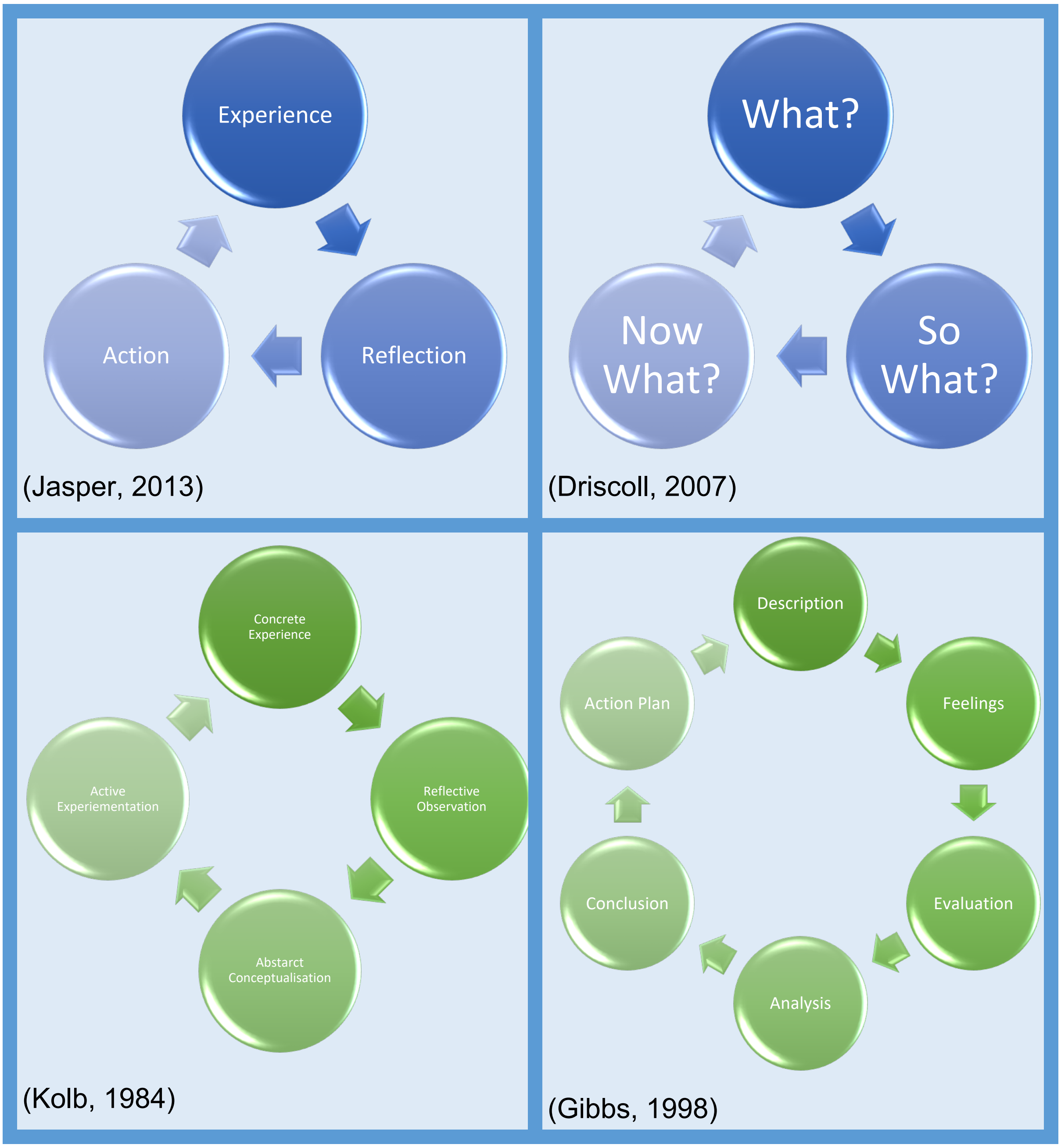


Figure 21 - Overview of commonly used reflective models.

Jasper and Driscoll's cycle have the advantage of being simple and therefore arguably more adaptable to various situations and uses, however an inexperienced clinician may find the very brief structure difficult to prompt reflection (Jasper, Rosser and Mooney, 2013; Matiukha, Hostishcheva and Kharchenko, 2021). Whereas Kolb's and Gibb's reflective cycles have several more steps which may be preferred by the more novice reflective practitioner, although it may feel very prescriptive and inflexible in specific situations, restricting the ability to reflect beyond individual practice and lead to 'change in practice' (Middleton, 2017; Adeani, Febriani and Syanfryadin, 2020). Unlike the other models listed here, Gibbs model has a focus on ‘feelings’ within the reflection which is acknowledged as an important part of self-development, especially in the development of emotional intelligence within clinical practice (Davies, 2012; Hilliard, James and Batt, 2017; Raghubir, 2018). Recognising the need for a detailed structure by some practitioners but one that is not restrictive and yet applicable to the types of events being reflected upon, the IFEAR reflective model was created in 2011, specifically for Paramedic reflections (Smart, 2011). This specific model, as seen in Figure 22 is an adaption of the Gibbs’ model which itself is noted as an adaption of the earlier Kolb’s cycle, however this adaptation has the advantage of specific questions for ‘front-line’ paramedics to help overcome the ‘writers block’ some find in reflective writing (Smart, 2011).

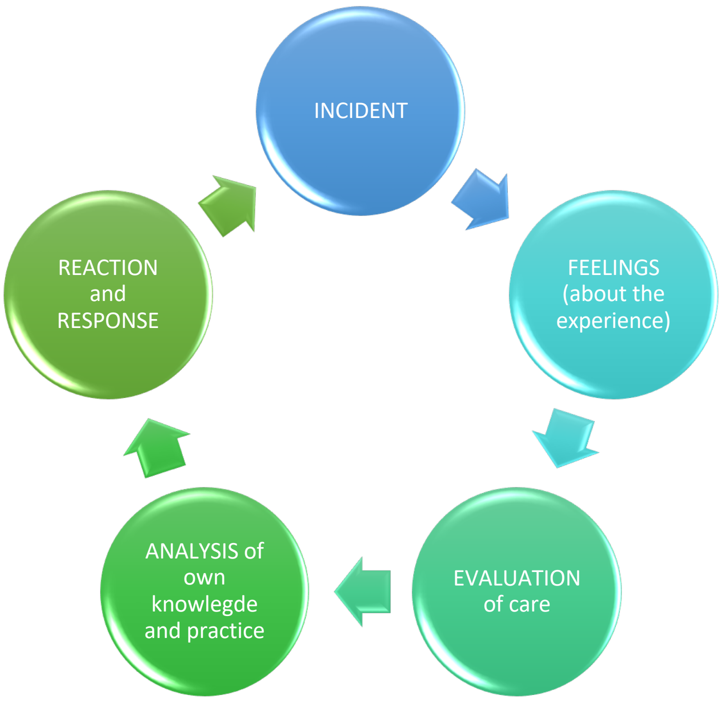


Figure 22 - I.F.E.A.R Paramedic Reflective Model (Smart 2011)

Chapter 3 – Ocular Nerve Sheath Diameter Ultrasound and Impedance Threshold Device Therapy in the assessment and management of increased intracranial pressure: A Systematic Review.

3.1 Introduction

Impedance threshold device (ITD) therapy originated as a treatment for patients in Cardiac arrest, through a device branded as the ResQpod. The ResQpod is an impedance threshold device used to enhance circulation during cardiopulmonary resuscitation (CPR). The device increases circulation in states of low blood pressure. In cardiac arrest the ResQpod harnesses the chest wall recoil after each compression to generate a small but crucial vacuum within the chest. During the decompression phase of CPR, an increase in negative pressure in the thoracic cavity results in drawing more blood back into the chest, providing greater venous return to the heart with each subsequent chest compression (Advanced Circulatory Systems, 2013; Lurie *et al.*, 2002). The device is reported through clinical trials to double the amount of blood that is pulled back to the heart, compared to CPR alone (Convertino *et al.*, 2011; Aufderhelde and Lurie, 2006). Trials have also shown that blood flow to the brain is increased by 50% (Convertino *et al.*, 2011; Aufderhelde and Lurie, 2006). In sustaining blood flow back to the brain, the ResQpod should increase the likelihood of survival by 75% and decreases the likelihood of neurological disorders due to the impact on Cerebral Perfusion Pressure (CPP) and therefore Intracranial Pressure (ICP) (NASA, 2007; Yannopoulos *et al.*, 2018). Early research and published works demonstrated that the ResQpod offered a significant improvement in cardiac output and blood flow to the brain and preventing shock in the event of considerable blood loss, when compared to conventional resuscitation (Sugiyama *et al.*, 1999; Lurie *et al.*, 1995; Lurie *et al.*, 1998a; Lurie *et al.*, 1998b; Voelckel *et al.*, 2001; Lurie *et al.*, 2001; Voelckel *et al.*, 2002). There has since been a further 39 animal studies, 45 human clinical studies and two further manikin / bench studies published regards the potential clinical benefits of the ResQpod.

Over time further devices have been developed to deliver impedance device therapy to both patients receiving ventilation, such as the intrathoracic pressure regulator (ITPR) and those who are spontaneously breathing such as the ResQgard

(Advanced Circulatory Systems, 2012). The ITPR is a non-invasive device designed to increase circulation and blood pressure by applying pressure during the expiratory phase of ventilation it decreases intrathoracic pressure and enhances venous return, which increases cardiac output (Kiehna *et al.*, 2013). Benefits of ITD therapy shown through research have also exceeded those related to the cardiac arrest patients alone. The use of ITD, in animal models, has been shown to lower ICP with each inspiratory effort resulting in overall improvement in CCP by increasing forward blood flow and lowering resistance (Lurie *et al.*, 2003; Yannopoulos *et al.*, 2006b; Convertino *et al.*, 2011; Metzger *et al.*, 2006; Yannopoulos *et al.*, 2006a; Alexander *et al.*, 2007; Yannopoulos, Halperin and Lurie, 2007; Aufderhelde *et al.*, 2008; Metzger *et al.*, 2012; Burnett *et al.*, 2011; Lurie *et al.*, 1995; Lurie *et al.*, 1998c; Lurie *et al.*, 2001; Raedler *et al.*, 2002; Voelckel *et al.*, 2002; Lurie *et al.*, 2008). There are however only two clinical trials in human subjects specifically monitoring ICP while using an ITD (Kiehna *et al.*, 2013; Hansen *et al.*, 2021).

Guidelines recognise the relationships between various physiological variables and their potential prognostic value in Traumatic Brain Injury (TBI). Emphasis is placed on the need for monitoring and targeted management of severe TBI patients in order to ensure adequate cerebral perfusion is achieved through a focus on maintaining target oxygenation levels and blood pressure in order to achieve successful outcomes (Bratton *et al.*, 2007; NICE, 2014a; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019). Additional scientific evidence indicates several measurements which represent direct and indirect measures of cerebral perfusion such as systemic hypotension, intracranial hypertensions and CPP (Chesnut *et al.*, 1993; Schoon *et al.*, 2002; Marmarou *et al.*, 1991). Moreover, (Bratton *et al.*, 2007) describe how CPP values of <50 mmhg are associated with poor outcomes in TBI patients. Evidence also demonstrates how accurately estimating CPP and cerebral hypoperfusion relies not only on continuous monitoring of blood pressure but also the monitoring of ICP (Miller *et al.*, 2004; Chambers and Mendelow, 2001; Chambers, Treadwell and Mendelow, 2000; Rosner, Rosner and Johnson, 1995). However, (Bratton *et al.*, 2007) also highlights how the benefits of invasive ICP monitoring must be weighed against the potential risks and costs of this intervention.

In the pre-hospital setting the introduction of ITD therapy may be possible but pre-hospital invasive monitoring of ICP, such as the insertion of an intracranial catheter, is not feasible; thus, an alternative non-invasive technique could be considered (Levitt, Joshua and Kim, 2013; Hartl and Philip, 2013; Mattei, 2013).

Ocular Nerve Sheath Diameter Ultrasound (ONSD) could prove a feasible alternative to invasive ICP monitoring in the pre-hospital setting as changes in the ONSD occur within a very short time following an increase in ICP (Major, Girling and Boyle, 2011). The rapid way in which ONSD responds to elevated ICP makes measuring of ONSD an extremely sensitive, early intervention for estimating ICP. The technique has shown great promise for use in a hospital or pre-hospital setting for the detection of both acute and hyper-acute increases in ICP and for monitoring changes in ICP of patients in a critical status (Frumin, 2014). When comparing non-invasive and invasive techniques, a review in 2012 concluded although invasive methods are less economical than non-invasive methods and associated with a much higher degree of risk to patients, specifically haemorrhage and infection, their superior accuracy currently makes them the methods of routine choice (Roboel *et al.*, 2012). A later review in 2014, emphasises the current research drive towards promoting non-invasive methods of monitoring ICP to replace invasive monitoring (Asiedua *et al.*, 2014). Moreover, both reviews refer to the potential benefits of measuring ONSD as a safe, non-invasive screening method for detecting raised ICP where invasive ICP monitoring capabilities are unavailable. A further review in 2011 similarly concludes that ultrasound measurement of the ONSD represents one of the most promising non-invasive method for ICP monitoring (Rosenberg *et al.*, 2011), more recently supported by a meta-analysis conducted in 2020 (Lee, Kim and Yun, 2020).

Impedance Threshold Device (ITD) therapy and Ocular Nerve Sheath Diameter (ONSD) ultrasound were chosen for this review due to their innovative approach and significant potential to improve the management of increased intracranial pressure (ICP) and traumatic brain injury (TBI). Current guidelines from the Brain Trauma Foundation and NICE emphasise the importance of maintaining adequate cerebral perfusion pressure (CPP) and monitoring ICP in managing severe TBI. ITD therapy and ONSD ultrasound align with these guidelines by offering non-invasive alternatives that can be used to monitor and manage ICP and CPP effectively, potentially reducing the risks associated with invasive methods.

These two literature reviews will therefore aim to answer the following questions:

1) Does Impedance threshold therapy device have a potential place in the management of increased ICP in the pre-hospital setting?
2) Does ONSD Ultrasound have a place in the detection and monitoring of increased ICP in the pre-hospital setting?

This chapter will provide a comprehensive review of the literature on ITD therapy and ONSD ultrasound, examining their potential benefits, current evidence, and implications for clinical practice. The review will be structured as follows:

3.2 Impedance Threshold Device Review

- **3.2.1 Methods**: Description of the systematic review process, including inclusion and exclusion criteria, search strategy, and critical appraisal.
- **3.2.2 Results**: Summary of the studies included in the review, focusing on the effectiveness of ITD therapy in managing ICP and CPP.
- **3.2.3 Discussion**: Analysis of the findings, highlighting the potential benefits and limitations of ITD therapy, and recommendations for future research and clinical practice.

3.3 ONSD Ultrasound Review

- **3.3.1 Methods**: Description of the systematic review process, including inclusion and exclusion criteria, search strategy, and critical appraisal.
- **3.3.2 Results**: Summary of the studies included in the review, focusing on the effectiveness of ONSD ultrasound in monitoring ICP.
- **3.3.3 Discussion**: Analysis of the findings, highlighting the potential benefits and limitations of ONSD ultrasound, and recommendations for future research and clinical practice.

3.4 Discussion

- **3.4.1 Summary of Findings**: Integration of the results from the ITD therapy and ONSD ultrasound reviews, providing an overall assessment of their potential in managing ICP and TBI.

- **3.4.2 Clinical Implications**: Discussion of the practical implications for paramedic practice, including the potential benefits for patient outcomes and the need for further research to establish standardised protocols.
- **3.4.3 Recommendations for Practice**: Clear recommendations based on the current evidence, including the need for further research and pilot implementation in clinical settings.
- **3.4.4 Impact on Thesis Intentions**: Explanation of how the findings will inform the thesis and contribute to the broader field of paramedic practice and quality improvement.

3.2 Impedance Threshold Device Review

3.2.1 Methods

3.2.1.1 Design

The design of this literature review was a systematic review with meta-synthesis of the qualitative data. The process and structure of this review has been formulated using the updated Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Page *et al.*, 2021b) and guidance from (Wright *et al.*, 2007) and (Nusrat *et al.*, 2016). The design of this review aimed to answer the first of the questions set out in the introduction to this chapter: Does Impedance threshold therapy device have a potential place in the management of increased ICP in the pre-hospital setting?

3.2.1.2 Inclusion and exclusion criteria

The search strategy was designed using pre-determined inclusion and exclusion criteria, as seen in Table 11. The inclusion criteria were limited to papers published post 2005, to capture a period of 10 year prior to the origins of this thesis, while still ensuring the literature review remained contemporary.

Table 11 - Inclusion and exclusion criteria for ITD literature review

Criteria	Inclusion	Exclusion
Type of participant	Living Mammals, i.e. Humans, Pigs and Dogs	Studies that do not include living participants, or studies using non-mammal species
Type of study	Qualitative, quantitative, or mixed method studies	Literature reviews, case studies
Phenomena of interest	Studies exploring a link between ITD therapy and either a direct effect on ICP or the measurement of CPP, cerebral blood flow or MAP	ITD studies that do not measure cerebral blood flow, MAP or CPP, or do not explore an ICP link.
Language	Studies published in English	Studies published in a language other than English
Date Range	Studies published between 2005 and 2022	Studies published pre-2005

3.2.1.3 Search strategy.

An initial search was made of the 'Advanced Circulatory System database' which holds a list of research papers relating to their ITD products (Advanced Circulatory Systems, 2012). This initial search was them complimented with a search of the following databases for additional relevant studies: CINAHL, MEDLINE, PUBMED and Cochrane. These databases were searched using the following search terms with the inclusion of Medical Subject Headings (MeSH) and Boolean operators of AND/OR: (Impedance Threshold Device or ResQgard or ResQpod) AND (Intracranial Pressure, or ICP, or Mean Arterial Pressure or MAP, or Cerebral Perfusion Pressure or CPP, or cerebral blood flow) (Sayers, 2008).
The following website was also searched: clinicaltrials.gov and further studies were identified by examining the reference lists of included articles.

3.2.1.4 Critical appraisal

The resources were appraised for their credibility, validity, reliability, and transferability. To complete this appraisal the researcher used the recognised 'Critical Appraisal Skills Programme' (CASP) checklists (CASP, 2018) and guidance by (Azzam and Salah, 2017).

3.2.1.5 Data extraction

Data extraction was performed by the researcher, using a data extraction table, which included the following information from each study: Author, date of publication, study aim, methods, sample size and participant type, intervention type and data analysis, results, and a summary of conclusion, as can be seen in Table 12.

Table 12 - ITD Literature Review: Data Extraction Table

Authors and date	Aim	Methods	Participants	Intervention / Data Analysis	Results	Discussion / Conclusion
(Convertino *et al.*, 2005)	To assess the effectiveness of an ITD in preventing orthostatic hypotension induced by a squat-to-stand test (SST).	Prospective randomized blinded protocol. Participants completed two 6-minute SST protocols with and without an ITD set to open at a 0.7 kPa (7-cm H_2O) pressure.	9 females and 9 males (18), normotensive volunteers	HR, SV, Q, TPR, and MAP were measured noninvasively using infrared finger photo plethysmography. Symptoms were recorded on a 5-point scale of subject perceived rating (SPR).	The ITD did not affect the reduction in TPR produced by SST. However, the reduction in MAP with ITD during the transient phase of the SST was less than that measured with the sham device. SV and Q were higher with the ITD compared to without it. SPR was lower with ITD compared to the sham device.	The ITD reduced orthostatic symptoms during the SST, associated with higher MAP, SV, and Q. The authors suggest its potential as a countermeasure against orthostatic hypotension.
(Cooke *et al.*, 2006)	To evaluate the impact of breathing through an ITD on autonomic neural and cerebrovascular function.	Subjects breathed through a sham ITD (0 cmH_2O) and an active ITD (−7 cmH_2O) in the supine position. ECG, finger photo plethysmography arterial pressure, cerebral blood flow velocity, and MSNA were recorded.	8	Data were analysed in both time and frequency domains.	Breathing through the active ITD increased mean arterial pressure, heart rate, and mean cerebral blood flow velocity with no effect on MSNA or estimates of vagal-cardiac control. The active ITD did not affect oscillations of inter-beat R-R intervals, arterial pressures, or cerebral flow velocities within the low frequency domain of the power spectrum.	The ITD increases arterial pressure, heart rate, and cerebral blood flow velocity independently of changes in autonomic cardiovascular control or dynamic cerebral autoregulation. The authors suggest it may slow the progression to hemodynamic instability in bleeding patients who can ventilate spontaneously.

(Yannopoulos *et al.*, 2006b)	To test the hypothesis that mechanical devices designed to reduce intrathoracic pressure will decrease ICP in a dose-related manner in normovolemic and hypovolemic animals.	Prospective, randomized animal study. An ITD was used in spontaneously breathing animals and an intrathoracic pressure regulator was attached to a positive pressure ventilator in apnoeic animals.	A total of 36 female farm pigs in four different protocols (n = 12, 6, 12, and 6, respectively).	Endotracheal, right atrial, central aortic, and ICP were measured continuously. Various protocols tested the effects of different ITD pressures and the intrathoracic pressure regulator on ICP.	Inspiratory impedance decreased ICP in a dose-dependent manner and decreased elevated ICP immediately after cardiac arrest and successful resuscitation. The same effect was seen in apnoeic animals with the intrathoracic pressure regulator. The effect was more pronounced in hypovolemia and sustained for ≥2 hrs.	Reduction of intrathoracic pressure to sub-atmospheric levels resulted in an instantaneous and sustained reduction in ICP in both spontaneously breathing and apnoeic animals, with the effect most pronounced in hypovolemic animals. The authors suggest this finding indicates potential clinical applications.
(Convertino *et al.*, 2007)	To test the hypothesis that an ITD would increase systolic, diastolic, and mean arterial blood pressure and delay the onset of symptoms and cardiovascular collapse associated with severe central hypovolemia.	Prospective, randomized, blinded trial design.	9 healthy non-smoking normotensive subjects (5 males, 4 females).	Central hypovolemia and impending cardiovascular collapse were induced by applying progressive lower body negative pressure under two conditions: breathing with an active ITD and breathing through a sham ITD.	Systolic, diastolic, and mean arterial pressures were lower when subjects breathed through the sham ITD compared to the active ITD at the same time of cardiovascular collapse. Elevated blood pressure was associated with greater lower body negative pressure tolerance using an active ITD compared with a sham ITD.	Use of an ITD increased systemic blood pressure and delayed the onset of cardiovascular collapse during severe hypovolemic hypotension in spontaneously breathing human volunteers. The authors suggest this device may provide rapid non-invasive hemodynamic support in patients with hypovolemic hypotension.

(Rickards *et al.*, 2007)	To test the hypothesis that breathing through an ITD during progressive central hypovolemia would protect cerebral perfusion and reduce pre-syncope symptoms.	Subjects were exposed to lower-body negative pressure until symptoms appeared while breathing through either an active ITD or a sham ITD.	8 healthy, normotensive, non-smoking subjects (3 women, 5 men).	Cerebral blood flow velocity (CBFV) was measured continuously via transcranial Doppler and analysed in both time and frequency domains. Subjects reported pre-syncope symptoms at the conclusion of each LBNP exposure.	Breathing on the active ITD increased LBNP tolerance time. There was no difference in mean CBFV at the time of symptoms between the sham and active ITD trials, but total oscillations of CBFV were higher with the active ITD.	Greater oscillations in CBFV induced by inspiratory resistance were observed. The authors suggest these may contribute to the delay in symptoms and cardiovascular collapse during progressive central hypovolemia.
(Rickards *et al.*, 2008)	To test the hypothesis that breathing through an ITD would attenuate the fall in CBFV during a hypotensive orthostatic challenge and reduce symptom severity.	Subjects performed a squat stand test while breathing through either an active ITD or a sham ITD. Symptoms were recorded on a 5-point scale.	19	Data from symptomatic subjects were analysed. MAP and mean CBFV were measured continuously throughout the SST and analysed in time and frequency domains.	Breathing with the active ITD during the SST reduced the severity of orthostatic symptoms in symptomatic subjects, but there was no significant difference in the reduction of mean CBFV between the two trials. High frequency oscillations in mean CBFV were greater during the active ITD trial.	Higher oscillations in CBFV while breathing with the active ITD were observed. The authors suggest these may account for the reduction in symptom severity during orthostatic hypotension despite the same fall in absolute CBFV.

(Convertino *et al.*, 2012)	To report on the feasibility, effectiveness, and safety of deploying the ITD by first responders to treat hypotension secondary to blood loss and trauma.	Therapeutic study, level III. Case Series	225	Hemodynamic data from hypotensive patients (pre-treatment systolic BP <100 mm Hg) from 3 U.S. cities where the ITD is deployed were evaluated. Primary end point was maximum change in SBP and DBP from before to during ITD use. Secondary end points were device tolerance, patient feeling 'better', change in heart rate, O2 saturation, and adverse events.	In the 39-patient subgroup with blood loss or trauma, SBP and DBP increased significantly after ITD placement. The ITD was well tolerated, resulted in feeling 'better' in more than 85% of patients, and had no reported adverse events.	Use of an ITD by emergency medical services personnel on hypotensive spontaneously breathing patients secondary to blood loss and trauma increased SBP and DBP. The authors reported it was feasible, well tolerated, and not associated with adverse effects.
(Kiehna *et al.*, 2013)	To test the hypothesis that the ITPR may decrease ICP and increase CPP in brain-injured patients by decreasing cerebral venous blood volume and increasing cardiac output.	Pilot Study. Open-label, 'first-in-humans' study of the ITPR in patients with an ICP monitor or external ventricular drain and altered intracranial elastance.	10	Baseline hemodynamic variables and ICP were recorded prior to inserting one of the two ITPRs into the ventilator circuit. Hemodynamic and ICP data were recorded sequentially every 2 minutes for 10 minutes. The procedure was repeated for the second device.	Ten patients with elevated ICP were enrolled. A decrease in ICP was observed in 16 of 20 applications. The −5 mm Hg device decreased ICP and increased CPP. The −9 mm Hg device also decreased ICP and increased CPP.	This pilot study demonstrates that use of the ITPR in patients with altered intracranial elastance is feasible. The authors suggest that the ITPR may be used to rapidly lower ICP and increase CPP without apparent adverse effects. They recommend additional studies to assess longitudinal changes in ICP and delineate treatment parameters.

(Wampler *et al.*, 2014)	To study changes in key vital signs when the ITD was added to the paramedic treatment protocol for hypotensive patients with prehospital traumatic injury.	Observational cohort feasibility study. 6-month prospective non-randomized observational cohort study. Therapeutic study, level IV.	200	This study included 200 spontaneously breathing symptomatic adult patients with prehospital hypotension due to multiple causes. Upon determination of hypotension, standard therapy was initiated by application of the mask-style ITD. Vital signs	Of the 200 patients treated for hypotension, 29 were due to trauma (excluding 6 for data issues). Their MAP increased from 60 to 78 mm Hg ($p = 0.001$) with no significant heart rate change. About 75% reported moderate to easy tolerance. Non-traumatic patients had similar MAP increases from 60 to 70 mm Hg ($p = 0.0001$).	In this observational cohort study involving patients with trauma-induced hypotension, the ITD was found to be well tolerated. Both MAP and systolic and diastolic blood pressures showed improvement. The intervention did not lead to over-resuscitation. The authors suggest that further research is needed to determine the necessity and advantages of additional fluid resuscitation when using the ITD in patients with traumatic hypotension.

(Hansen *et al.*, 2021)	Methods to lower intracranial pressure (ICP) include the use of thigh cuffs and breathing with inspiratory resistance. Given the relationship between central venous pressure (CVP) and ICP, the researchers proposed that both ICP and CVP would decrease with these interventions.	Observational study with experimental intervention.	4 males	Four male participants (average age 32 ± 13 years) with Ommaya reservoirs implanted for unrelated conditions had their ICP measured invasively through these ports. The subjects were healthy during the tests. CVP was measured using a peripherally inserted central catheter. Participants used an impedance threshold device (ITD, −7 cmH2O) to create negative intrathoracic pressure for 5 minutes, followed by wearing bilateral thigh cuffs inflated to 30 mmHg for 2 minutes.	Using an ITD lowered both CVP (6 ± 2 to 3 ± 1 mmHg; P = 0.02) and ICP (16 ± 3 to 12 ± 1 mmHg; P = 0.04) compared to baseline, an effect not seen during normal breathing (CVP, 6 ± 2 to 6 ± 2 mmHg, P = 0.87; ICP, 15 ± 3 to 15 ± 4 mmHg, P = 0.68). Inflating the thigh cuffs to 30 mmHg did not significantly reduce CVP (5 ± 4 to 5 ± 4 mmHg; P = 0.1) or ICP (15 ± 3 to 14 ± 4 mmHg; P = 0.13). Inspiratory resistance breathing likely reduced both ICP and CVP due to intrathoracic unloading.	The main findings of this study are: 1) inspiratory resistance breathing lowers both CVP and ICP compared to baseline, and 2) thigh cuff inflation has minimal impact on CVP and ICP. The authors suggest that the positive linear relationship between changes in CVP and ICP indicates that the degree of ICP reduction depends on the extent of CVP reduction.

3.2.1.6 Data synthesis

The synthesis of data was conducting using the 3-stage approach by (Thomas and Harden, 2008). In stage 1 the author read each paper 'Line by Line' to establish codes relating to the original literature review question. In stage 2 the author reviewed the codes to identify similarities and grouped them into descriptive themes, then finally combining them within stage 3 into analytical themes for further discussion. A quantitative synthesis of the included papers was considered during the review process. However, the studies included in this review exhibited significant heterogeneity in terms of study design, population, interventions, and outcomes. This heterogeneity would have compromised the validity of a meta-analysis, as combining such diverse studies could lead to misleading conclusions. Therefore, a narrative synthesis was deemed more appropriate to provide a comprehensive overview of the current evidence on ITD therapy.

3.2.2 Results

3.2.2.1 Study inclusion

An initial search identified 1287 studies. An initial search of the Advanced Circulatory Systems database identified 60 of these studies. This search was them increased to include CINAHL, MEDLINE, PUBMED and Cochrane databases which identified another 1226 studies. One further study was found by searching clinicaltrials.gov database. The studies were scanned for duplicates and 100 were removed. A further 1154 studies were excluded after reading the titles and abstracts. At this stage, 33 reports were sought for retrieval successfully. Of those 33 studies, 14 were removed as they did not meet the inclusion criteria. A further 39 studies were identified from citation searching of which one study was retrieved for consideration and deemed to meet the full inclusion criteria. In total 10 studies were included in the final literature review. A PRISMA flow diagram for the search data can be found in Figure 23 (Page *et al.*, 2021a).

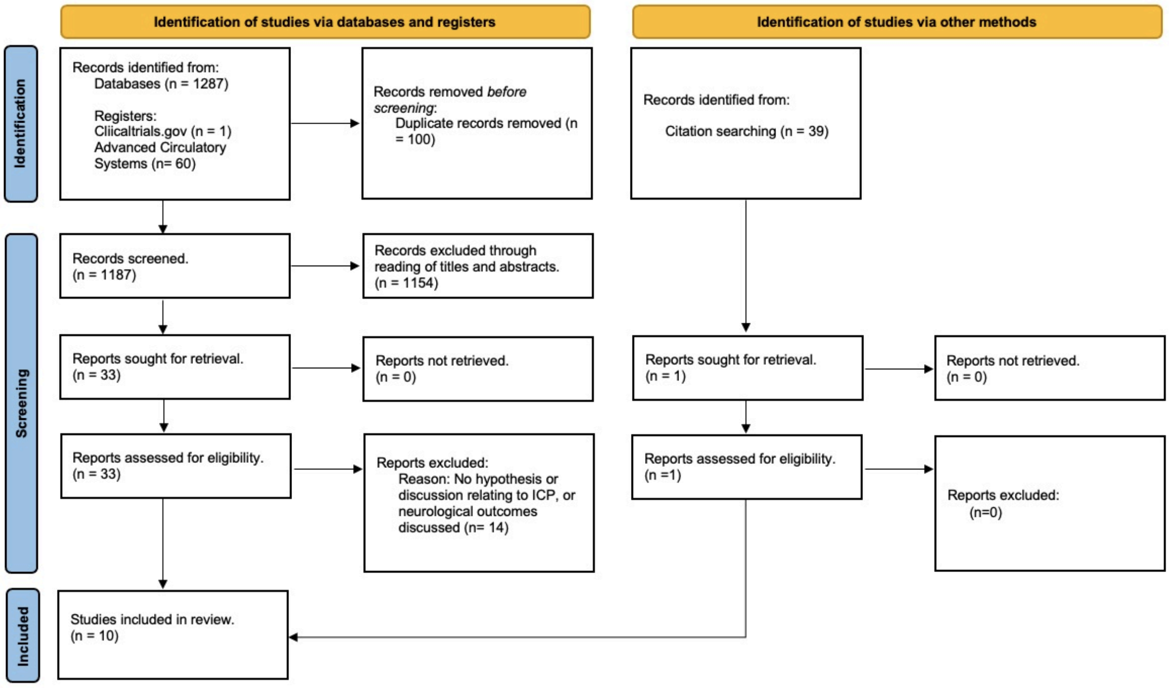


Figure 23 - PRISMA flowchart of ITD Search data (Page et al 2021a).

2.2.2.2 Critical appraisal

The small sample sizes of Convertino *et al*. (2005) and Kiehna *et al.* (2013) reduces external validity and limits generalisability. Several papers have limited applicability to clinical settings or broader clinical implications due to the narrow focus, such as Convertino *et al* (2005) due to the focus on squat-test responses, Hansen *et al*. (2021) due to a focus on spaceflight syndrome, Rickards *et al.* (2008) due to a focus on acute hypotension and Convertino *et al.* (2007) due to the focus on severe haemorrhage. The study by Cooke *et al.* (2006) has limited clinical relevance due to a focus on physiological responses rather than practical application. Moreover, the pig subjects used in Yannopoulos *et al.* (2006b) may not fully represent human responses thus again limiting clinical relevance and transferability of findings. The study by Convertino *et al.* (2012) has limited generalisability due to the case series design and the lack of a control group makes it challenging to establish causation. Potential bias was present in Rickards *et al.* (2008) due to subjective symptom reporting. The observational cohort study of Wampler *et al.* (2014) lacks a control, thus limiting the ability to establish causation.

2.2.2.3 Study characteristics

Three of the studies aimed to evaluate the effect of ITD therapy on ICP, two of which were with humans participants (Kiehna *et al.*, 2013; Hansen *et al.*, 2021) and one study using pigs (Yannopoulos *et al.*, 2006b). Four of the studies aimed to evaluate the effect of ITD therapy on hypotension (Convertino *et al.*, 2005; Rickards *et al.*, 2008; Convertino *et al.*, 2012; Wampler *et al.*, 2014) and a further two studied the effect on hypovolemia (Convertino *et al.*, 2007; Rickards *et al.*, 2007). The final paper aimed to evaluate effects of the ITD on autonomic neural and cerebrovascular function (Cooke *et al.*, 2006).

Four of the studies used prospective randomised protocols, three using human participants (Convertino *et al.*, 2005; Convertino *et al.*, 2007; Kiehna *et al.*, 2013) and one study using pigs (Yannopoulos *et al.*, 2006b). Two studies were therapeutic studies (Convertino *et al.*, 2012; Wampler *et al.*, 2014).

Various physiological measurements were taken during the studies with the most common being MAP in 5 studies (Convertino *et al.*, 2005; Convertino *et al.*, 2007; Cooke *et al.*, 2006; Rickards *et al.*, 2008; Wampler *et al.*, 2014).
Cerebral blood flow was monitored in 3 studies (Cooke *et al.*, 2006; Rickards *et al.*, 2008; Rickards *et al.*, 2007) as was ICP (Yannopoulos *et al.*, 2006b; Kiehna *et al.*, 2013; Hansen *et al.*, 2021).

2.2.2.4 Participants

In total there were 501 human participants and 36 pigs across the 10 studies.

3.2.3 Review findings

Three themes were identified from the data analysis. The first theme was research with a primary hypothesis separate to ICP but with the measurement of hemodynamic variables which may directly relate to ICP, such as MAP. The second theme was the measurement of Mean Cerebral Blood Flow Velocity during ITD research, and the third theme was the intentional use of a research method to establish a link between ITD and ICP.
These themes will now be explored in more depth.

2.2.3.1 Effect of ITD on Hemodynamic variables such as MAP

The randomised blinded study by Convertino *et al.* (2005) of 18 healthy, normotensive volunteers using a squat-to-stand test (SST) to provoke orthostatic hypotension included measured variables of Heart Rate (HR), Stroke Volume (SV), Cardiac Output (Q), total peripheral resistance (TPR), and Mean Arterial Pressure (MAP). The results showed a reduction in orthostatic symptoms when breathing through an ITD during the SST, which was also associated with higher MAP, SV, and Q. Thus, inspiration through a low level of resistance can delay onset of orthostatic intolerance symptoms, providing a theoretical basis for other indications relating to improved cerebral perfusion.

Subsequently Convertino *et al.* (2007) conducted a prospective, randomised, blinded trial in human volunteers with induced central hypovolemia and impending cardiovascular collapse. Nine volunteers were studied when either breathing through an ITD (ResQgard) or a sham device. Results indicated significantly lower systolic, diastolic and MAP with the sham device than ResQgard ($p<0.02$) and supported the notion that ResQgard increased systemic blood pressure and delayed the onset of cardiovascular collapse. The ResQgard can therefore be said to provide non-invasive hemodynamic support in patients with hypovolemic hypotension.

Moreover, Convertino *et al.* (2012) performed a prospective, non-randomised study investigating the ITD (providing 7 cm H_2O resistance during inspiration) in 39 patients who developed hypotension secondary to blood loss or trauma in the pre-hospital setting. The results proved the device was successful in improving arterial perfusion pressures with Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) (mean +/- SD) significantly increasing following ITD placement (79 +/- 14mmHg and 48 +/- 12mmHg before to 110 +/- 17 mmHg and 66 +/- 14mmHg after placement ($p < 0.001$). The hemodynamic variables collected did not include direct measures of cerebral blood flow or ICP, however clinical symptoms potentially associated with these parameters were recorded as secondary variables and the authors concluded that findings would suggest a potential positive relationship between the application of the ITD, increased stroke volume and cerebral perfusion, but that further research was required.

Convertino was also part of a research team in 2014 who conducted a similar prospective, non-randomised study aimed at providing further proof of the clinical benefit of the ITD in patients with traumatic injuries in a pre-hospital setting. This time MAP was calculated, and subsequently compared with after ITD use, as a representation of the primary endpoint. A total of 29 patients were classified as having suffered trauma and their MAP was shown to significantly increase with the ITD intervention (60 +/- 10mmHg increasing to 70 +/- 15mmHg ($p<0.001$). As in their previous study, systolic and diastolic blood pressures were also significantly improved (SBP = 78 +/- 13mmHg, increasing to 97 +/- 19mmHg with the ITD ($p<0.001$); DBP = 51 +/- 13mmHg increasing to 63 +/- 15mmHg with the ITD ($p<0.001$)) (Wampler *et al.*, 2014).

<u>3.2.3.2 Effects of ITD on Mean Cerebral Blood Flow Velocity</u>

In a study by Cooke *et al.* (2006) a sham and ITD were tested in eight volunteers in the supine position breathing either spontaneously or at a rate of 25 breaths/min. The ITD significantly increased MAP by approximately 5 mm Hg, HR by 2 bpm, and mean cerebral blood flow velocity (CBFV) by 10% ($p<0.05$).

These results were supported by Rickards *et al.* (2007) in their study in which CBFV was measured continuously via transcranial Doppler in eight human volunteers. The study involved breathing through an ITD or sham device during progressive levels of central hypovolemia arising from exposure to lower-body negative pressures (LBNP). Subjective measurements of symptoms such as dizziness or nausea were also collected. Using the ITD significantly increased LBNP tolerance time ($p=0.006$) and delayed onset of symptoms of syncope. Differences in mean CBFV did not reach statistical significance, however frequency of oscillations in mean CBFV were statistically greater with ITD.

A similar study in the same laboratory in 2008 involved 19 volunteers, who were assessed following an SST while breathing through an ITD or sham device. Variables included levels of faintness upon standing, using subject-perceived ratings (SPR), plus MAP and mean CBFV measured continuously. Results indicated the ITD served to reduce the severity of orthostatic symptoms in eight of nine symptomatic subjects. Although no significant difference was found in the reduction of mean CBFV with ITD, again higher oscillations in CBFV were found with the ITD suggesting improved cerebral perfusion may account for the improvement in symptoms (Rickards *et al.*, 2008).

3.2.3.3 Effect of ITD on ICP

Yannopoulos *et al.* (2006b) investigated vital organ perfusion in twelve anaesthetised pigs at different intrathoracic pressures under hypovolemic conditions. They measured variables relating to cerebral blood velocity dynamics namely ICP, aortic pressure, right atrial pressure (RAP), arterial blood gases and end tidal CO_2. Decreased intrathoracic pressure causes an immediate, proportionate reduction in ICP. In addition, the mean arterial and cerebral coronary perfusion pressures were improved. This animal study demonstrated a clear correlation between negative intrathoracic pressure, intracranial pressure, aortic pressure, and cerebral blood flow. The projection is that by imposing an increased negative Intrathoracic pressure, the aortic pressure increases, ICP is lowered, and cerebral perfusion is enhanced.

In a study investigating the effects of the ITPR on ICP and cerebral perfusion pressure (CPP), hemodynamic variables were assessed in six females and four males (ages 17–60) with elevated ICP. The intervention included randomly assigned endotracheal tube pressures (-5 mm Hg or -9 mm Hg) applied via ITPR. Measurements were taken at baseline and sequentially during 20 device applications, with ICP decreasing significantly by 3.3 mm Hg ($p = 0.003$) with the -5 mm Hg device, accompanied by a significant CPP increase of 6.5 mm Hg ($p = 0.019$). The -9 mm Hg device showed a smaller but statistically significant decrease in ICP by 2.4 mm Hg ($p = 0.044$) and a concurrent CPP increase of 6.5 mm Hg ($p = 0.001$). Although the sample size was small, these encouraging preliminary results suggest the potential of ITPR in lowering ICP and increasing CPP in brain-injured patients (Kiehna *et al.*, 2013).

With an apparent gap in published research in ITD clinical trials, a recent study published in 2021 has again suggested a link between inspiratory resistance and reduction in ICP (Hansen *et al.*, 2021). The study focused on evaluating potential countermeasures to address spaceflight associated neuro-ocular syndrome (SANS). The primary objective was to assess the impact of reducing ICP by lowering central venous pressure (CVP) through various interventions. The research explored countermeasures such as thigh cuffs and ITD to reduce the effects of increased ICP associated with spaceflight (Hansen *et al.*, 2021).

This study has a small sample size of four male patients, each of which had an invasive ICP monitor fitted and were breathing through a -7cmH20 ITD device for 5 min intervals to generate negative intrathoracic pressure. Findings showed a reduction in ICP and Central Venous Pressure (CVP) both thought to be because of intrathoracic loading. Thigh cuff inflation to 30 mmHg showed minimal reduction in both CVP and ICP. However, inspiratory resistance breathing resulted in substantial reductions in both parameters, suggesting intrathoracic unloading as a potential mechanism (Hansen *et al.*, 2021).

3.2.4 Discussion

The review published literature established three overarching themes. These themes will now be discussed in more depth below.

3.2.4.1 Effect of ITD on Hemodynamic variables such as MAP

The potential for ITD to affect ICP in human subjects can be inferred from animal studies and human studies where measurements such as Mean Atrial Pressure or Cerebral Perfusion Pressure were measured. Mean atrial pressure is the average blood pressure during one cardiac cycle, normally 70-100mmHg, and the driving force that pushes blood into the brain, while ICP is the opposing force that keeps blood out (Mount and Das, 2023). Cerebral perfusion pressure is the defining factor of cerebral blood flow and the difference between MAP and ICP (Mount and Das, 2023). If autoregulation is maintained, in the presence of hypotension vasoconstriction will occur, thus increasing MAP, decreasing ICP and maintaining a 'normal' CPP, while in the presence of hypertension the opposite will occur resulting in CPP regulation (Mount and Das, 2023; Armstead, 2016). Therefore, any ability of an ITD to effect MAP or cerebral blood flow will subsequently affect ICP. The inverse correlation between high ICP and favorable outcome in TBI was proven over a decade ago in a study involving 846 TBI patients. Patients whose ICP was < 20 mm Hg by 48 hours had a mortality rate of 14%, in contrast to those with ICP > 20 mm Hg whose mortality rate was 34% (Jiang *et al.*, 2002).

3.2.4.2 Effects of ITD on Mean Cerebral Blood Flow Velocity

Studies exploring the impact of ITDs on CBFV provide varying perspectives. While some studies, like the one conducted by Moore *et al.* (2021a) suggest that head and thorax elevation during active cardiopulmonary resuscitation with an impedance threshold device improves cerebral perfusion, others, such as the studies by Rickards focus on the potential effects of spontaneously breathing through an ITD (Rickards *et al.*, 2007; Rickards *et al.*, 2008).
Despite the absence of consistent statistical significance in the reduction of mean CBFV (Rickards *et al.*, 2008), the documented increase in oscillations in CBFV was observed (Rickards *et al.*, 2007). The authors suggest potential benefits for cerebral perfusion with ITD usage. Moreover, with varying research suggesting a link between head injury recovery and prognostic forecasting and CBFV, this is an area worthy of further research (Chan, Miller and Dearden, 1992; Purkayastha *et al.*, 2019; Gaggi *et al.*, 2023).

3.2.4.3 Effect of ITD on ICP

There has been, to date, only one human trial in the use of the spontaneously breathing ITD device, to evaluate its effect on ICP (Hansen *et al.*, 2021). However, the study by Hansen *et al.* (2021) had very limited generalisability and transferability of findings given the very specific focus of the study and participant population. The focus of the study was very specific to SANS, a condition experienced by astronauts, the cause of which is not fully understood but causes optic disc oedema (Fall *et al.*, 2022). Moreover SANS has a different pathologic process with no direct evidence of ICP elevation in astronauts and so generalisation of results is limited (Fall *et al.*, 2022). The study also had a very small sample size (n=4) all of which were male and who had Ommaya reservoirs fitted for unrelated clinical conditions, allowing direct access to CSF and the ability to administer medication across the brain blood barrier (Zubair and De Jesus, 2024).

In contrast, a human trial has also taken place in intubated patients using the ITPR. The pilot study conducted by Kiehna *et al.* (2013) assessed the use of the ITPR in patients with an ICP monitor or external ventricular drain and altered intracranial elastance. A decreased ICP and increased CCP in brain injury patients studied within the ITPR pilot study were observed (Guerci *et al.*, 1985; Kiehna *et al.*, 2013).

The authors suggest this may be explained by a decrease in cerebral venous blood volume and increasing output. Although only a small study (n=10) the conclusion found that the use of ITPR in patients with altered intracranial elastance is feasible. Although the study was not powered to demonstrate efficacy, the data strongly suggests that ITPR may be used to rapidly lower ICP and increase CCP without apparent adverse effects. The study suggests that additional studies are now needed to assess longitudinal changes in ICP when the device is in use and to delineate treatment parameters (Kiehna *et al.*, 2013).

The ResQgard provides -7cmH2o resistance (Convertino *et al.*, 2012) which converts to -5.1mmHg using the equation of 1mmHg = 1.36cmH2o (Sabir and Usher-Smith, 2008). Although different devices, it is hypothesised that taking into consideration the ITPR pilot study results, the ResQgard may decrease ICP by 3.3mmHg over a 10-minute period. However, the studies small sample size (n=10) raises concerns about generalisability. Additionally, the lack of a control group and the open-label design introduce potential biases. While the paper suggests a decrease in ICP and an increase in CPP during ITPR application, the absence of statistical power to demonstrate efficacy weakens the findings. Moreover, the short-term nature of the study may not capture longitudinal changes or assess long-term outcomes. The paper could benefit from a larger, randomized controlled trial with robust statistical analyses to validate its conclusions.

Notably, the scientific evidence underpinning the Brain Trauma Foundation (BTF) guidelines are level II-III evidence (Bratton *et al.*, 2007). Of relevance is that there is no robust level I evidence from randomised controlled trials investigating the use of medical devices, such as the ITD, to treat raised ICP or suboptimal CPP arising from TBI. There has, however, been two pilot clinical trial performed to date in this area. One on the use of the ITPR as discussed above (Kiehna *et al.*, 2013). It is worth noting that a similar study in head injury patients was commissioned by Advanced Circulatory System in collaboration with The US Army Medical Research and Materiel Command in 2014 (Clinicaltrials.gov, 2014). The aim was to prove application of ITPR results in an increase in CPP and a decrease in ICP in this patient population. The protocol specified application of two pressures: -7 cm H2O ITPR and -12cm H2O ITPR to 40 mechanically ventilated intubated patients. The intervention allocation was randomised, and the study was a blinded crossover design. Primary assessments included change in ICP from baseline compared with the ICP during 15 minutes of ITPR use, measurement of mean and maximum CPP during ITPR use and time to maximum increase in CPP. Lung compliance and arterial blood gases were also monitored. No study results are currently available, and the status of this study is reported as terminated (Clinicaltrials.gov, 2014).

3.2.5 Conclusion

The evidence presented in this literature review indicates that devices which create sub-atmospheric intrathoracic pressure, such as the ResQgard, have been observed to rapidly lower ICP and raise CPP using safe non-invasive therapeutic interventions in head injury patients. Hypotension and raised ICP are well-known poor prognostic indicators in patients suffering traumatic brain injuries, therefore based on the combined benefits of the ITD in increasing MAP and CCP while decreasing ICP, a strong theoretical clinical benefit exists for the intervention in this patient population (Convertino *et al.*, 2005; Cooke *et al.*, 2006; Yannopoulos *et al.*, 2006a; Convertino *et al.*, 2007; Rickards *et al.*, 2007; Convertino *et al.*, 2012; Wampler *et al.*, 2014; Hansen *et al.*, 2021). The use of ITPR in intubated and mechanically ventilated inpatients has already been researched within a pilot study, indicating positive effects on ICP and CPP (Kiehna *et al.*, 2013). The authors suggest that there now exists a clear need for a proof of clinical concept study to show that application of an ITD can be used as a safe and effective non-invasive method to increase CPP and decrease ICP in spontaneously breathing patients with raised ICP following TBI in a pre-hospital setting.

However, the authors recommend that before any pre-hospital feasibility or proof-of-concept studies are conducted in the use of ITD in head injury patients, considerations should be made to any potential transferability or implementation issues regarding a change to current head injury management and evidence-based practice (The Health Foundation, 2013; Mosadeghrad, 2014; Correa *et al.*, 2020; Allcock *et al.*, 2015; Bach-Mortensen, Lange and Montgomery, 2018).

Based on the current evidence, ITD therapy shows the potential to improve hemodynamic variables and manage raised ICP. However, more robust clinical trials are needed to establish its efficacy conclusively. It is recommended that ITD therapy be considered for further research and pilot implementation in clinical settings. This would involve conducting larger, randomised controlled trials to validate its effectiveness and safety. The potential benefits of ITD therapy include providing a non-invasive method to manage ICP and CPP, which could significantly enhance patient outcomes in pre-hospital and emergency settings.

3.3 ONSD Ultrasound Review

3.3.1 Methods

3.3.1.1 Design

The design of this literature review was a systematic review with meta-synthesis of the qualitative data. The process and structure of this review has been formulated using the updated Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Page *et al.*, 2021b) and guidance from (Wright *et al.*, 2007) and (Nusrat *et al.*, 2016).
The aim of this literature review is to establish if ONSD ultrasound has a place in the pre-hospital care of head injury patients, as a triage or 'red flag' tool, to highlight those patients likely to have increased ICP on further testing using other modalities. Specifically, the consideration of the sensitivity and specificity of results and subsequent suggested increased ICP threshold or 'cut off' ONSD measurement. To achieve this, included papers were those comparing ONSD measurements with various modalities that the patient may be exposed to during in-hospital assessment and monitoring, such as computed tomography (CT) Scan and invasive monitors such as a Camino bolt or ventriculostomy. Various modalities have been considered as it is unclear at this stage how pre-hospital screening such as this may change the patient pathway, such as the potential for direct admission or referral for specialist assessment or treatment on immediate hospital arrival.

3.3.1.2 Inclusion and exclusion criteria

The search strategy was designed using pre-determined inclusion and exclusion criteria, as seen in Table 13. The inclusion criteria were limited to papers published post 2005, to capture a period of 10 year prior to the origins of this thesis, while still ensuring the literature review remained contemporary.

Table 13 - Inclusion and exclusion criteria for ONSD Ultrasound literature review

Criteria	Inclusion	Exclusion
Type of participant	Adult human participants	Paediatric human participants or other non-human species.
Type of study	Qualitative, quantitative, or mixed method studies, meta-analysis.	Literature reviews, case studies
Phenomena of interest	Studies exploring a link between ONSD ultrasound and ICP measurements with a direct comparison to another modality and a focus on emergency or trauma presentations.	Studies focusing on a 'special patient group' therefore reducing potential transferability of results. Or studies without an emergency or trauma focus.
Language	Studies published in English	Studies published in a language other than English
Date Range	Studies published between 2005 and 2022	Studies published pre-2005

3.3.1.3 Search strategy.

To conduct a review of the evidence, the following databases were searched for relevant studies: CINAHL, MEDLINE and PUBMED and Cochrane. These databases were searched using the following search terms with the inclusion of Medical Subject Headings (MeSH) and Boolean operators of AND/OR: (ICP or increased intracranial pressure) AND (Ocular or optic Nerve) AND (Ultrasound or sonography), (Sayers, 2008).

3.3.1.4 Critical appraisal

The resources were appraised for their credibility, validity, reliability, and transferability. To complete this appraisal the researcher used the recognised 'Critical Appraisal Skills Programme' (CASP) checklists (CASP, 2018) and guidance by (Azzam and Salah, 2017).

3.3.1.5 Data extraction

Data extraction was performed by the researcher, using a data extraction table, which included the following information from each study: Author, date of publication, methods, sample size, results, and a summary of conclusion, as can be seen in Table 14.

Table 14 - ONSD Ultrasound Literature Review: Data extraction table

Authors	Aim	Methods	Sample	Results	Conclusions
(Blaivas, Theodoro and Sierzenski, 2003)	This study hypothesized that using ultrasound (US) to measure the optic nerve sheath diameter (ONSD) could reliably indicate elevated intracranial pressure (EICP).	The researchers conducted a prospective, blinded observational study on emergency department (ED) patients suspected of having EICP due to potential focal intracranial pathology. This study took place over six months at a large community ED with an emergency medicine residency program. Patients suspected of EICP by an ED attending were included when study physicians were available, excluding unstable patients. ONSD was measured 3 mm behind the globe using a 10-MHz linear probe on the closed eyelids of supine patients, bilaterally. An ONSD above 5 mm on ultrasound was considered abnormal based on prior literature. CT findings indicative of EICP included mass effect with a midline shift of 3 mm or more, a collapsed third ventricle, hydrocephalus, effacement of sulci with significant oedema, and abnormal mesencephalic cisterns. For each patient, the average of the two ONSD measurements was calculated, and head CT scans were evaluated for signs of EICP. Student's t-test was used to compare ONSDs in normal and EICP groups, and sensitivity, specificity, and predictive values were calculated.	35	Thirty-five patients were included in the study, with 14 showing CT results indicative of EICP. All cases of EICP identified by CT were accurately predicted by an ONSD greater than 5 mm on ultrasound. One patient had an ONSD of 5.7 mm in one eye and 3.7 mm in the other, with a mass abutting the optic nerve but no shift on CT; this patient was categorized as having EICP. The mean ONSD for the 14 patients with CT-confirmed EICP was 6.27 mm (95% CI = 5.6 to 6.89), while the mean ONSD for the others was 4.42 mm (95% CI = 4.15 to 4.72). The difference of 1.85 mm (95% CI = 1.23 to 2.39 mm) was statistically significant ($p = 0.001$). The sensitivity and specificity of ONSD compared to CT results were 100% and 95%, respectively, with positive and negative predictive values of 93% and 100%.	Although the study had a small sample size and potential selection bias, the authors suggest that bedside ultrasound in the ED could be a valuable tool for diagnosing EICP.

(Tayal *et al.*, 2007)	The study aimed to determine if bedside ultrasonographic measurement of the optic nerve sheath diameter (ONSD) could accurately predict computed tomographic (CT) findings of elevated intracranial pressure (EICP) in adult head injury patients in the emergency department.	This prospective, blinded observational study involved adult emergency department (ED) patients suspected of having intracranial injury with potential elevated intracranial pressure. Patients under 18 years or with obvious ocular trauma were excluded. Using a 7.5-MHz ultrasonographic probe on the closed eyelids, a single ONSD measurement was taken 3 mm behind the globe in each eye. An average binocular ONSD greater than 5.00 mm was considered abnormal. Cranial CT findings indicative of elevated intracranial pressure, such as shift, oedema, or effacement, were used to evaluate the accuracy of the ONSD measurements.	59	Fifty-nine patients participated in the study, with an average age of 38 years and a median Glasgow Coma Scale (GCS) score of 15 (interquartile range 6 to 15). Eight patients with an ONSD of 5.00 mm or more had CT findings consistent with elevated intracranial pressure. The sensitivity of ultrasonography for detecting elevated intracranial pressure was 100% (95% confidence interval [CI] 68% to 100%), and the specificity was 63% (95% CI 50% to 76%). For detecting any traumatic intracranial injury found by CT, the sensitivity was 84% (95% CI 60% to 97%) and the specificity was 73% (95% CI 59% to 86%).	The authors concluded that bedside ultrasonographic measurement of the optic nerve sheath diameter shows potential as a sensitive screening tool for detecting elevated intracranial pressure in adult head injury patients in the emergency department.

(Kimberly *et al.*, 2008)	The study aimed to evaluate the relationship between optic nerve sheath diameter (ONSD) and intracranial pressure (ICP) and to validate the commonly used ONSD threshold of 5 mm using direct ICP measurements obtained via ventriculostomy.	A prospective, blinded observational study was conducted using a convenience sample of adult patients in both the emergency department (ED) and the neurologic intensive care unit (ICU) who had invasive intracranial monitors placed as part of their clinical care. Ocular ultrasounds were performed with a 10–5 MHz linear probe. Emergency physicians with prior experience in ocular ultrasound conducted the ONSD measurements while being blinded to the contemporaneous ICP readings obtained directly from invasive monitoring. The association between ONSD and ICP was assessed using the Spearman rank correlation coefficient, and a receiver operator characteristic (ROC) curve was created to determine the optimal ONSD cut-off for detecting ICP greater than 20 cm H2O.	15	Thirty-eight ocular ultrasounds were performed on 15 individual patients. The Spearman rank correlation coefficient between ONSD and ICP was 0.59 ($p<0.0005$), indicating a significant positive correlation. An ROC curve was created to evaluate the ability of ONSD to distinguish an abnormal ICP greater than 20 cm H2O. The area under the ROC curve was 0.93 (95% confidence interval [CI] = 0.84 to 0.99). Based on the ROC curve, an ONSD greater than 5 mm performed well in detecting ICP greater than 20 cm H2O, with a sensitivity of 88% (95% CI = 47% to 99%) and specificity of 93% (95% CI = 78% to 99%).	The study systematically confirmed the commonly used threshold of ONSD greater than 5 mm to detect ICP greater than 20 cm H2O. The authors concluded that this research directly correlates ventriculostomy measurements of ICP with ultrasound ONSD measurements, providing further support for the use of ONSD measurements as a non-invasive test for elevated ICP.

(Moretti *et al.*, 2009)	The study aimed to validate the effectiveness of optic nerve ultrasound in detecting intracranial hypertension in patients with spontaneous intracranial haemorrhage. Additionally, it sought to evaluate the consistency of optic nerve sheath diameter (ONSD) measurements and to determine if ONSD changes align with variations in intracranial pressure (ICP).	The study included 63 adult patients diagnosed with either subarachnoid haemorrhage (34 patients) or primary intracerebral haemorrhage (29 patients), all of whom required sedation and invasive ICP monitoring in a 10-bed intensive care unit. ONSD was measured 3 mm behind the globe using a 7.5-MHz ultrasound probe. The mean binocular ONSD was used for statistical analysis, and ICP values were recorded simultaneously with the ultrasound measurements. To assess measurement consistency, 28 ONSD measurements were taken consecutively by two different observers. Additionally, 12 paired measurements were taken before and within one minute after cerebrospinal fluid (CSF) drainage to manage elevated ICP.	63	A total of 94 ONSD measurements were analysed. An ONSD cut-off point of 5.2 mm was identified as optimal for predicting elevated ICP (>20 mmHg), with a sensitivity of 93.1% and a specificity of 73.85%. The correlation coefficient between ONSD and ICP was 0.7042. The median difference between observers was 0.25 mm. CSF drainage resulted in a significant reduction in ONSD from 5.89 ± 0.61 mm to 5 ± 0.33 mm (P < 0.01).	The authors concluded that optic nerve ultrasound is a reliable non-invasive method for detecting elevated ICP in patients with intracranial haemorrhage. The ONSD measurements demonstrated good reproducibility and were shown to change concurrently with CSF pressure variations.

(Soldatos *et al.*, 2008)	The study aimed to investigate whether optic nerve sheath diameter (ONSD) measurements correlate with both non-invasive and invasive intracranial pressure (ICP) measurements in adults with brain injuries.	The study included 76 critical care patients, comprising 58 males with an average age of 47 years. Fifty of these patients had brain injuries, while the remaining 26 served as control subjects without intracranial pathology. Initially, brain-injured patients were assessed clinically using the Glasgow Coma Scale and a semi-quantitative neuroimaging scale (Marshall Scale). Patients were then categorized into moderate brain injury (Marshall Scale I and Glasgow Coma Scale > 8) and severe brain injury (Marshall Scale II to VI and Glasgow Coma Scale ≤ 8). All patients underwent non-invasive ICP measurement via transcranial Doppler sonography and simultaneous ONSD measurement using optic nerve sonography. Invasive ICP measurement using an intraparenchymal catheter was performed in patients with severe brain injury.	66	The study found that both ONSD and estimated ICP were significantly higher in patients with severe brain injury (6.1 ± 0.7 mm and 26.2 ± 8.7 mmHg, respectively) compared to those with moderate brain injury (4.2 ± 1.2 mm and 12.0 ± 3.6 mmHg) and control subjects (3.6 ± 0.6 mm and 10.3 ± 3.1 mmHg). In patients with severe brain injury, ONSD measurements showed a strong correlation with estimated ICP values (r = 0.80) and neuroimaging scale results (r = 0.82). Additionally, ONSD measurements correlated with invasive ICP values (r = 0.68) in these patients. The optimal ONSD cut-off value for predicting elevated ICP was determined to be 5.7 mm, with a sensitivity of 74.1% and specificity of 100%.	The authors concluded that ONSD measurements correlate well with both non-invasive and invasive ICP measurements, as well as with head CT scan findings in adults with brain injuries. Therefore, they suggest that optic nerve sonography can serve as an additional diagnostic tool to alert clinicians to the presence of elevated ICP, especially when invasive ICP evaluation is contraindicated or unavailable.

(Rajajee *et al.*, 2011)	The study aimed to validate the use of optic nerve ultrasound (ONUS) performed by neuro-intensivists as a method for detecting intracranial hypertension and to identify the optimal optic nerve sheath diameter (ONSD) threshold for detecting intracranial pressure (ICP) greater than 20 mmHg.	This prospective, blinded observational study included patients in the ICU who were at risk for intracranial hypertension and had either external ventricular drains or intraparenchymal ICP monitors. Neuro-intensivists measured the ONSD at the bedside while simultaneously recording invasive ICP measurements. An ROC curve was constructed to determine the optimal ONSD threshold for detecting ICP greater than 20 mmHg.	65	The ROC curve analysis revealed an area under the curve (AUC) of 0.98, indicating high accuracy (95% CI 0.96–0.99; $P < 0.0001$). The optimal ONSD threshold for detecting ICP greater than 20 mmHg was determined to be ≥0.48 cm, with a sensitivity of 96% (95% CI 91–99%) and specificity of 94% (95% CI 92–96%). A higher cut-off of ≥0.52 cm, proposed by some authors, showed lower sensitivity (67%) but higher specificity (98%).	The authors concluded that bedside ONSD measurement performed by neuro-intensivists is an accurate, non-invasive method for identifying ICP greater than 20 mmHg in a diverse group of patients with acute brain injury. The ONSD threshold of ≥0.48 cm demonstrated the greatest accuracy, although they suggest that internal validation of ONSD criteria may be necessary.
(Sahoo and Agrawal, 2013)	The study aimed to evaluate the feasibility and reliability of using optic nerve sheath diameter (ONSD) as an objective measure of intracranial pressure (ICP) in patients with severe head injuries.	This prospective study was conducted over a three-month period in the Neurosurgery ICU. It included patients with severe traumatic brain injury (admission Glasgow Coma Scale ≤8) who had ICP monitoring using a Codman® intraparenchymal transducer. Serial bedside ONSD measurements were taken by a single neurosurgeon using a 7.5 MHz linear probe on the same ultrasound machine (SonoSite Micromaxx®). Patients with significant ocular trauma to either eye were excluded from the study.	20	The mean ONSD in patients with ICP >20 mmHg was 6.6 ± 0.45 mm, compared to 5.9 ± 0.57 mm in patients with ICP <20 mmHg ($p = 0.028$). The Pearson Correlation Coefficient between ONSD (average of both eyes) and ICP was 0.499 ($p = 0.041$). An ONSD cut-off of 6.3 mm detected ICP >20 mmHg with 100% sensitivity and 72.7% specificity.	The authors concluded that ONSD is a technically simple, non-invasive method for assessing ICP and correlates well with actual ICP in patients with severe traumatic brain injury. They suggest that an ONSD cut-off of 6.3 mm can be used to plan therapeutic interventions when ICP monitoring is unavailable or contraindicated.

(Amini *et al.*, 2013)	The objective of the study was to assess the accuracy of using sonographic measurements of the optic nerve sheath diameter (ONSD) to estimate intracranial pressure (ICP) in patients who are being considered for a lumbar puncture (LP).	This descriptive prospective study involved using ultrasonography to measure the optic nerve sheath diameter (ONSD) in 50 non-trauma patients who were candidates for lumbar puncture (LP) due to various diagnoses. The ONSD was measured before the LP, and immediately after, the intracranial pressure (ICP) of each patient was measured via LP. Correlation tests were conducted to evaluate the relationship between ICP and the sonographic diameter of the optic nerve sheath. A receiver operating characteristic (ROC) curve was utilized to determine the optimal cut-off point for diagnosing ICP values exceeding 20 cm H_2O.	50	The average ONSD values were 5.17 ± 1.01 mm on the left side and 5.19 ± 1.06 mm on the right side ($P = .552$). For patients with elevated ICP, the mean ONSD was 6.66 ± 0.58 mm, compared to 4.60 ± 0.41 mm in individuals with normal ICP ($P < .001$). There was a significant correlation between ONSD and ICP values ($P < .05$; $r = 0.88$). An ONSD greater than 5.5 mm predicted an ICP of ≥ 20 cm H_2O with 100% sensitivity and specificity (95% CI, 100-100) ($P < .001$).	The authors concluded that the sonographic measurement of the optic nerve sheath diameter is a reliable and precise indicator of elevated intracranial pressure.
(Geeraerts *et al.*, 2007)	To evaluate the relationship between optic nerve sheath diameter (ONSD) and intracranial pressure (ICP) at the time of ICU admission, and to determine whether an increased ONSD upon admission is linked to elevated ICP within the first 48 hours following trauma.	A prospective, blind, observational study was conducted in a surgical critical care unit at a level 1 trauma centre, involving 31 adult patients with severe traumatic brain injury (TBI; Glasgow Coma Scale ≤ 8) who required sedation and ICP monitoring, and 31 control patients without brain injury who required sedation. The optic nerve sheath diameter (ONSD) was measured using a 7.5-MHz linear ultrasound probe. Two TBI groups were defined based on their ICP profiles. Patients were classified as having high ICP if their ICP exceeded 20 mmHg for more than 30 minutes within the first 48 hours (before any specific treatment); otherwise, they were classified as having normal ICP.	31	The highest ONSD value (the maximum measurement for the right and left eye) was significantly greater in patients with high ICP (6.3 ± 0.6 mm) compared to those with normal ICP (5.1 ± 0.7 mm) and control patients (4.9 ± 0.3 mm). There was a significant correlation between the highest ONSD and ICP at admission ($r = 0.68$). The highest ONSD was an effective predictor of elevated ICP, with an area under the ROC curve of 0.96. When the ONSD was below 5.7 mm, the sensitivity and negative predictive values for high ICP were 100%.	The authors propose that ocular ultrasound scans may be valuable for detecting elevated ICP in the early post-traumatic period following severe TBI.

(Geeraerts *et al.*, 2008)	This study aimed to evaluate the relationship between optic nerve sheath diameter (ONSD) and intracranial pressure (ICP) in neurocritical care patients.	An observational study was conducted with 37 adult patients, including those with severe traumatic brain injury (n = 22), subarachnoid haemorrhage (n = 6), intracranial hematoma (n = 8), and stroke (n = 1), all of whom required sedation and ICP monitoring using an intraparenchymal probe in the frontal lobe. For each optic nerve, two measurements of ONSD were taken using a 7.5 MHz linear probe (HP Sonos 5500®; Hewlett Packard) in 2D mode, 3 mm behind the globe, with one measurement in the sagittal plane and one in the transverse plane. The mean value for both eyes was recorded. ONSD and ICP were measured simultaneously once a day during the first 2 days after ICP probe placement and in cases of significant changes in ICP.	37	There was a significant linear relationship between ONSD and ICP (Spearman correlation $\rho = 0.75$, $P < 0.0001$). Changes in ICP (delta) were also significantly correlated with variations in ONSD ($\rho = 0.78$, $P < 0.001$). The ONSD cut-off for detecting ICP greater than 20 mmHg was 5.8 mm (area under the ROC curve = 0.91). The negative likelihood ratio for this cut-off was 0.07.	The authors concluded that there is a significant relationship between ONSD and ICP in neuro-ICU patients. Changes in ICP are accurately detected by ONSD. They suggest that the likelihood of having elevated ICP is very low when the ONSD is below 5.8 mm, indicating that this non-invasive method could be used to confirm the absence of raised ICP.
(Kwan *et al.*, 2009)	The objectives of this research were twofold: (1) to assess the relationship between ultrasound measurements of the optic nerve sheath diameter (ONSD) and subsequent invasive intracranial pressure (ICP) measurements, and (2) to evaluate the correlation between the side of head injury and both ipsilateral and contralateral ONSD and invasive ICP measurements.	A blinded, prospective clinical study was conducted on adult trauma patients with blunt or penetrating head injuries who required intracranial pressure (ICP) monitoring at an urban, university-based trauma centre. The optic nerve sheath diameters (ONSD) on both the left and right sides were measured using optic ultrasound before and after the invasive placement of an ICP monitor.	7	Seven trauma patients (six with blunt trauma and one with penetrating trauma) who required intracranial pressure (ICP) monitoring for head injuries were enrolled in the study. The measurements of the optic nerve sheath diameter (ONSD) on the left and right sides, both before and after the intervention, showed no significant differences ($p>0.31$). Additionally, there was no observed correlation between the invasive ICP measurements and the ONSD on either side, regardless of the side of the head injury, the location of the pressure monitor, or the presence or absence of elevated ICP ($p>0.11$).	The authors concluded that, despite the increasing use of ultrasound in assessing trauma patients, the clinical effectiveness of using ocular ultrasound to measure optic nerve sheath diameter (ONSD) for predicting intracranial pressure (ICP) in head-injured patients before invasive monitoring is unreliable due to variability and lack of correlation.

(Strumwasser *et al.*, 2011)	The hypothesis proposed that bedside measurements of optic nerve sheath diameter (ONSD) could accurately estimate intracranial pressure (ICP) in acutely injured patients. The specific objectives were: (1) to evaluate the accuracy of ONSD in estimating elevated ICP, (2) to correlate ONSD with ICP in both unilateral and bilateral head injuries, and (3) to assess the impact of ICP monitor placement on ONSD measurements.	A blinded, prospective study was conducted on adult trauma patients who required intracranial pressure (ICP) monitoring at an urban, university-based trauma centre. The optic nerve sheath diameter (ONSD) was measured using ultrasound both before and after the placement of an ICP monitor (either Camino Bolt or Ventriculostomy).	10	A total of 114 measurements were collected from 10 trauma patients who required intracranial pressure (ICP) monitoring. The optic nerve sheath diameter (ONSD) measurements taken before and after the placement of an ICP monitor were compared with the side of the injury. Receiver operating characteristic (ROC) analysis indicated that ONSD is a poor predictor of elevated ICP (AUC = 0.36). The overall sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy for estimating ICP using ONSD were 36%, 38%, 40%, 16%, and 37%, respectively. There was a poor correlation between ONSD and ICP in both unilateral ($R2 = 0.45$, $P < 0.01$) and bilateral ($R2 = 0.21$, $P = 0.01$) injuries. The placement of the ICP monitor did not significantly affect ONSD measurements on the right side ($P = 0.5$), left side ($P = 0.4$), or both sides combined ($P = 0.3$).	The authors concluded that using sonographic measurements of optic nerve sheath diameter (ONSD) as a substitute for invasive monitoring to detect elevated intracranial pressure (ICP) is unreliable due to poor accuracy and correlation.

(Cammarata *et al.*, 2011)	The aim of this study was to investigate whether dilation of the optic nerve sheath, as detected by bedside ocular ultrasound, could reliably identify increases in intracranial pressure (ICP) measured with an intraparenchymal probe in adult patients with head trauma.	Eleven adult patients with head trauma, admitted to the intensive care unit with a Glasgow Coma Scale score of 8 or less and confirmed cerebral contusion via computed tomography scan, requiring invasive intracranial pressure (ICP) monitoring, were enrolled in the study. ICP values of 20 mm Hg or less were considered normal. Patients with acute or chronic ocular lesions were excluded. Additionally, ten non-trauma intensive care unit patients, who did not require ICP monitoring, were enrolled as a control group. Invasive arterial pressure was monitored, and the optic nerve sheath diameter (ONSD) was assessed using ocular ultrasound in all patients.	21	Head trauma patients without intracranial hypertension had optic nerve sheath diameter (ONSD) values, measured by ultrasound, similar to those of the control group (5.52 mm ± 0.36 mm vs. 5.51 mm ± 0.32 mm). However, ONSD significantly increased to 7.0 mm ± 0.58 mm when intracranial pressure (ICP) exceeded 20 mm Hg ($p < 0.0001$ compared to normal ICP and control). There was a significant correlation between ONSD values and ICP values ($r = 0.74$, $p < 0.001$).	The authors concluded that when intracranial pressure (ICP) exceeded 20 mm Hg, the optic nerve sheath diameter (ONSD) increased, whereas when ICP was below 20 mm Hg, ONSD values returned to levels similar to those in control non-trauma patients. They suggest that ocular ultrasound could be a viable alternative for a rapid, indirect assessment of ICP in head trauma patients.

(Sekhon *et al.*, 2014a)	Evaluate the relationship between optic nerve sheath diameter (ONSD) measured using bedside portable computed tomography (CT) scans and simultaneously measured intracranial pressure (ICP) in patients with severe traumatic brain injury.	A retrospective cohort study of 57 patients admitted between 2009 and 2013 was conducted. Linear and logistic regression analyses were used to model the correlation and discrimination between optic nerve sheath diameter (ONSD) and intracranial pressure (ICP) or intracranial hypertension, respectively.	57	The cohort had a mean age of 40 years (SD 16) and a median admission Glasgow Coma Scale score of 7 (IQR 4–10). The between-rater agreement, measured by the intraclass coefficient, was 0.89 (95% CI 0.83–0.93, $P < 0.001$). The mean optic nerve sheath diameter (ONSD) was 6.7 mm (SD 0.75), and the mean intracranial pressure (ICP) during CT was 21.3 mmHg (SD 8.4). There was a strong correlation between ICP and ONSD ($r = 0.74$, $P < 0.001$). The area under the curve for ONSD to discriminate elevated ICP (≥20 mmHg vs. <20 mmHg) was 0.83 (95% CI 0.73–0.94). Using a cut-off of 6.0 mm, ONSD had a sensitivity of 97%, specificity of 42%, positive predictive value of 67%, and negative predictive value of 92%. In linear regression models, ONSD was a much stronger predictor of ICP (R2 = 0.56) compared to other CT features (R2 = 0.21).	The authors concluded that simultaneous measurement of ONSD on CT and ICP were strongly correlated, and ONSD was effective in discriminating intracranial hypertension. They found that ONSD was a much stronger predictor of ICP than other CT features and noted excellent agreement between raters in measuring ONSD.

(Sekhon *et al.*, 2014b)	The aim of the study was to evaluate the independent relationship between optic nerve sheath diameter (ONSD) measured using CT and mortality in a population of patients admitted with severe traumatic brain injury (TBI).	A retrospective cohort study was conducted on patients with TBI requiring intracranial pressure (ICP) monitoring, admitted to the ICU between April 2006 and May 2012 at two neurotrauma centres. ONSD was independently measured by two physicians who were blinded to patient outcomes. Multivariable logistic regression modelling was used to assess the association between ONSD and hospital mortality.	220	A total of 220 patients were included in the analysis. The cohort had a mean age of 35 years (SD 17), and 171 of 220 (79%) were male. The median admission Glasgow Coma Scale (GCS) score was 6 (IQR 3–8). The intra-class correlation coefficient between raters for ONSD measurements was 0.92 (95% CI 0.90–0.94, $P < 0.0001$). On multivariable analysis, each 1 mm increase in ONSD was associated with a twofold increase in hospital mortality (OR 2.0, 95% CI 1.2–3.2, $P = 0.007$). Using linear regression, ONSD was independently associated with increased ICP in the first 48 hours after admission ($\beta = 4.4$, 95% CI 2.5–6.3, $P < 0.0001$).	The authors concluded that in patients with TBI, ONSD measured on CT scanning was independently associated with ICP and mortality.

(Raffiz and Abdullah, 2017)	The objective of the study was to determine the correlation between sonographic measurements of optic nerve sheath diameter (ONSD) and intracranial pressure (ICP) values measured using the gold standard invasive intracranial ICP catheter. Additionally, the study aimed to identify the cut-off value of ONSD for predicting elevated ICP, along with its sensitivity and specificity.	A prospective observational study was conducted using a convenience sample of 41 adult neurosurgical patients treated in a neurosurgical intensive care unit with invasive ICP monitoring as part of their clinical care. A portable SonoSite ultrasound machine with a 7 MHz linear probe was used to measure ONSD using the standard technique, while simultaneous ICP readings were obtained directly from the invasive monitoring.	41	A total of 75 measurements were performed on 41 patients. The non-parametric Spearman correlation test revealed a significant correlation at the 0.01 level between ICP and ONSD values, with a correlation coefficient of 0.820. The receiver operating characteristic (ROC) curve generated an area under the curve (AUC) of 0.964, with a standard error of 0.22. From the ROC curve, an ONSD value of 5.205 mm was found to be 95.8% sensitive and 80.4% specific in detecting elevated ICP.	The authors concluded that an ONSD value of 5.205 mm is both sensitive and specific in detecting elevated ICP. They suggest that bedside ultrasound measurement of ONSD is easily learned, reproducible, and reliable in predicting elevated ICP. This non-invasive technique can serve as a useful adjunct to current invasive intracranial catheter monitoring and has broad potential clinical applications in district hospitals, emergency departments, and intensive care units.

(Wang *et al.*, 2017)	The authors aimed to quantitatively assess intracranial pressure (ICP) using optic nerve sheath diameter (ONSD) measurements.	Researchers recruited 316 neurology patients, in whom ultrasonographic ONSD was measured before lumbar puncture. The patients were randomly divided into a modelling group and a test group at a ratio of 7:3. In the modelling group, univariate and multivariate analyses were conducted to assess associations between ICP and ONSD, age, sex, BMI, mean arterial blood pressure, and diastolic blood pressure. The authors derived the mathematical function "Xing & Wang" from the modelling group to predict ICP and evaluated the function in the test group.	316	In the modelling group, ICP was strongly correlated with ONSD ($r = 0.758$, $p < 0.001$), and this association was independent of other factors. The mathematical function was ICP = −111.92 + 77.36 × ONSD (Durbin-Watson value = 1.94). In the test group, a significant correlation was found between the observed and predicted ICP ($r = 0.76$, $p < 0.001$). Bland-Altman analysis yielded a mean difference between measurements of −0.07 ± 41.55 mmH2O. The intraclass correlation coefficient and its 95% CIs for non-invasive ICP assessments using the prediction model was 0.86 (0.79–0.90).	The authors concluded that ultrasonographic ONSD measurements provide a potential non-invasive method to quantify ICP that can be conducted at the bedside.
(Lee, Kim and Yun, 2020)	The aim of the study was to evaluate and compare the diagnostic feasibility of measuring optic nerve sheath diameter (ONSD) using brain computed tomography (CT) and ocular ultrasonography (US) for predicting raised intracranial pressure (ICP) in patients with severe traumatic brain injury (TBI).	The PubMed and EMBASE databases were searched for studies assessing the diagnostic accuracy of brain CT or ocular US for predicting raised ICP. Bivariate and hierarchical summary receiver operating characteristic (HSROC) modelling were performed to evaluate and compare the diagnostic feasibility of measuring ONSD in adult patients with severe TBI according to modality (ocular US vs. brain CT).	546	A total of 11 studies with 546 participants were included. Five studies (four using ocular US and one using brain CT) were analysed. The ONSD had a pooled sensitivity of 0.91, pooled specificity of 0.77, and an area under the HSROC curve of 0.92 for predicting raised ICP. Notably, studies using ocular US demonstrated almost equal sensitivity (0.91 vs. 0.90; $p = .35$) and higher specificity (0.82 vs. 0.58; $p = .01$) compared to those using brain CT.	The authors concluded that measuring ONSD may be a useful method for predicting raised ICP in adult patients with severe TBI.

3.3.1.6 Data synthesis

The synthesis of data was conducted using the 3-stage approach by (Thomas and Harden, 2008). In stage 1 the author read each paper 'Line by Line' to establish codes relating to the original literature review question. In stage 2 the author reviewed the codes to identify similarities and grouped them into descriptive themes, then finally combining them within stage 3 into analytical themes for further discussion.

A quantitative synthesis of the included papers was considered during the review process. However, the studies included in this review exhibited significant heterogeneity in terms of study design, population, interventions, and outcomes. This heterogeneity would have compromised the validity of a meta-analysis, as combining such diverse studies could lead to misleading conclusions. Therefore, a narrative synthesis was deemed more appropriate to provide a comprehensive overview of the current evidence on ONSD ultrasound.

Additionally, the review/meta-analysis by Lee, Kim, and Yun (2020) was included to ensure that the most up-to-date evidence was considered. This review/meta-analysis provided valuable insights but had a different focus and scope compared to the current review. The current review specifically aimed to explore the potential of ONSD ultrasound in monitoring ICP in pre-hospital settings, which was not the primary focus of the included review/meta-analysis.

To avoid overlaps and double counting, careful cross-referencing of included studies was conducted. The data extraction process ensured that primary studies included in the review/meta-analysis were not duplicated in the analysis. This approach allowed for a clear distinction between the findings of the current review and those of the included review/meta-analysis, highlighting the unique contributions and added value of the current review.

3.3.2 Results

3.3.2.1 Study inclusion

An initial search of CINAHL, MEDLINE, PUBMED and Cochrane databases identified 517 studies. The studies were scanned for duplicates and 122 were removed. A further 348 studies were excluded after reading the titles and abstracts. At this stage, 47 reports were sought for retrieval successfully. Of those 47 studies, 31 were removed as they did not meet the inclusion criteria. A further 2 studies were identified from citation searching both of which were retrieved for consideration and deemed to meet the full inclusion criteria. In total 18 studies were included in the final literature review.

A PRISMA flow diagram for the search data can be found in Figure 24 (Page *et al.*, 2021a).

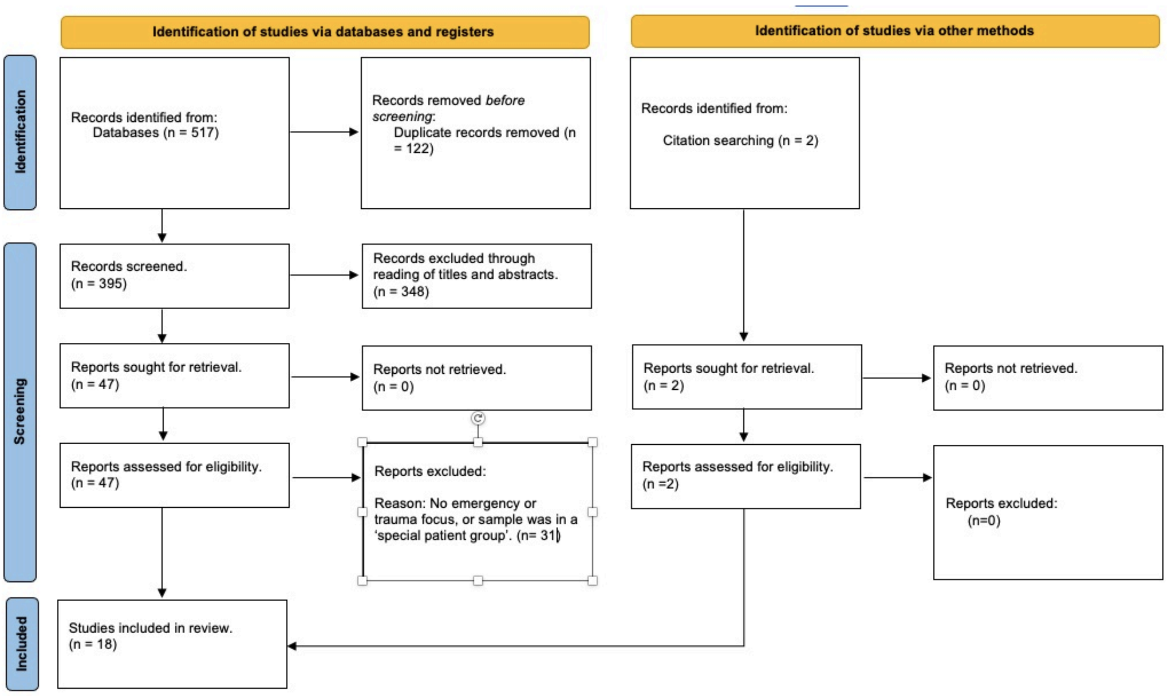


Figure 24 - PRISMA flowchart of ONSD Ultrasound Search date (Page et al 2021a).

3.3.2.2 Critical appraisal

Several studies, including Amini *et al.* (2013), Blaivas, Theodoro and Sierzenski (2003) and Sahoo and Agrawal (2013) are potentially limited by small sample sizes, raising concerns about the generalisability of findings.

A number of studies, such as Amini *et al.* (2013), Geeraerts *et al.* (2007) and Sahoo and Agrawal (2013) are conducted in single-centre settings, potentially limiting the external validity of the results.
The diversity of patient populations across studies, ranging from trauma patients to those with spontaneous intracranial haemorrhage, may introduce variability and impact the ability to apply findings universally (Sahoo and Agrawal, 2013; Lee, Kim and Yun, 2020; Rajajee *et al.*, 2011).
Variations in measurement techniques and methodologies, as seen in studies like Geeraerts *et al.* (2007) and Rajajee *et al.* (2011) may introduce inconsistencies and affect the reliability of optic nerve sheath diameter as a predictor.
Limited standardisation in measurement protocols across studies, as observed in Lee, Kim and Yun (2020) and Sekhon *et al.* (2014a) may impact the reproducibility and comparability of results.
Studies like Kwan *et al.* (2009) and Strumwasser *et al.* (2011) lack comprehensive validation of ultrasound measurements against gold standard methods, potentially affecting the accuracy and reliability of the optic nerve sheath diameter.

3.3.2.3 Study characteristics

Six of the studies were prospective observational studies (Blaivas, Theodoro and Sierzenski, 2003; Tayal *et al.*, 2007; Kimberly *et al.*, 2008; Rajajee *et al.*, 2011; Geeraerts *et al.*, 2007; Raffiz and Abdullah, 2017). Two were retrospective cohort studies (Sekhon *et al.*, 2014a; Sekhon *et al.*, 2014b) and one was a mathematical predictive modelling analysis (Wang *et al.*, 2017). One meta-analysis was included (Lee, Kim and Yun, 2020). The remaining eight made no clear declaration of their method.

Three studies took place in an emergency department (Blaivas, Theodoro and Sierzenski, 2003; Tayal *et al.*, 2007; Kimberly *et al.*, 2008). Eight studies took place in an intensive or critical care unit (Kimberly *et al.*, 2008; Moretti *et al.*, 2009; Rajajee *et al.*, 2011; Sahoo and Agrawal, 2013; Geeraerts *et al.*, 2007; Geeraerts *et al.*, 2008; Sekhon *et al.*, 2014a; Raffiz and Abdullah, 2017).
Two studies were based in a trauma center (Kwan *et al.*, 2009; Strumwasser *et al.*, 2011) and the remaining seven studies made no clear declaration of clinical setting.

There was a variation of MHz probes used for measuring of the ONSD. A 10-MHz probe was used in Blaivas, Theodoro and Sierzenski (2003), with 10-5MHz being used by Kimberly *et al.* (2008). A lower 7 MHz was used in Raffiz and Abdullah (2017) with the more commonly declared 7.5MHz declared in 5 studies (Tayal *et al.*, 2007; Moretti *et al.*, 2009; Sahoo and Agrawal, 2013; Geeraerts *et al.*, 2007; Geeraerts *et al.*, 2008).

Six of the papers declared measuring the ONSD bilaterally (Geeraerts *et al.*, 2007; Blaivas, Theodoro and Sierzenski, 2003; Tayal *et al.*, 2007; Moretti *et al.*, 2009; Sahoo and Agrawal, 2013; Amini *et al.*, 2013). One of those six studies reporting to only use the highest figure (Geeraerts *et al.*, 2007) with the others taking an average. One paper declared measuring only on the side of injury (Strumwasser *et al.*, 2011).

Variations of comparative ICP measurements were used throughout the studies. Four studies compared ONSD findings to CT findings (Blaivas, Theodoro and Sierzenski, 2003; Tayal *et al.*, 2007; Cammarata *et al.*, 2011; Sekhon *et al.*, 2014a). Invasive monitoring was also used, including ventriculostomy (Kimberly *et al.*, 2008) and intraparenchymal monitoring (Soldatos *et al.*, 2008; Sahoo and Agrawal, 2013; Geeraerts *et al.*, 2008; Cammarata *et al.*, 2011). One study compared to lumbar puncture (Amini *et al.*, 2013) and one compared to transcranial doppler alongside an invasive option (Soldatos *et al.*, 2008).

3.3.2.4 Participants

There were a total of 1113 participants across the 17 studies and a further 546 participants within the meta-analysis (Lee, Kim and Yun, 2020). Of the 1113 participants, the majority were brain injury patients with the exception of 50 participants who required a lumbar puncture for various reasons (Amini *et al.*, 2013), and 36 who made up control groups in two of the studies (Cammarata *et al.*, 2011; Soldatos *et al.*, 2008).

3.3.3 Review findings

Four themes were identified from the data analysis. The first theme was establishing the correlation between ONSD and raised ICP. The second theme was establishing a ‘cut off’ ONSD measurement with high levels of sensitivity and specificity correlated to an increased ICP. The third theme was questioning the correlation and ability to establish an ONSD 'cut off' for raised ICP detection and the fourth theme was the practicalities of ONSD Ultrasound within clinical practice.

3.3.3.1 Establishing the correlation between ONSD and raised ICP.

A study in 2003 carried out on thirty-five adults with altered levels of consciousness and suspected of having raised ICP showed that all cases of CT-determined elevated ICP were correctly predicted by ONSD over 5 mm on ultrasound measurement. Results demonstrated 100% sensitivity and 95% specificity from ONSD measurements when compared to ICP evidence from CT scans. The mean ONSD for the 14 patients with CT evidence of elevated ICP was 6.27 mm (95% CI = 5.6 to 6.89) and for the others the mean was 4.42 mm (95% CI = 4.15 to 4.72) (Blaivas, Theodoro and Sierzenski, 2003).

In Geeraerts *et al.* (2008) prospective observational study of 37 sedated adults with TBI, an ultrasound probe was used to measure ONSD over the first two days. Significant correlations were found between ONSD and ICP ($r = 0.71$, $P < 0.0001$). The researchers concluded that an enlarged ONSD was a good predictor of elevated ICP (>20 mmHg).

A previous study by the same authors in 2007 was again a prospective observational study but this time had a control group and analysis was blinded, thereby increasing validity of the results (Geeraerts *et al.*, 2007). This study by Geeraerts *et al.* (2007) investigated the correlation between ONSD upon patient hospital admission and the degree of ICP increase during the following 48 hours. Thirty-one sedated patients with TBI were assessed using an ultrasound probe to measure ONSD. Results were compared with those of 31 control patients without TBI. If ICP exceeded 20 mmHg for more than 30 min in the first 48 hours patients were considered to have high ICP. The largest ONSD value was significantly higher in patients with increased ICP. Furthermore, a significant relationship existed between the largest ONSD and ICP at admission ($r=0.68$) (Geeraerts *et al.*, 2007).

Moreover, a prospective blinded study of 59 patients with suspected raised intracranial pressure found a correlation between raised ICP and patients with an ONSD over 5 mm ($n=8$) measured by CT (Tayal *et al.*, 2007). In this study sensitivity was 100% (95% CI = 68% to 100%) and specificity was 63% (95% CI = 50% to 76%) (Tayal *et al.*, 2007).

Another prospective blinded observational study, on fifteen adult patients has also shown very high sensitivity in the detection of an increased ICP (Kimberly *et al.*, 2008). The patients in this study had in place a monitor for ICP and their ONSDs were measured repeatedly. The outcome of this study showed that ONSD over 5 mm detects ICP > 20 cm H_2O with a sensitivity of 88% (95% CI = 47% to 99%) and specificity of 93% (95% CI = 78% to 99%) (Kimberly *et al.*, 2008).

A further prospective study demonstrating a strong relationship between intracranial hypertension or raised ICP and ultrasound ONSD measurement was performed in 2011. The eleven head trauma patients enrolled in the study had a Glasgow Coma Score (GCS) of <8 and were receiving invasive ICP monitoring within the intensive care unit. A control group of 10 non-trauma intensive care patients with no ICP monitoring were also enrolled, thereby increasing the validity and robustness of the data. The head trauma patients without elevated ICP (<20mm Hg) had ONSD values equivalent to those measured in control patients (5.52 mm ± 0.36 mm vs. 5.51 mm ± 0.32 mm). However, where ICP was >20 mm Hg, ONSD values were significantly higher (7.0 mm ± 0.58 mm; $p < 0.0001$ vs. normal ICP and control). Again, the researchers concluded that ocular ultrasound may be a reasonable technique for a rapid indirect evaluation of ICP in head trauma patients (Cammarata *et al.*, 2011).

In 2014 a retrospective study investigated the relationship between ONSD on CT scan and ICP in patients with severe TBI. The cohort of 57 patients had a median GCS of 7 upon admission, a mean ONSD of 6.7 mm (sd 0.75) and mean ICP of 21.3 mmHg (sd 8.4). Regression analysis demonstrated a strong and significant correlation between ICP and ONSD ($r = 0.74$, $P < 0.001$). Using a cutoff of 6.0 mm, ONSD had a sensitivity of 97 % and specificity of 42 %. Moreover, ONSD was considered a stronger predictor of ICP than other CT features (Sekhon *et al.*, 2014a). The same researchers performed a further retrospective analysis in a larger population of 220 patients requiring ICP monitoring following TBI at two trauma centers. ONSD was independently measured by two physicians blinded to patient outcomes which enhanced credibility and validity of the results. In this study the analysis was also geared towards investigating how ONSD related to mortality. Patients had a median admission GCS of 6. Multivariable logistic regression modeling indicated a strong correlation between ONSD and mortality. Linear regression showed that ONSD was independently associated with an increase in ICP in the first 48 hours after admission. Moreover, for each 1 mm increase in ONSD there was a two-fold increase in hospital mortality (Sekhon *et al.*, 2014b).

In 2017, Wang et al, conducted a study of 316 neurological patients which further supported the correlation between ONSD measurements and ICP ($r=0.758$, $p<0.001$). This study devised a mathematical equation for the prediction of increased ICP, the 'Xing & Wang' mathematical function. That equation was published as ICP = -111.92+77.36 x ONSD (Durbin-Watson value = 1.94). Within the research participant group a significant correlation was reported between the predictive equation and the subsequent observed ICP ($r=0.76$, $p<0.001$) (Wang et al., 2017).

3.3.3.2 Establishing a 'cut off' ONSD measurement with high levels of sensitivity and specificity correlated to an increased ICP.

Geeraerts *et al.* (2007) concluded from their research that the largest ONSD was a suitable predictor of elevated ICP with ONSD cutoff of 5.7 mm proving to be highly sensitive and predictive for elevated ICP. The results from the Moretti *et al.* (2009) study showed a similar ONSD threshold of 5.2 mm as a predictor of ICP >20 mm Hg and had a sensitivity and specificity of 94% and 76%, respectively. However, later the report published by Rajajee (2011) reported greater results, with sensitivity of 96% and specificity of 94% for elevated ICP >20 mmHg and with a lower ONSD cutoff value of 4.8 mm.

The results of a prospective study of 20 patients with severe TBI, by Sahoo and Agrawal (2013) suggested a higher again ONSD cutoff of 6.3mm to detect ICP>20 mmHg, with 100% sensitivity, however a resulting reduced specificity of 72.7%, potentially as a result of the increased 'cut off'. Results from the larger prospective study of 50 patients, in the same year, by Amini *et al.* (2013) showed significant correlation between ONSD and ICP with a significantly higher ($P < 0.001$) mean

ONSD in patients with increased ICP (6.66 ± 0.58mm) than that measured in normal individuals (4.60 ± 0.41 mm). Furthermore, mean ONSD was significantly correlated with ICP values ($P < 0.05$; $r = 0.88$). However, the study suggested a slightly lower ONSD cutoff again of 5.5 mm for predicting an ICP of ≥20 cm H2O with sensitivity and specificity of 100% (95% CI, 100-100) ($P < .001$).

Moreover, in 2017 a prospective observational study of 41 adult patients with both traumatic and non-traumatic brain injuries were performed. Noting the results of previous similar studies, the authors aimed to further establish a potential correlation between increased ICP measured through invasive techniques and ONSD ultrasound as well as establishing a cut off value for this measurement. The findings noted a 95.8% sensitivity, however only achieved a specificity of 80.4% in detecting raised ICP using ONSD ultrasound at a cut off rate of 5.205mm (Raffiz and Abdullah, 2017).

Some studies have questioned the link between ONSD and increased ICP (Kwan *et al.*, 2009; Strumwasser *et al.*, 2011). In 2009 a small study was conducted with seven participants requiring invasive ICP monitoring post head trauma. ONSD measurements were recorded, both left and right, pre and post invasive monitoring. Correlations were noted post invasive measurements ($p <0.0002$) however no correlation was noted pre invasive monitoring ($p >0.11$) (Kwan *et al.*, 2009). In 2011 another study questioned the reliability of ONSD ultrasound as a reliable measurement of increased ICP through comparison of results to both pre and post invasive ICP monitoring. This study was once again small in terms of number of participants (n-10). However, a total of 114 measurements were taken in this small sample group. This blinded prospective study used ROC analysis and concluded an overall sensitivity of 36% and specificity of 38% (Strumwasser *et al.*, 2011). However, in 2020, the results of a meta-analysis were published. These results strongly supported the use of ONSD ultrasound measurement to identify increased ICP, with a conclusion of an overall sensitivity aligned to CT findings at 91%, and specificity higher than those reported in CT findings at 77%. The meta-analysis did not however suggest a universally accepted ONSD measurement to signify increased ICP. The meta-analysis did however note that the maximum 'normal' ICP correlated ONSD measurement was 5.8mm and acknowledged that this measurement was also the minimum for an associated increase in ICP (Lee, Kim and Yun, 2020)

3.3.3.3 Practicalities of ONSD Ultrasound within clinical practice

ONSD measurement is cheap and efficient with the examination taking approximately 5 minutes per patient (Kimberly *et al.*, 2008). An ONSD measurement of above 5.8mm is generally considered abnormal and therefore in such cases clinicians should suspect an elevated ICP and therefore consider further investigations (Lee, Kim and Yun, 2020).

Results also concluded that when the ONSD is measured for intracranial pressure monitoring, the most stable results can be obtained if the diameter is measured 10 mm from the globe (Geeraerts *et al.*, 2007).

Nevertheless, the accuracy of ONSD measurements can be adversely affected by lack of operator experience and absence of crucial skills necessary in the use of such technology (Geeraerts *et al.*, 2007; Soldatos *et al.*, 2008; Rajajee *et al.*, 2011; Blaivas, Theodoro and Sierzenski, 2003; Geeraerts *et al.*, 2008).

3.3.4 Discussion

The four identified themes within the findings will now be explored in more depth below.

3.3.4.1 Establishing the correlation between ONSD and raised ICP.

There is a plethora of evidence from many studies demonstrating a correlation between the nerve sheath diameter and invasively measured ICP, suggesting that measuring ONSD can diagnose an elevated ICP (Vaiman, Gottlieb and Bekerman, 2014; Le *et al.*, 2009; Blaivas, 2000; Blaivas, Theodoro and Sierzenski, 2003; Tayal *et al.*, 2007; Kimberly *et al.*, 2008; Soldatos *et al.*, 2009; Moretti *et al.*, 2009; Rajajee *et al.*, 2011; Sahoo and Agrawal, 2013; Amini *et al.*, 2013; Geeraerts *et al.*, 2007; Geeraerts *et al.*, 2008; Cammarata *et al.*, 2011; Sekhon *et al.*, 2014a; Sekhon *et al.*, 2014b; Raffiz and Abdullah, 2017; Wang *et al.*, 2017; Wang *et al.*, 2020).

The basis of using ONSD ultrasound as a screen for elevated ICP relies on a relationship between ICP and ONSD, arising largely due to the location of the optic nerve within the human anatomy. The surrounding of the optic nerve is made up of subarachnoid cerebrospinal fluid which in turn is encapsulated by the optic nerve sheath. A subarachnoid space between the optic nerve and dura represents an important communication channel, relaying information to and from the CNS. Its location between the optic nerve and nerve sheath makes it possible for timely transmission of information from the CNS. Any pressure change inside the intracranial cavity is transmitted to the optic nerve sheath by cerebrospinal fluid infiltration into the subarachnoid space, with the resultant increase in the nerve diameter (Price, Simon and Park, 2003).

The study by Wang *et al.* (2017) found a strong correlation ($r = 0.758$) between ICP and ONSD in the modelling group. The derived mathematical function, ICP = -111.92 + 77.36 × ONSD, predicted ICP accurately in the test group ($r = 0.76$). Bland-Altman analysis showed a mean difference of -0.07 ± 41.55 mmH2O, and the interclass correlation coefficient for non-invasive ICP assessments using their model was 0.86 (0.79-0.90). A subsequent case study by Wang et al in 2020 using the 'Xing & Wang' function not only provided further supportive data to support the correlation between ONSD measurements and ICP ($r=0.758$, $p <0.001$), it also reported a 95% CI in the proposed mathematical equation devised (Wang et al., 2020).

It is noted that those papers unsupportive of using ONSD to detect increased ICP are either small in terms of participants or acknowledge some link and therefore the benefit of further research and analysis is noted or are discouraging a particular use of the technique such as a replacement for other measurements, which is not suggested within the scope of this literature review. A potential explanation for the outlying non-correlation findings in the face of a plethora of papers suggesting significant correlation may lie in the initial management of the collected data; some papers are noted to analyse individual measurements collected from both the left and right eye in isolation, while others are using either an average figure or the higher of the two recorded figures for further comparison. The significance of such a variable requires further randomised controlled evaluation before an agreed clinical technique can be reached and implemented.

3.3.4.2 Establishing a 'cut off' ONSD measurement with high levels of sensitivity and specificity correlated to an increased ICP.

Although all the previously discussed studies indicated a high sensitivity of ONSD in detecting ICP and therefore support the notion that this technique represents a potentially useful tool for future diagnosis of raised ICP, there are also some studies that recommend the technique is not a reliable measurement for detecting increased ICP. There is clearly still debate within the supportive studies regarding the optimal cutoff point for the ONSD value. The commonly used ONSD threshold for the diagnosis of elevated ICP is generally quoted as 5 mm; however, no universally agreed value exists (Moretti *et al.*, 2009; Kimberly *et al.*, 2008; Harbison, Shah and Noble, 2006; Foster *et al.*, 2003; Ballantyne *et al.*, 2002; Tayal *et al.*, 2007). Meanwhile a review of studies by Soldatos *et al.* (2009) suggested a cutoff range of 5.0 -5.9 millimeters with a sensitivity of 74–95% and specificity of 79–100%. Despite a common maximum 'normal' ONSD measurement of 5.8mm and thus minimum measurement associated with increased ICP, within the recently conducted meta-analysis, this paper did not explicitly suggest this as a supported cut-off measurement in their findings (Lee, Kim and Yun, 2020). The lack of a universally accepted cut-off measurement for ONSD also presents a challenge in creating guidance for the implementation of this technique. Therefore, future research should aim at justifying and validating the value chosen thereby helping to standardise an approach.

Moreover, most of those papers have used ROC curve analysis, incorporating an error or spatial resolution, to establish an optimal sensitivity measure. Whilst 5.5mm may hold a high level of sensitivity (Amini *et al.*, 2013) the greater the sensitivity the higher chance of 'false positive' results. When considering 'risk verses benefit' to the patient of being triaged as experiencing increased ICP pre-hospital and thus a potential change in patient assessment in-hospital, it may be deemed appropriate to increase the level of suspicion therefore a higher sensitivity at the expense of greater 'false-positives' (Rajajee *et al.*, 2011). This may be considered ethical within a utilitarianism paradigm, as given a high enough sensitivity this could result in an absence of 'false negatives. It may also be that this lack of a definitive consensus regarding the threshold value is attributable to variations in sonographic techniques, experience levels of physicians, artifact observation and/or the very small dimensions of ONSD (Yic *et al.*, 2023).

3.3.4.3 Practicalities of ONSD Ultrasound within clinical practice

Contraindications within certain patient groups could be considered a major limiting factor to the use of ONSD ultrasound in diagnosing elevated ICP. Thus, patients such as those presenting with ocular traumas, such as open globe injury, tumours, inflammation, Graves' disease, and sarcoidosis would be unsuitable for this diagnostic screen (Hightower, Chin and Heiner, 2012; Soldatos *et al.*, 2008; Soldatos *et al.*, 2009).

The limitation of operator experience as, highlighted in several papers, can be overcome by ensuring adequate training and supervision for inexperienced clinicians (Hightower, Chin and Heiner, 2012). A sonographer is thought to need a minimum exposure of 10 scans to detect an abnormality, whilst inexperienced clinicians in this field should take as many as 25 scans to achieve accurate and reliable measurements (Paldino, Mogilner and Tenner, 2003). Factors likely to affect and cause differences in measurements of ONSD include the position of the globe and the model of ultrasound device employed. Therefore, the technique requires training to optimise reproducibility and minimise intra- and inter-observer variance (Roboel *et al.*, 2012). With proper training and supervision paramedics in the emergency settings could theoretically introduce ONSD ultrasound into their practice, for the diagnosis of elevated ICP.

Post-mortem investigations show that the ONSD is quite sensitive to any changes in terms of ICP, with the sheath starting to distend three millimeters to the posterior side of the globe (Le *et al.*, 2009). Further, statistical information from ophthalmology and radiological literature gives varying norms in terms of the diameter of the nerve sheath in patients. A study by Vaiman, Gottlieb and Bekerman (2014) reports that in healthy persons, the ONSD varies from 3.65 mm to 5.17 mm in different locations within the intra-orbital space. However, the authors stress that for purposes of intracranial pressure monitoring, the most stable results are obtained when the diameter is measured 10 mm from the globe. Moreover, when examining the patient, sonographers have recommended the use of a 7.5 to 10 MHz resolution linear array ultrasound transducer in order to view even the finest details important to the analysis and measurement of the ONSD (Blaivas, 2000).

The ONSD ultrasound technique is inexpensive, provides rapid results, and is non-invasive making it a quick, simple, safe, and an economical means of early detection of elevated ICP, allowing early and rapid interventions to potential reduce mortality (Kaur *et al.*, 2021; Bittencourt and Caldas, 2021; Dinsmore and Venkatraghavan, 2022). Although presently not accurate enough to replace invasive ICP measuring methods it is a potentially useful tool for ICP screening in a variety of settings from the bedside in intensive care units through to emergency and non-acute settings (Kaur *et al.*, 2021; Bittencourt and Caldas, 2021; Dinsmore and Venkatraghavan, 2022). Notably it could play a crucial role during triage and patient evaluations in which CT and MRI imaging are not easily available or pre-hospital where these are not immediately available. Indeed, portable ultrasound equipment is increasingly being made available thereby expanding the applicability and ease of use of the technique across a variety of settings (Amaral, Ralston and Becker, 2020).

3.3.5 Conclusion

The studies discussed in the review consistently support the correlation between ONSD measurements and ICP. Notably, the study by Balivas, Theodoro and Sierzenski (2003) showed 100% sensitivity and 95% specificity for ONSD measurements over 5 mm in predicting elevated ICP compared to CT evidence. Geeraerts *et al.* (2008) and subsequent studies reaffirmed this correlation, suggesting that an enlarged ONSD is a good predictor of elevated ICP, particularly when exceeding 20 mmHg. The meta-analysis in 2020 further strengthened the evidence, aligning ONSD ultrasound with CT findings (Lee, Kim and Yun, 2020). However, discrepancies arise in determining an optimal cut-off value for ONSD. Studies propose values ranging from 4.8 mm to 6.3 mm, emphasising the need for standardised guidelines. The debate also considers the trade-off between sensitivity and specificity, acknowledging the challenge of defining a universally accepted cut-off.

Practically, ONSD ultrasound proves cost-effective, efficient (approximately 5 minutes per patient), and potentially valuable in various clinical settings. Nevertheless, operator experience, contraindications in specific patient groups, and variations in sonographic techniques must be addressed. Proper training and supervision are crucial to enhance accuracy and reproducibility.

In conclusion, while ONSD measurements demonstrate a promising correlation with ICP, further research is needed to establish standardised cut-off values and address practical challenges in clinical implementation.

The evidence reviewed suggests that ONSD ultrasound is a promising non-invasive tool for ICP monitoring. However, further research is needed to establish standardised protocols and validate its effectiveness. It is recommended that ONSD ultrasound be considered for further research and pilot implementation in clinical settings. This would involve conducting larger, randomised controlled trials to validate its effectiveness and safety. The potential benefits of ONSD ultrasound include providing a non-invasive method to monitor ICP, which could significantly enhance patient outcomes in pre-hospital and emergency settings.

3.4 Discussion

3.4.1 Summary of Findings

The review of ITD therapy and ONSD ultrasound has highlighted their significant potential in managing ICP and TBI. ITD therapy has shown potential in improving hemodynamic variables, such as MAP and CPP, while reducing ICP. Similarly, ONSD ultrasound has demonstrated its effectiveness as a non-invasive tool for monitoring ICP, with strong correlations between ONSD measurements and elevated ICP. Both technologies align with current guidelines emphasising the importance of maintaining adequate CPP and monitoring ICP in severe TBI management.

3.4.2 Clinical Implications

The practical implications of ITD therapy and ONSD ultrasound for paramedic practice are substantial. ITD therapy offers a non-invasive method to manage ICP and CPP, which could lead to earlier interventions and better management of TBI patients in pre-hospital settings. ONSD ultrasound provides a reliable, non-invasive technique for monitoring ICP, potentially reducing the need for invasive procedures. Implementing these technologies could enhance patient outcomes by providing safer and more effective monitoring and management options. However, further research is needed to establish standardised protocols and validate their effectiveness in various clinical settings.

3.4.3 Recommendations for Practice

While the initial systematic review suggested potential recommendations for the implementation of ITD therapy and ONSD ultrasound, the chosen methodology of Mediated Discourse Analysis (MDA) and Nexus Analysis provided a more nuanced understanding of paramedic practice. This approach allowed for an in-depth exploration of the experiences and perceptions of paramedics, which was crucial for understanding the complexities of clinical decision-making and reflective practices in the assessment and management of head injury patients.

The interpretivist/constructivist paradigm enabled the researcher to capture the rich, contextualised experiences of paramedics, which would not have been possible through a purely quantitative approach. By focusing on the social actions mediated through cultural tools, the research identified key practices and chains of mediated actions that are integral to paramedic practice.

The findings from this qualitative approach highlighted the importance of reflective practice and continuous professional development in improving patient care. Therefore, the recommendations for practice emphasise the need for further research to validate the effectiveness of ITD therapy and ONSD ultrasound, as well as the development of training and education programmes to support their implementation.

1. **Further Research**: Conduct larger, randomised controlled trials to validate the effectiveness and safety of ITD therapy and ONSD ultrasound in managing ICP and TBI.
2. **Pilot Implementation**: Consider pilot implementation of these technologies in clinical settings to gather real-world data and assess their feasibility and impact on patient outcomes.
3. **Standardised Protocols**: Develop standardised protocols for the use of ITD therapy and ONSD ultrasound, ensuring consistency and reliability in their application.
4. **Training and Education**: Provide training and education for paramedics and other healthcare professionals on the use of these technologies to ensure proper implementation and maximise their benefits.

3.4.4 Impact on Thesis

The findings from this systematic review and the subsequent research phases of this PhD have significant implications for the thesis and the broader field of paramedic practice and quality improvement. By utilising Mediated Discourse Analysis (MDA) and Nexus Analysis, this research has provided a nuanced understanding of the experiences and perceptions of paramedics in the assessment and management of head injury patients.

1. **Methodological Overview**: Mediated Discourse Analysis (MDA) focuses on social actions mediated through cultural tools, examining the intersection of historical body, interaction order, and discourses in place. Nexus Analysis identifies chains of mediated actions and practices, creating a comprehensive view of the nexus of paramedic practice. This qualitative approach allowed for an in-depth exploration of the complexities of clinical decision-making and reflective practices, which would not have been possible through a purely quantitative approach.
2. **Contribution to Paramedic Practice**: The insights gained from the semi-structured interviews, written reflections, and social media case studies have highlighted the complexities of clinical decision-making and the importance of reflective practice in paramedic care. These findings underscore the need for continuous professional development and the integration of reflective practices into paramedic training programmes. By understanding the real-world challenges and decision-making processes of paramedics, this research contributes to the development of more effective training and support systems, ultimately enhancing patient care.
3. **Advancement of Quality Improvement**: The research has identified key areas for improvement in the assessment and management of head injury patients, emphasising the potential benefits of ITD therapy and ONSD ultrasound. The qualitative approach allowed for a deeper exploration of the barriers and facilitators to implementing these technologies in clinical practice. This understanding is crucial for developing targeted quality improvement initiatives that address the specific needs and challenges faced by paramedics.
4. **Future Research and Implementation**: The research highlights the need for further studies to validate the effectiveness of ITD therapy and ONSD ultrasound in managing ICP and TBI. It also emphasises the importance of developing standardised protocols and training programmes to support the implementation of these technologies. By providing a detailed understanding

of the current state of paramedic practice and the potential for innovation, this thesis lays the groundwork for future research and quality improvement initiatives.

In summary, the findings from this PhD research will inform the thesis by providing a robust foundation for exploring the potential of ITD therapy and ONSD ultrasound in improving the management of ICP and TBI. The insights gained will contribute to the broader field of paramedic practice and quality improvement, highlighting the importance of reflective practice, continuous professional development, and targeted quality improvement initiatives.

3.5 Funding and Conflict of Interest

No external funding.

Papers and evidence included in the ITD literature review have a strong link to the ResQgard product; the author has no interest in, or link to the product to declare.

No further conflicts of interest to declare.

3.6 Limitations

The first limitation of these literature reviews was the use of a single researcher thus meaning the inability to validate decisions regarding study inclusion, data extraction or critical appraisal. Secondly the reviews were limited by the small numbers of studies included in each review.

Chapter 4 – Methods

4.1. Introduction

To answer the research question and achieve the research aims, as listed below, a research design process was undertaken. Initial decisions made within this design process were guided by the ontological and epistemological underpinning of the research, from which decisions relating to methodology and methods could then be made.

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

1. Establish **What** treatment and assessment paramedics are currently providing in the management of head injury patients.
2. Understand **Why** paramedics are making the decision they are, in relation to the assessment and management of head injury patients.
3. Understand **How** paramedics are engaging with reflective practices and how this relates to their decision making.
4. Establish if reflective practice can contribute to healthcare quality improvement and implementation science **(QI)**.

In order to understand the link between data collection methods, analysis and interpretation of this research, it is necessary to understand the research paradigm via the exploration of underpinning epistemology and ontology or 'belief about the nature of knowledge' (Kivunja and Kuyini, 2017). This research is based within the interpretivist / constructivist paradigm, utilising a mediated discourse and nexus analysis methodology through qualitative data collection and content analysis methods, as seen in Table 15 below.

Table 15 - Paradigm Framework (POEM)

Paradigm	**Interpretivist / constructivist**
Ontology	**Constructivism**
Epistemology	**Interpretivist**
Methodology	**Mediated Discourse Theory**
Methods	**Qualitative data collection and Nexus Analysis**

The underpinning ontology of this research was constructivism with an epistemological underpinning of Interpretivism as the aim was to understand the phenomena through human experience, in particular the experiences and perceptions of paramedics when assessing and treating head injury patients. This approach allowed an exploration of paramedics' experiences, without the influence of any theories, and construction of a pattern of meanings through analysis. An interpretivist / constructivist paradigm has enabled the researcher to recognise the impact their own experiences and background may have on the research which is important as the researcher is also a registered paramedic (Creswell, 2017). The interpretivist paradigm is centered on the notion that reality is socially constructed (Willis, 2007). Interpretivism is from the philosophy of hermeneutics; the study of interpretive understanding as described by philosophers such as Edmund Husserl and Martin Heidegger (Mertens, 2010; Sheehan, 2010). Interpretivism could be argued as an opposing paradigm to postpositivism; where researchers are more likely to accept only one scientific interpretation of reality (Denzin and Lincoln, 2005). Whereas the interpretivist / constructivist paradigm involves predominately qualitative methods to understand a complex and ever-changing world that is socially constructed. In contrast quantitative methodology is aligned with a postpositivist paradigm understanding the world through observable and measurable methods (Willis, 2007; Glesne, 2016; Thomas, 2003; Silverman, 2005; Nind and Todd, 2011).

4.1.1 Clarifying Improvement and Implementation

In this research, improvement and implementation are used to address different aspects of enhancing paramedic practice in the assessment and management of head injuries.

Improvement Science (ImpS) focuses on increasing the adoption of existing evidence-based practices. This involves identifying current best practices and ensuring they are consistently applied in clinical settings. For example, improving the adherence to guidelines for head injury management, such as the use of appropriate immobilisation techniques and accurate assessment methods.

Implementation Science (ImpR), on the other hand, is concerned with introducing new evidence into practice. This involves evaluating new interventions or technologies and integrating them into clinical workflows. For instance, exploring the potential of new non-invasive techniques for assessing intracranial pressure (ICP) in the pre-hospital setting.

The research aims to address both aspects:

Increasing the Adoption of Existing Evidence: By understanding the barriers to compliance with current guidelines and developing strategies to enhance adherence among paramedics.

Introducing New Evidence: By evaluating the feasibility and effectiveness of new assessment tools and techniques, such as the use of optic nerve sheath diameter (ONSD) ultrasound for ICP estimation.

The phrase 'in to' clinical practice refers to the introduction of new evidence, while 'how paramedics practice' pertains to the adoption of existing guidelines and evidence. This distinction is crucial for understanding the dual focus of the research on both improving current practices and integrating new innovations.

4.2 Methodology

4.2.1 The Six Central Concepts

Scollon defined six central concepts within MDA (Scollon, 2001c), these are listed below. This list can also be seen in Figure 25 which will be further explained and discussed in the sub sections to follow.

1. Mediated action
2. Mediational means
3. Sites of engagement
4. Practice
5. Nexus of practice
6. Community of practice

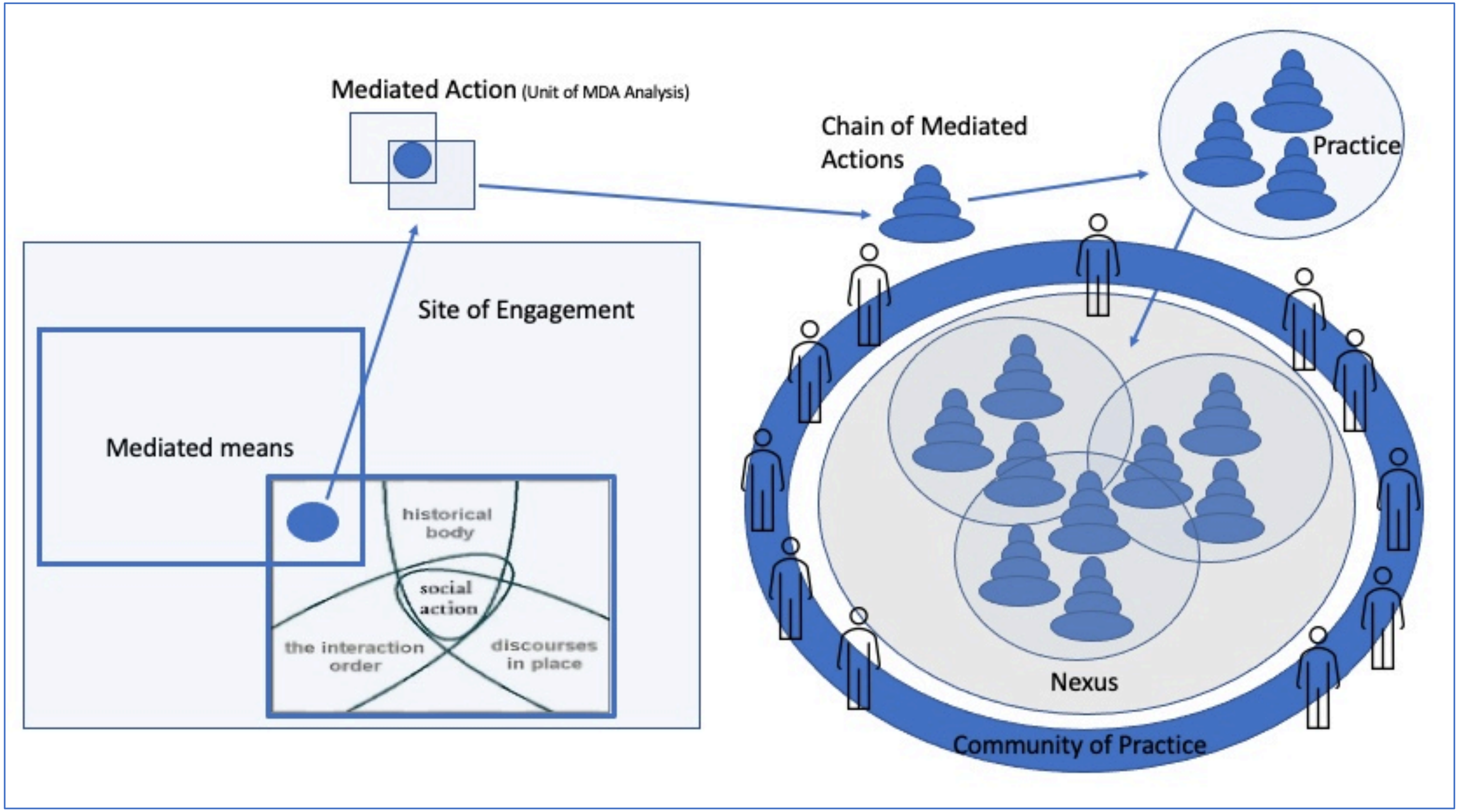


Figure 25 - Schematic of the MDA Six Central Concepts

4.2.1.1 Mediated Action

Mediated action is defined as a social action mediated through 'cultural tools', these cultural tools are referred to in MDA as mediated means (Scollon, 2001a; Jones and Norris, 2017).

The 'social action' is recognised as the intersection between the '*historical body'* of the individual participating in the mediated action, the '*interaction order'* of individuals engaging in or present within a mediated action and the '*discourses in place'* to enable a mediated action or form part of a mediational means. This social action intersection and essential components can be seen depicted in Figure 26 below (Scollon and Scollon, 2004b).

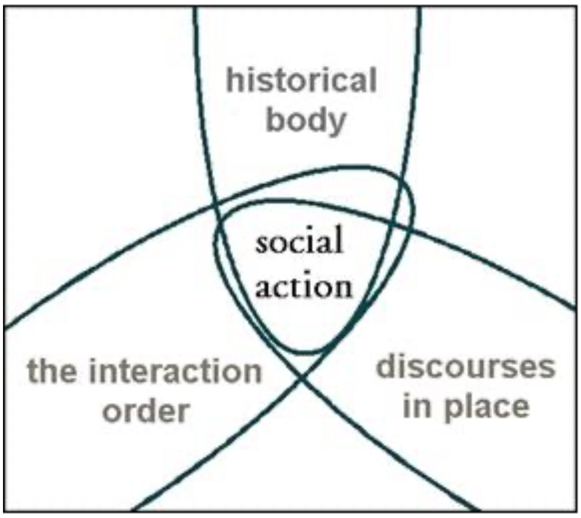


Figure 26 - Mediated action essential components and social action (Scollon R and Scollon SW 2004a)

It is important to note that the mediated action is not the discourse but rather the moments in practice where discourse is utilised (Scollon, 2001c).

As mediated action is the unit of analysis within MDA, this PhD has focused on answering; "**what actions can be identified as contributing to the practice** of the assessment and management of head injury patients by paramedics in the pre-hospital setting"?

4.2.1.2 Mediational means (cultural tools)

Mediational means refers to **the 'tool(s)' via which the mediated action and therefore practice is enabled**. These semiotic means include language text and material objects as appropriate to mediate action (Scollon, 2001a). Possible mediated means relevant to this PhD research were identified as part of a review of the nexus literature prior to data collection, seen here in Table 16, and discussed within Chapter 2.

Table 16 - Mediated means identified prior to data collection.

Acquired knowledge through various sources that will need to be recalled later (i.e., **lectures, textbooks, and journals**)
Utilise **cue acquisition** and patient or bystander **conversation** to inform a history and enable a patient assessment
Implementation evidence-based practice to enable delivery of treatment options or instigate patient pathway **protocols or guidelines** (utilising paper or online documents to refer to as necessary)
Using various pieces of **technology or equipment** to deliver patient care or enable assessment
Reflecting in-action through **conversations** with colleagues, either in a simulated learning environment or in a patient interaction
Conversation with colleagues after a learning event or patient interaction
Written Reflection after a learning event or patient interaction

4.2.1.3 Sites of engagement

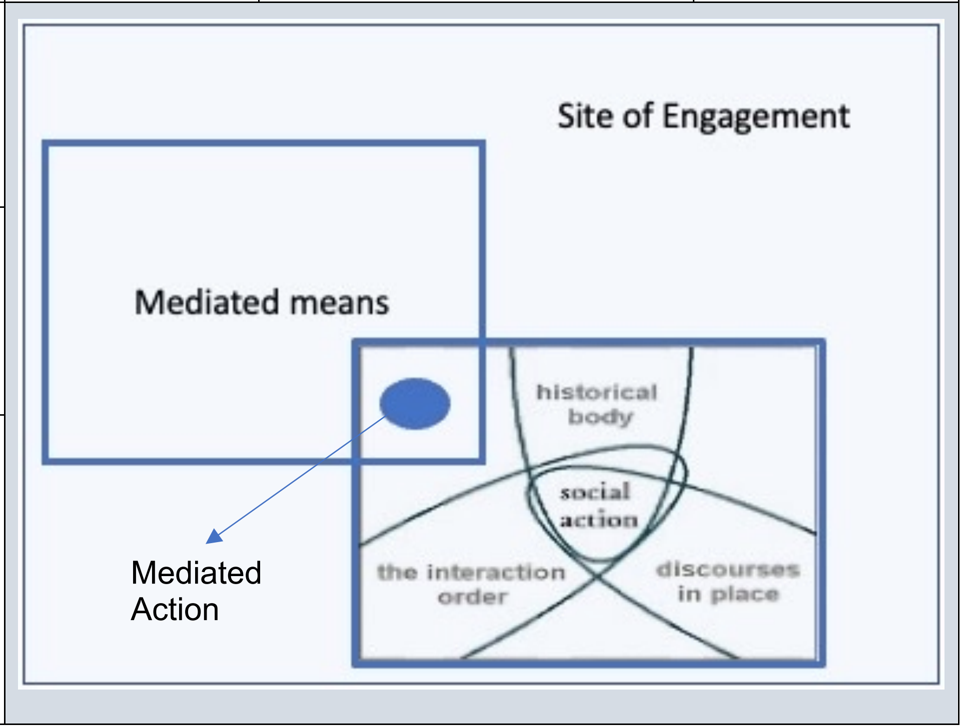
Sites of engagement are points in space and time where mediational means and social action intersect in order to enable a mediated action (Scollon, 2001a). A site of engagement is not defined by one unique practice and as such the findings of an MDA study could reveal multiple practices via differing trajectories of mediational means and actions.

Moreover, researchers in MDA construct sites of engagement in partnership with their participants, known as space-time stations, to facilitate data collection and field work (de Saint-Georges, 2005). Within this PhD the researcher has created 'space-time stations' utilising recognised discourses in place, such as written reflections, peer conversations and problem-based learning among peers, allowing for reflective practice either 'before', 'in' or 'on' action which was either an individual or peer activity and either virtual or 'face to face', as can be seen in Table 17 below.

Table 17 - Research 'space-time stations' allowing for data collection.

←Space→

←Time→

<table>
<tr><td></td><td>Face to Face</td><td>Virtual (Computer mediated)</td><td>Solitary (written)</td></tr>
<tr><td>Before-Action</td><td colspan="3" rowspan="3">
</td></tr>
<tr><td>On-Action</td></tr>
<tr><td>In-Action</td></tr>
</table>

4.2.1.4 Practice

MDA has a suggested link with social practice theory developed by Bourdieu (Harker, Cheleen and Wilkes, 1990), through Scollon's following description of 'practice':

> *"a historical accumulation within the habitus/historical body of the social actor of mediated actions taken over his or her life (experience) and which are recognizable to other social actors as 'the same' social action." (Scollon, 2001c, p. 149)*

Practice is the combination of multiple '**chains of mediated actions**' which themselves may also form part of other practices thus creating a nexus through this overlap of chains and practices (Scollon, 2001b). MDA therefore aims to explore individual awareness of such chains. Moreover, MDA recognises that within chains of actions there are lower and higher level mediated actions, thus creating a potential hierarchy of steps within such chains and as a result may be utilised within the analytical frameworks or methodologies (Scollon, 2001a).

The practice under focus within this PhD research is '***the assessment and management of head injury patients by paramedics in the pre-hospital setting***'.

To achieve this practice, the paramedic would need to make a series of clinical decisions, enabled through education and CPD. They would then need to reflect on those decisions both in and on action, participate in audit or clinical trials where appropriate and contribute to the improvement of services through feedback and debrief mechanisms where available (**mediated actions**). All of this is achieved using clinical guidelines, protocols, reflective tools, and professional conversations (**mediational means**).

This research will aim to identify not only the mediational actions and means used within this practice but also identify in the data analysis, any '**chains of mediated actions**' that may or may not overlap with other practices.

4.2.1.5 Nexus

A nexus can be thought of as the point of intersection for **multiple chains of mediated actions and practices** creating the point at which the historical trajectories of individuals, ideas, objects, places, and discourses intersect. This intersection enables various **social action's and mediational means** to align**,** which inevitably results in the alteration of those previous trajectories through future sites of engagement and mediated actions (Scollon and Scollon, 2004b; Scollon, 2001c; Scollon, 2001a).

In relation to this PhD research the Nexus can be seen as **'Paramedic Practice'**.

4.2.1.6 Community of practice

The community of practice, listed as the final 6th concept has been defined as:

> *"An aggregate of people who come together around mutual engagement in an endeavour. Ways of doing things, ways of talking, beliefs, values, power relations – in short, practices – emerge during this mutual endeavour. As a social construct, a Community of Practice is different from the traditional community, primarily because it is defined simultaneously by its membership and by the practice in which that membership engages."* (Eckert and McConell - Ginet, 1992, p. 464)

However, in addition to this definition, the community of practice is of relevance in MDA when considering the progression of a Nexus of Practice into an explicitly recognised group (Scollon, 2001c). To widen the previous 'Paramedic Practice' nexus lens, the 'community of practice' relevant to this PhD research is the wider '**QI and Implementation Science in Paramedicine**', this will be further explained and explored in Chapter 6.

4.3 Data Collection

4.3.1 Phase 1 (Semi-Structured Interviews)

Phase 1 aims, objectives, design, methods, including sampling, and participants, and structural analysis will now be discussed.

4.3.1.1 Phase 1 Aims

The aim of this phase was to explore current clinical knowledge and attitudes towards a change in clinical practice, amongst Paramedics, with regards to the assessment and management of head injury patients.

The initial analysis from phase 1 will allow a purposeful design to any future training resources and clinician support through a change of practice in this area. This work will also highlight any feasibility issues regarding staff attitude towards the possible introduction of the ResQgard and ultrasound in head injury assessment and management. The opportunity for guided reflection will aid the participants CPD activities thus ultimately benefit patient care.

4.3.1.2 Phase 1 Objectives

- Investigate how participants currently assess and treat head injury patients (What).
- Explore how evidence-based practice and continued professional development feature within participants decision making (Why).
- Examine participant's thoughts on change in practice (QI).

4.3.1.3 Phase 1 Design and Methods

The interview schedule was designed to explore paramedics' clinical knowledge, attitudes towards changes in clinical practice, and experiences with head injury assessment and management. The schedule included open-ended questions to allow participants to share their experiences in detail. Key topics included current assessment practices, decision-making processes, and reflections on clinical experiences. The design of phase 1 was influenced by Driscoll's reflective model of reflection which uses a 'what', 'so what' and 'now what' structure (Driscoll, 2007).

Interviews are continuing to become an important element of QI projects in order to understand issues within a change project (Rodriguez and Hallas, 2019). The design of this phase has utilised interviews within QI to establish ideas for change and highlight recognised or potential implementation barriers.

Data were collected in 2017 in the form of ' semi-structured interviews also known as an Interview guided approach (Cohen, Manion and Morrison, 2011; Reeves, Kuper and Hodges, 2008) via the virtual platform 'Skype'. This method allowed guided reflection by the participants and exploration of their experiences through open questions with the flexibility for the interviewer to explore a particular question or answer in more detail if needed (Davies, 2007; Britten, 1995). However this chose of interaction has been known to cause some difficulties such as calls disconnecting, or the need for participants to have certain software (Krouwel, Jolly and Greenfield, 2019). In this research the participants experienced no problems with downloading software but there were some issues with dropped calls, which fortunately reconnected. The researcher acknowledge that a virtual platform may exclude some participants who do not have access to necessary technology, or the skills required, however this was deemed a low risk in the paramedic population because of this technology and skill set featuring within their education and clinical practice.

Participants were expected to engage in 'reflection 'ON' action' during the semi-structured interviews through a recollection of their previous experiences and thinking about how those experiences influence their current practice. A 'phase specific' version of each of the 'what, so what, now what' elements was created as can be seen in the green ovals in Figure 27, thus creating the research objectives and forming the initial guiding questions.
These guiding questions were then supplemented through a conversational journey with follow-up and probing as depicted within the grey 'thought bubbles' within Figure 27. These interview questions can be seen again in appendix 1.
As seen in Figure 27 the structure of the semi structured interviews aimed to establish the current knowledge base of paramedic participants with regards to the assessment and management of head injuries and raised ICP in pre-hospital care and the potential feasibility and opinion of Paramedics regarding introducing the ResQgard and ultrasonic optic nerve sheath diameter measurements in the pre-hospital setting.

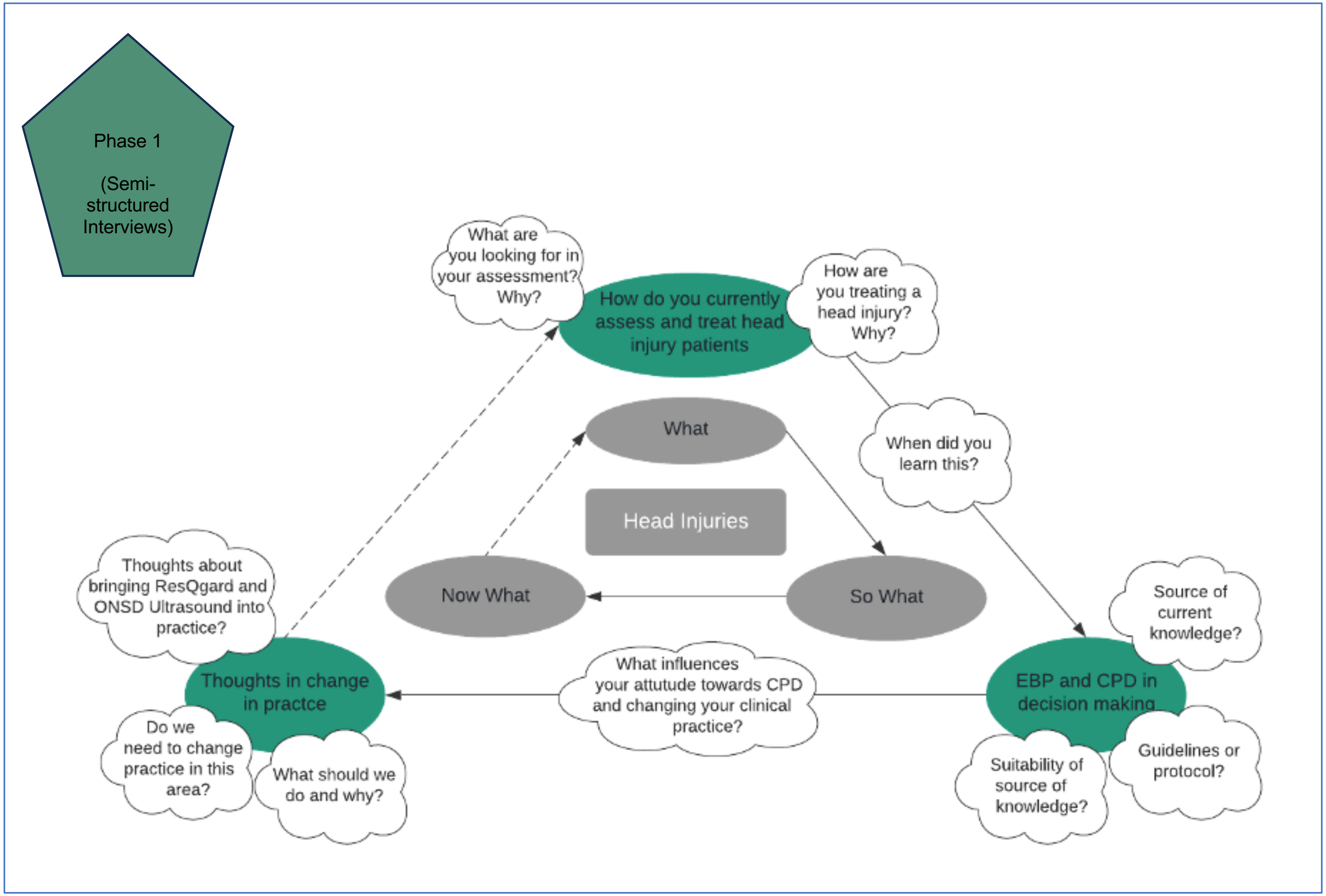


Figure 27 - Phase 1 Design

4.3.1.4 Phase 1 Participants and Sampling

Purposive sampling was used to select participants for phase 1. The inclusion criteria were HCPC registered paramedics with experience in managing head injury patients. The approach ensured that participants had relevant clinical experience and could provide rich, detailed insights into the research questions. The sample included paramedics from various clinical grades and roles, ensuring a diverse range of perspectives. Participants were recruited via social media adverts targeted at paramedic related social media accounts through twitter and Facebook utilising purposeful sampling, the inclusion and exclusion criteria listed in Table 18 below (Emmel, 2013).

Table 18 - Phase 1 Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
HCPC registered paramedics (no restriction to criteria based on grade, role, or organisation).	Paramedics with an in-depth knowledge of this PhD research and therefore a potential bias.
Experience of attending to a traumatic head injury patient	
Ability to participate over a virtual platform	

Sample size in qualitative research is arguably a more difficult concept than the statistical rules applied to quantitative research. However guidance has been offered both in terms of generic recommendations, including the importance of acknowledging the time complexity of conducting and analysing qualitative research through to specific advice relating to suggested numbers of participants, suggesting that no new information is likely to be achieved after interviewing 20 participants, a concept referred to as saturation of data (Vasileiou *et al.*, 2018; Morse, 1995; Morse, 2000). Moreover, saturation rate is argued as the emerging ‘gold standard’ of sample sizing in qualitative research (Fusch and Ness, 2015; Guest, Bunce and Johnson, 2006). However suggested size to achieve saturation varies, others argue that a study may need as many as 50 participants, with others offering more specific advice tailored to particular disciplines and approaches (Morse, 2000; Green and Thorogood, 2017; Ritchie, Lewis and Elam, 2003; Creswell, 2007) with one particular study of sample size suggesting that no more than 12 participants are needed to achieve saturation using an interview method (Guest, Bunce and Johnson, 2006).

As a result, 12 participants were recruited over a period of three months. The final sample size of 12 was considered adequate to achieve saturation of data as no new codes or themes were identified at this point during data analysis (Hennink, Kaiser and Marconi, 2017). The participant information sheet and consent form for this phase can be found in appendix 2 and 3.

4.3.1.5 Phase 1 Interview Structural Analysis

In phase 1, saturation was reached after analysing the data from 12 semi-structured interviews. No new themes or codes emerged after the 10th interview, indicating that additional interviews were unlikely to provide new insights. This was further confirmed by the consistency of themes identified across the interviews.
The transcripts of the 12 interviews were analysed (participants comments only) with a total of 31890 words including 3,087 unique word forms. The vocabulary density of each participant's transcript (ratio of words in each transcript compared to the number of unique words) can be seen in Table 19 and Figure 28.

Table 19 - Interview Structural Analysis

Interview Participant Number	Pre-reg education	Clinical Grade	Word count	Ordered by word count	Vocabulary Density	Interview time (mins)	Ordered by interview time
P1	IHDC	Specialist Paramedic (Research)	2485	6	0.249	45.51	5
P2	FdSc	Specialist Paramedic (Education)	5244	2	0.186	51.00	3
P3	IHCD	Paramedic	5527	1	0.211	72.57	1
P4	FdSc	Paramedic	913	12	0.375	33.49	9
P5	IHCD	Specialist Paramedic (Clinical)	2570	5	0.248	38.19	6
P6	Non-UK	Paramedic	1522	10	0.307	24.22	12
P7	DipHE	Paramedic	1934	8	0.320	35.22	8
P8	FdSc	Paramedic	2860	4	0.250	47.34	4
P9	BSc	Paramedic	1905	9	0.308	36.40	7
P10	BSc	Paramedic	1454	11	0.294	33.35	10
P11	IHCD	Specialist Paramedic (Clinical)	3504	3	0.223	53.08	2
P12	BSc	Specialist Paramedic (Clinical)	1972	7	0.251	32.59	11
			Mean (2657.5) Median (2228.5)		Mean (0.2685) Median (0.2505)	Mean (41.94) Median (37.29)	

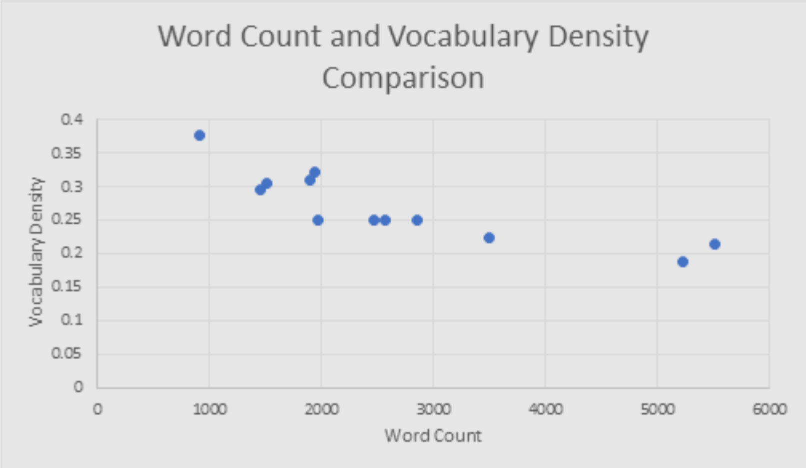


Figure 28 - Interview Vocabulary Density

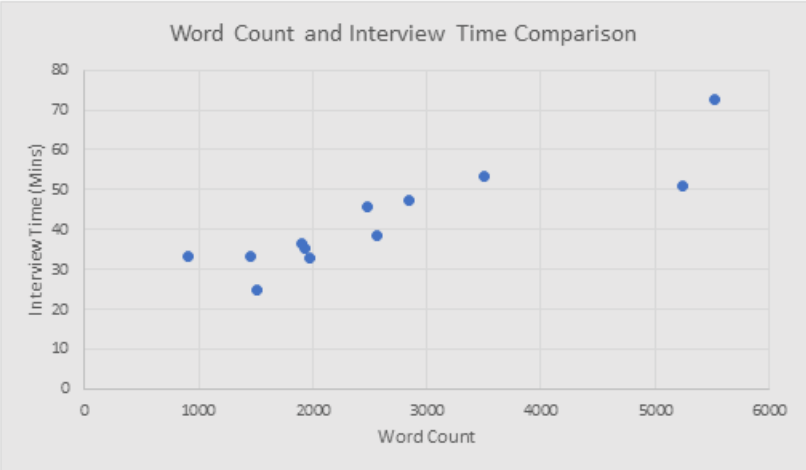


Figure 29 - Word Count and Interview Time Comparison

This vocabulary density analysis shows a potential relationship between lower word count and higher vocabulary density, suggesting that the higher the word count within the interviews, the more complex the texts were in terms of an increased number of unique words. Utilising the order of word count compared to the order of interview time, the data also shows a potential relationship between length of interview and word count, as seen in Figure 29. Thus, suggesting that to achieve an interview narrative which has a breadth of vocabulary, time is required.

4.3.2 Phase 2 (Reflections)

Phase 2 aims, objectives, design, methods, including sampling, and participants, and structural analysis will now be discussed.

4.3.2.1 Phase 2 Aims

The aim of this phase was to explore the assessment and management of head injury patients in pre-hospital care by paramedic clinicians, and the practice of reflection within paramedic practice.

The knowledge generated from Phase-2 may help to inform any future changes in paramedic training and clinical practice around head injury assessment and management. Utilising previously written reflections for this phase of research will enable the profession to better understand how paramedics reflect on their clinical interactions.

4.3.2.2 Phase 2 Objectives

- Explore participants chosen subject focus for reflections and their assessment and treatment decisions (what).
- Understand participant's use of evidence-based practice in decision making and establish any perceived learning through reflection (why).
- Analyse participant's personal development plan for improvement or their wider QI suggestions within their reflections (QI).

4.3.2.3 Phase 2 Design and Methods

The data collection methods for this phase were written reflective accounts from UK paramedic clinicians, of any grade, who have assessed and managed a traumatic head injury patient. Data were collected in 2019.
The design of this phase was also influenced by Driscoll's reflective model as can be seen in Figure 30 (Driscoll, 2007).   The participants were not required to use a reflective model, allowing the researcher to see if models were used within practice and any apparent benefit to such models. The researcher expanded the generic 'what, so what, now what, titles to show how this reflective model specifically links to this phase, depicted in the light blue ovals of Figure 30, thus creating the research objectives.

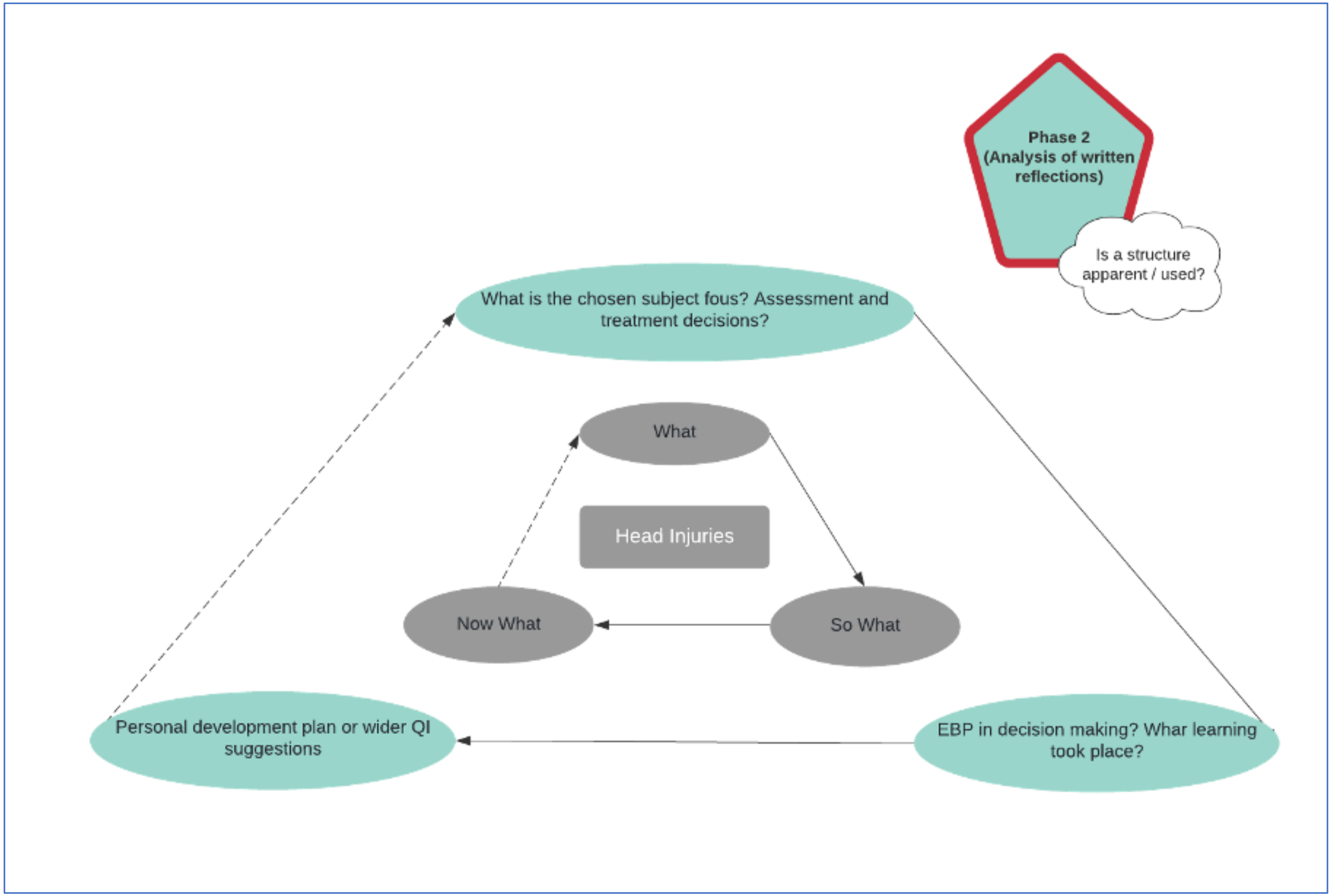


Figure 30 - Phase 2 Design

4.3.2.4 Phase 2 Participants and Sampling

Purposive sampling was used to select participants for phase 2. The inclusion criteria were HCPC registered paramedics who had written reflections on cases involving the assessment and management of head injury patients. This approach ensured that participants had relevant clinical experience and could provide rich, detailed insights into the research questions. The sample included paramedics from various clinical grades and roles, ensuring a diverse range of perspectives.

Participants were recruited via social media adverts targeted at paramedic related social media accounts through Twitter and Facebook, through purposeful sampling in order to select the most information rich resources for analysis (Emmel, 2013). The researcher attempted unsuccessfully to recruit, for several months with the first iteration of design for this phase. The first design had limited this phase to reflections on head injury patients utilising the use of point of case ultrasound, aligned to initial intention for the overall PhD research to focus on exploring ITD and ONSD as potential changes into clinical practice. Although the researcher was privy to various conversations around paramedics being trained in point of care ultrasound (POCUS) for head injuries in various countries, there did not seem to be either an interest in participating in research or enough suitable candidates to create an interest. After considered these issues, the overall themes emerging from phase 1 and the belief in the benefit of exploring reflections within the overall research, the researcher decided to expand the scope of this phase to invite paramedics to share their reflections on head injury patients they had managed but not restricting them to having utilised POCUS as an assessment feature. While widening the subject matter the researcher also decided to narrow the participants to UK paramedics only, thus allowing for a more specific comparison of themes emerging. The resulting Inclusion and Exclusion criteria can be seen in Table 20 below. There was no absolute target sample size for this phase, however once reaching recruitment of 10 participants data analysis indicated this number of participants was deemed adequate to achieve saturation of data as no new codes or themes were identified (Hennink, Kaiser and Marconi, 2017). The participant information sheet and consent form for this phase can be found in appendix 4 and 5.

Table 20 - Phase 2 Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
Reflections by HCPC registered paramedics on cases involving the assessment and management of head injury patients.	Reflections by student paramedics as not HCPC registered. As a student they will be likely to have a strict model or learner outcomes to achieve, hence the exclusion. Cases centered around the care of a paediatric patient as this is outside of the scope of discussions within this PhD.

4.3.2.5 Phase 2 Written Reflections Structural Analysis

In phase 2, saturation was reached after analysing the data from 10 written reflections. No new themes or codes emerged after the 10th reflection, indicating that additional reflections were unlikely to provide new insights. This was further confirmed by the consistency of themes identified across the reflections.

The 10 reflections were analysed with a total of 16564 words including 3316 unique word forms. The vocabulary density of each reflection (ratio of words in each reflection compared to the number of unique words) can be seen in Table 21 and Figure 31.

Table 21 - Reflection Structural Analysis

Reflection Number	Theme of reflection	Document Length	Average Words per sentence	Vocabulary Density
R1	Sudden deterioration of patient and decision-making being questioned at ED	1499	19.5	0.360
R2	Unable to access CCP or use advanced skills	1754	27.4	0.369
R3	Decision making in elderly trauma (Query Ageist)	2229	21.2	0.377
R4	Decision to send to hospital from custody unit	436	16.1	0.491
R5	Almost missing a head injury	1216	24.8	0.441
R6	Beyond scope of practice and seeking support	1925	18.3	0.397
R7	Managing multi-trauma	704	20.1	0.462
R8	Difficulties associated with festival medicine	783	23.7	0.455
R9	Head injuries complicated by anticoagulant medicines	4468	30.6	0.307
R10	Managing hemorrhagic shock and TBI together	1550	24.2	0.0408
		Mean (1656.4) Median (1524.5)	Mean (22.59) Median (22.45)	Mean (0.369) Median (0.387)

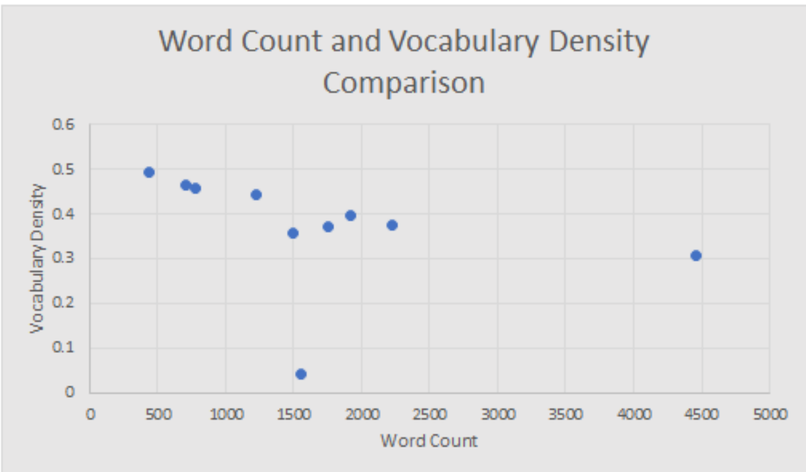


Figure 31 - Reflection Word Count and Vocabulary Density Comparison

This vocabulary density analysis shows a potential relationship between lower word count and higher vocabulary density, suggesting that the higher word count reflections are more complex texts with an increased number of unique words.

The participants were invited to reflect, or submit a previously compiled reflection, on any subject relating to an adult head injury patient. As a result of the freedom of subject and structure, there has been the opportunity to analyse the subject matter chosen, the structure used and the focus of discussion within these structures.
The focus of the 10 reflections can be seen in Table 22. When compiling the detail within table 22, it was decided to include the presenting complaint and description to understand the focus area and to use GCS as a way of depicting severity.

Table 22 - Subject Focus of reflections

Reflection number	Subject Focus	Presenting Complaint	Description	GCS
R1	Sudden deterioration of patient and decision-making being questioned at ED	Poor recollection of fall initially, sudden deterioration including seizures	72yr old male, slipped and fallen on ice	14, initially with confusion and then fitting later.
R2	Unable to access a critical care practitioner or use advanced skills	Unconscious, multiple injuries	Found in road, age unknown	5
R3	Decision making in elderly trauma (query Ageist)	Unresponsive	80yr old female, found unresponsive at bottom of stairs	5
R4	Decision to send to hospital from custody unit	Fluid from ears, swelling around both eye and behind one ear.	52yr old male, intoxicated, fallen, and hit head prior to being arrested.	Not listed but conscious and refusing to go to hospital
R5	Almost missing a head injury	Dizziness	71yr old Female. Fall off step 6 days ago, feeling unwell past 4 days with accompanying ear pain	15
R6	Beyond scope of practice and seeking support	Unconscious with noisy breathing	25yr old male. Possible assaulted with bottle and stamped on.	3
R7	Managing multi-trauma	Amnesia, chest wall pain with unilateral absence of air entry	55yr old male. Patient has come off bicycle and laying in road, reason unknown	15
R8	Difficulties associated with festival medicine	Open fractured skull	57yr old male, head stamped on by a horse	15 initially rapidly dropping to 7
R9	Head injuries complicated by anticoagulant medicines	Small wound to head. Described as minor head injury.	72yr old female, trip over rug	Not listed but deemed able to have capacity
R10	Managing hemorrhagic shock and TBI together	Multi-trauma including visual head injuries	40yr old male, jumped off motorway bridge	Not listed but mentioned as conscious and alert

As can be seen from Table 22, there were a range of subject focus within the reflections. There does however seem to be a theme of reflections focusing on perceived ‘wrong’ decision making, incidents that did not go as well as hoped or posed the clinician difficulties. The inclusion and exclusion criteria limited to submissions of ‘adult’ patients only, however on analysis the focus of most of the submissions were over the age of 40 years. Although GCS is not listed in all reflections, most of the reflections focus on patients with a GCS of 14 or above, or evidently conscious and alert. Thus, the overall focus would appear to be on complex decision making in the assessment and management of head injury patients with a high GCS.

The reflections were subsequently analysed for models of reflection evident in the discourse, as seen in Table 23.

Table 23 - Analysis of reflective models within written reflections

Reflection number	Word Count	Declared Structure	Structure in text	Percentage of Word Count	References?	Role / Clinical Grade	Specific reason for reflecting?
R1	1499	No	Description	59%	Yes	Trust Paramedic	x
			On reflection	41%			
R2	1754	No	Description	24%	Yes	Trust Paramedic	x
			Feelings	19%			
			Evaluation	40%			
			Analysis	8%			
			Conclusions	9%			
R3	2229	IFEAR[1]	Incident	24%	Yes	Trust Paramedic	x
			Feelings	16%			
			Evaluation	25%			
			Analysis	21%			
			Reaction	6%			
			Response	7%			
R4	436	No	What	8%	No	Forensic / Specialist Paramedic	x
			So, What	54%			
			Now What	38%			
R5	1216	No	Presenting problem and summary of history (8%) Examination findings (19%) Differential diagnosis (2%) Management (5%)	34%	Yes	Trust Paramedic	x
			Clinical Decision Making	28%			
			Evidence Base	31%			
			Effect of an illness on patent and family carers	3%			
			Ethical / Governance Issues	2%			
			Additional Reflection	2%			

[1] Smart, G. (2011) 'I.F.E.A.R reflection: an easy to use, adaptable template for paramedics', *Journal of Paramedic Practice,* 3(5).

Reflection number	Word Count	Declared Structure	Structure in text	Percentage of Word Count	References?	Role / Clinical Grade	Additional reason for reflecting evident?
R6	1925	Gibbs[2]	Describe Feelings Evaluation Analysis	33% 13% 45% 9%	Yes	NQP	NQP Portfolio
R7	704	No	No structure evident	100%	No	Trust Paramedic	x
R8	783	(No) External CPD platform with reflective template	Description of events	58%	No	Event / Specialist Paramedic	x
			Feelings	22%			
			Evaluation	5%			
			Analysis	6%			
			Conclusion	5%			
			Action Plan	4%			
R9	4468	Rolfe[3]	No structure evident	100%	Yes	Trust Paramedic	Post Reg Uni Module
R10	1550	Willis[4]	Description	28%	Yes	Trust Paramedic	x
			Areas for investigation	11%			
			Literature Search	32%			
			What could be done differently next time	20%			
			Conclusion	9%			

[2] Gibbs, G. (1998) *Learning by Doing: A Guide to Teaching and Learning Methods.* Oxford: Further Education Unit: Oxford Polytechnic.
[3] Rolfe, G., Freshwater, D. and Jasper, M. (2001) *Critical reflection in nursing and the helping professions: a user's guide.* Basingstoke: Palgrave Macmillan, p. 14.
[4] Willis, S. (2010) 'Becoming a reflective practitioner: frameworks for the prehospital professional', *Journal of Paramedic Practice,* 2(5).

The findings from Table 23 show that only four of the ten reflections declared the use of an intentional model of reflection within the text, however a model was evident within eight of the ten discourses. As the findings reveal, the models declared were, I.F.E.A.R', 'Gibbs', 'Rolfe' and 'Willis'. However not every declared model had a clear supporting structure to the discourse, with the declared 'Rolfe' model having no evident structure within the text. Of the eight structures evident within the text, each was individual in terms of sub-titles evident. All eight structures had an initial 'descriptive' sub section, with four of the eight having a dedicated sub section relating to feelings. Only two of the ten reflections had no 'references' within the text or a 'reference list'; both of which had no declared structure, although one of which had an evident structure in text. Only two of the 12 reflections mentioned a specific reason to reflect additional to the chosen focus of the reflection; these were 'requirements of an NQP Portfolio' and 'requirements of a post-registration university module'. The findings also show a relationship between the previous 'outlier' in terms of word count (4468 words) and the only identifiable 'academic' piece of writing. However, there does not appear to be a relationship between reflective structure and word count.

The analysis of word count percentage divided across the structures suggests that those reflections with no declared reflective model in use (despite some subheadings noted) had the higher percentage of discussion within the descriptive element of their reflective account, except for reflection 4, with no declared structure in use however utilising the simple subheadings of 'what', 'so what' and 'now what'. Although reflection 4 did not declare a model of reflection, this simple use of subheadings, known as Driscoll's model, was able to allow the reflective author to balance their writing away from descriptive and towards critical reflection. This suggestive balance of writing, allowing for most of the reflection to be critical in nature was evident in all reflections with a declared reflective model. The data is therefore suggestive that the purposeful use of a reflective model supports criticality within reflective writing.

4.3.3 Phase 3 (Case Studies)

Phase 3 aims, objectives, design, methods, including sampling, and participants, and structural analysis will now be discussed.

4.3.3.1 Phase 3 Aims

The aim of this phase was to explore how paramedics interact with four fictional head injury case studies in a 'closed' social media group setting within an open conversation amongst other peers.

This knowledge will help to inform any future changes in paramedic training and clinical practice around head injury assessment and management. The utilisation of Nexus analysis may also help the profession better understand how paramedics use social media as a platform for education.

4.3.3.2 Phase 3 Objectives

- Establish types of questions evoked, and assessment and treatment options discussed by participants (what).
- Explore the use of peers and evidence base in clinical decision making (why).
- Analyse suggestions for change in practice or comparisons of ways of working among participants (QI).

4.3.3.3 Phase 3 Design and Methods

Phase 3 was designed to further explore how social media plays a part in influencing clinical decision making in head injury assessment and management both as a source of learning but also as a peer interaction. This design was influenced by findings from phase 1 and 2, as the researcher was now able to establish areas of assessment and management with suggested importance to participants through the repetition of their mention. The Driscoll reflective model also influenced the design of this phase to allow for the objectives to be achieved, as can be seen in Figure 32 below (Driscoll, 2007). Data were collected in 2019.

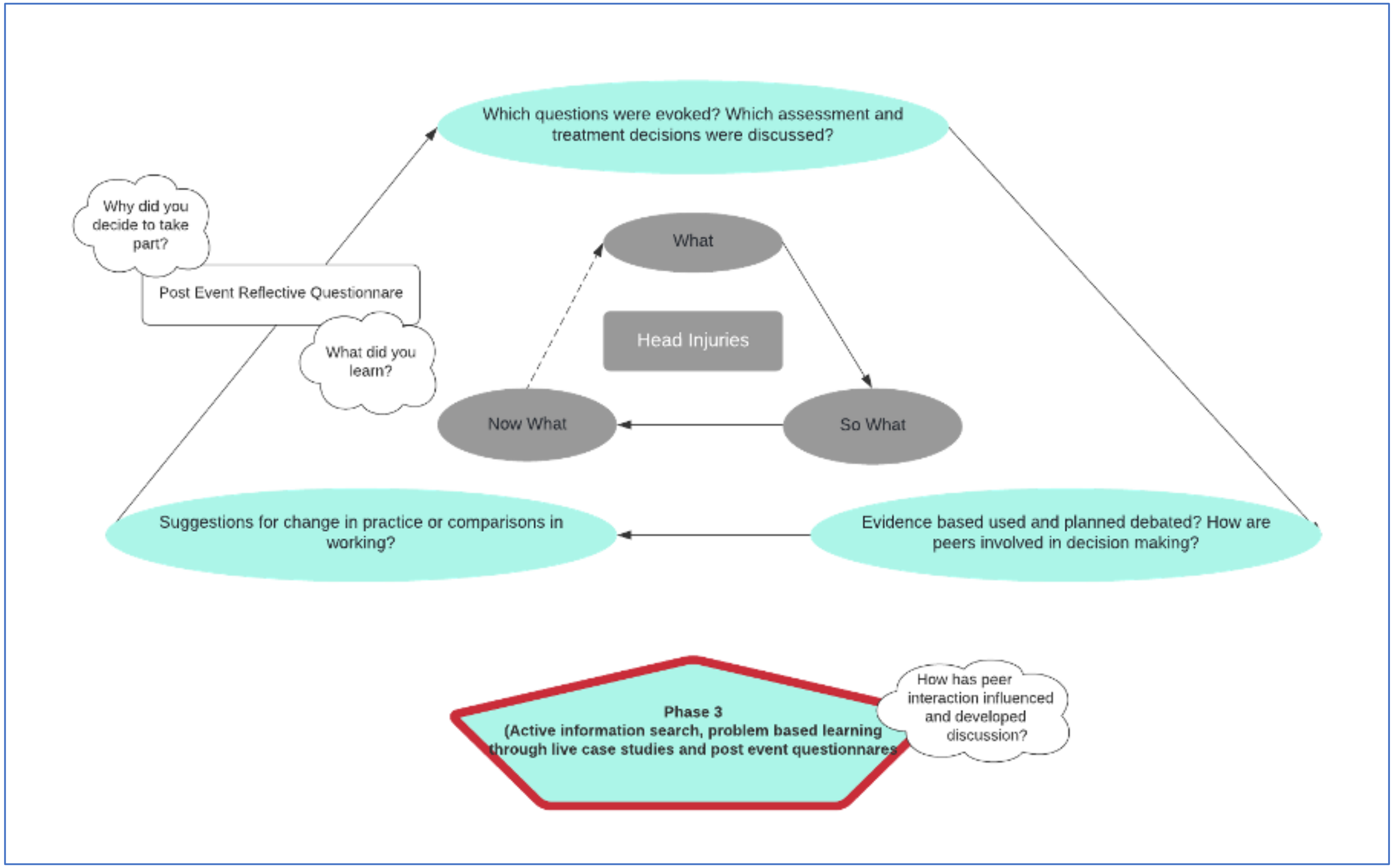


Figure 32 - Phase 3 Design

The method for this phase is a modified ‘think out loud’ ethnographic study, allowing analysis of peer conversation regarding the assessment and management of four fictional head injury case studies. These four case studies were designed to capture a range of possible assessment and management options through a spectrum of severity of injury, patient demographics and clinical findings while ensuring that pertinent issues from analysis of phases 1 and 2 were included within this purposeful design process.

The four case studies were developed in group consultation between the researcher and the three clinical founding administrators of the social media group and informed by phase 1 and 2. These founding members included an ambulance service paramedic (band 6), trainee advanced clinical practitioner paramedic in emergency medicine (band 7) and a trainee critical care advanced paramedic (band 7), this skill mix has allowed for a range of depth and breadth in head injury training and experience. The creator of each case study was either the researcher or a founding administrator to allow for a standardised approach. The lead and creator for each case study was decided upon based on clinical expertise resulting in the researcher leading case study 2 as an advanced clinical practitioner paramedic in acute medicine, case study 1 being led by the ambulance service paramedic as a generalist, case study three being led by the trainee advanced clinical practitioner in emergency medicine and case study 4 led by the trainee critical care paramedic. The creator of each case study then facilitated the case study by launching it at the agreed time and responding to comments and questions as they were posted live. The team discussed various clinical decisions featuring in the assessment and management of head injury patients and considered how the design of each case study would allow for these clinical decisions to be discussed; for example, allowing for a progression in severity in head injury through each case study and a range of clinical pathway alternatives within the design of each case.

An overview of each case study can be found in Table 24 below and the full case study information can be found in appendices 6, 7, 8 and 9.

Table 24 - Phase 3 Case Design Study Overview

Case Study	Overview	Potential areas for discussion	Facilitator
1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	Impact of alcohol consumption on clinical decision making, i.e. masking symptoms such as reduced GCS. Differentiating minor head injury from facial injury.	Ambulance Service Paramedic
2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	Delayed head injury in older adults, recognition, and management. Possible link of historic head impacts such as Rugby playing to Parkinson or Dementia presentation in later life. Cerebral T Waves on ECG.	ACP (Acute)
3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	Decision to close wound out of hospital or not. Head wound verse head injury discussion. Capability and role limitations discussion alongside accountability for clinical decision making.	tACP (EM)
4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	Management of critically ill head injury trauma patient and use of critical care advanced clinicians, per alerts and trauma divert decisions.	tCCP

The four fictional head injury case studies were posted on a closed Facebook group called ‘Parameducate’ which was designed to facilitate continued professional development relating to paramedic practice through social media, and has a proven track record of successful engagement in this type of peer learning with a membership of 12 thousand at the time of this research (Parameducate, 2016). There are also well set out ground rules for activity within the group as shown in appendix 10, these same ground rules were used within the case studies as part of this research.

Case studies were initially planned to be posted one month apart from each other to ensure that conversation from one case study has come to a natural end and therefore reducing the chance that one case study will negatively impact on another because of a saturation of 'head injury' themed case studies within this learning environment and therefore a knock-on reduction in participation. However, on advice of the group founders and administrators, the decision was taken to launch a case study each week on a Friday at around 6pm, as statistically this was shown to have their greatest interaction and response rate as seen in Figure 33, it was also felt that weekly would keep interest heightened in the overall research element of the case studies; thus, allowing a launch message and unique 'profile cover photo' to be created and used for the duration. It was also agreed that no other posts would go live, in between the case studies, to also maintain interest and increase the likelihood of interaction.

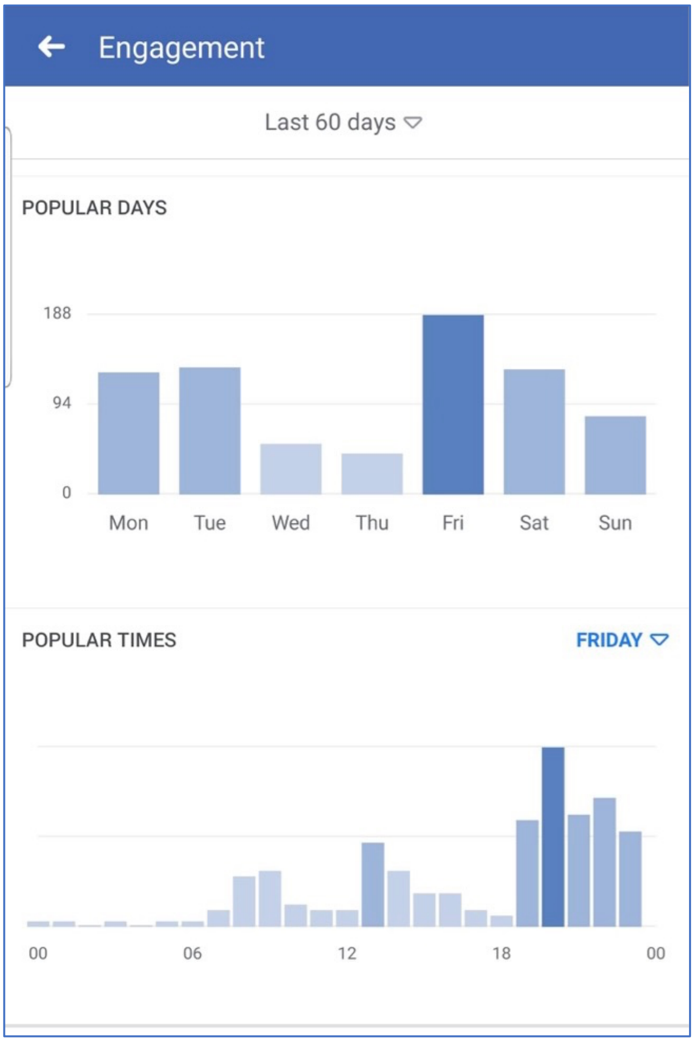


Figure 33 - Parameducate engagement statistics by day and time.

Detailed Explanation of the Online Discussion Process

Platform Details:
The online discussions were conducted on a closed Facebook group called 'Parameducate' which is dedicated to the continued professional development of paramedics. This group has a membership of 12,000 and is known for its active engagement in peer learning. The group's features, such as threaded comments, notifications, and the ability to post multimedia content, facilitated the discussions.

Participant Interaction:
Participants were invited to engage with four fictional head injury case studies posted weekly. Each case included a detailed scenario and specific prompts to guide the discussion. Participants were encouraged to ask questions, share their assessment and treatment options, and discuss the evidence base for their decisions. The discussions were open-ended, allowing for a natural flow of conversation.

Moderation and Facilitation:
Each case study was facilitated by one of the four administrators, who are experienced clinicians. The facilitators posted the case studies, responded to comments, and guided the discussions by asking follow-up questions and providing additional information as needed. They followed a set of guidelines to ensure the discussions remained focused and respectful.

Data Collection:
Comments from the discussions were collected using Facebook's built-in tools. The comments were exported and stored securely for analysis. Each comment was tagged with the participant's clinical grade and role to allow for detailed analysis.

Analytical Approach:
The comments were analysed using qualitative content analysis. The data were coded and categorised based on type of questions asked, assessment and treatment options discussed, use of evidence base, and suggestions for change in practice. The analysis aimed to identify common themes and patterns in the discussions.

Challenges and Solutions:
One challenge faced was ensuring consistent engagement across all case studies. To address this, the case studies were posted at the same time each week, and reminders were sent to participants. Technical issues, such as connectivity problems, were minimal and did not significantly impact discussions.

4.3.3.4 Phase 3 Participants and Sampling

Purposive sampling was used to select participants for phase 3. The inclusion criteria were members of the 'Parameducate' Facebook group, which included HCPC registered paramedics, unregistered pre-hospital clinicians, and other clinical grades outside of paramedicine. This approach ensured that participants had relevant clinical experience and could provide rich, detailed insights into the research questions. The sample included a diverse range of clinical grades and roles, ensuring a broad range of perspectives.

The administrators of 'Parameducate' and the researcher agreed that case studies would be open to all clinical grades, as members of the group vary from registered paramedics, unregistered pre-hospital clinicians and a range of other clinical grades outside of paramedicine, such as Doctors and Nurses. This decision was made for two reasons, firstly this is standard facilitation practice within this social media group and so as to allow for a true virtual ethnographic study of people and cultures, the researcher made a conscious decision to disrupt this as little as possible (Hammersley and Atkinson, 2007). Secondly, paramedics work with other clinicians on a regular basis and so their opinion and advice would feature in the paramedic's clinical decision making, the decision to allow for this to take place in the virtual setting was therefore made in order to allow for 'insider' and 'outsider' perspectives (Hammersley and Atkinson, 2007). However, to capture which comments have originating from which clinical grade, it was decided that this data would be captured from each participant in a short questionnaire. As well as establishing clinical grade and role, the participants were also asked the following two open questions within the questionnaire, to also allow for qualitative analysis of their interaction with the case studies:

1) Why did you decide to contribute to this case study?
2) What has been the impact of, or what have you gained from, contributing to this case study?

Within the opening statement of each case study, participants were invited to contribute to this research via a contribution to the case. Ensuring the opening statement clearly explained the case study was for research purposes, thus allowed for informed consent before contribution (Librett and Perrone, 2010). Participants were informed that they would be contacted after the case study had concluded to agree to their comments being included for analysis or withdraw their consent, as it recognised that informed consent can be difficult to achieve in full, in ethnographic research, before participation, given that all circumstances pertaining to the research event can be difficult to foresee (Mapedzahama and Dune, 2017). After one week had elapsed, the case study was closed for comments before the next case study was launched. At the end of the 4th case study a table of contributors was designed and cross matched against all four case studies, thus allowing the researcher to contact those participants to share the participant information sheet, consent form and questionnaire. These can be found in appendix 11, 12 and 13. Participants, who contributed but then decided to withdraw their consent, or not confirm their consent for analysis, had their comments removed from final transcripts.

A total of 94 individuals participated across the four case studies with 15 participating in more than one case study, three of these participants withdrew from the study and 11 were withdrawn as confirmed consent for analysis was not obtained.

Table 25 and Table 26 below highlight the participant numbers per case study, number of comments per case study and the number of comments needing to be removed due to either withdrawal or an inability to gain consent for analysis.

Table 25 - Phase 3 participant numbers per case study

	Participants per case study	Withdrawn	Not able to make contact to gain consent	Consent Gained
Case Study 1	21	0	1	20
Case Study 2	24	1	0	24
Case Study 3	47	2	7	38
Case Study 4	21	0	3	18
		3	11	

Table 26 - Phase 3, number of comments per case study

	Number of comments	Number of comments removed	Comments for analysis
Case Study 1	109	1	108
Case Study 2	119	4	115
Case Study 3	145	14	131
Case Study 4	93	10	83
	466	28	438

4.3.3.5 Phase 3 Case studies Structural Analysis

In phase 3, data saturation was not applicable as the case studies were very different from each other. Instead, it was decided that four cases were created to cover the spectrum of minor to major head injuries, a variation of acuity, and a variation of patient demographics. This approach ensured a comprehensive exploration of the different aspects of head injury assessment and management.

In total 94 individuals took part across four case studies, some participating in more than one study, creating a total of 466 comments. Those four case studies were:

1) Young male, minor facial injury after fall, small amount of alcohol, GCS 15.
2) Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14
3) Older adult with an open head-wound to the back of his head from a minor fall. GCS 15
4) Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.

A total of 15 participants contributions were removed across the four case studies, prior to analysis because of withdrawal from the study or removal due to no confirmed consent.
The 15 removed participants had contributed 29 comments in total, thus leaving a remaining 437 comments for analysis, with case studies 3 and 4 mainly affected. A breakdown of the contribution for analysis can be seen in Table 27, revealing the greatest contribution within case study 3 (older adult with open head wound).

Table 27 - Case Study Contributions for Analysis

	Participants per case study	Number of comments	Withdrawn	Not able to make contact to gain consent	Number of comments removed
Case Study 1	21	108	0	1	1
Case Study 2	24	118	1	0	4
Case Study 3	47	144	2	7	14
Case Study 4	21	92	0	3	10
		462	3	11	28

The 437 comments for analysis were contributed from a total of 80 participants. A further breakdown of the 80 participants by clinical grade can be seen in table 28.

Table 28 - Clinical grade analysis of case study participants

<table>
<tr><th colspan="3">Clinical Grade</th><th>Number of individuals across the case studies</th></tr>
<tr><td colspan="3">Hospital Health Care Assistance (HCA)</td><td>1</td></tr>
<tr><td colspan="3">Non-registered Ambulance Clinician (NRAC)</td><td>7</td></tr>
<tr><td colspan="3">Student Paramedic</td><td>15</td></tr>
<tr><td colspan="3">Newly Qualified Paramedic (NQP)</td><td>3</td></tr>
<tr><td colspan="3">Paramedic</td><td>29</td></tr>
<tr><td colspan="3">Specialist Paramedic (clinical n=13 (C), research n=0 (R), education n=2 (E), or leadership n=2 (L))</td><td>17</td></tr>
<tr><td>Clinical (13)</td><td>Research (0)</td><td>Education (2)</td><td>Leadership (2)</td></tr>
<tr><td colspan="3">Advanced Paramedic</td><td>7</td></tr>
<tr><td colspan="3">Hospital Doctor (Middle Grade)</td><td>1</td></tr>
<tr><td colspan="3"></td><td>Total 80</td></tr>
</table>

The initial clinical grade analysis revealed most participants were from a ‘paramedic’ grade, with a large percentage also from ‘student paramedics’ and ‘specialist paramedic’ grades. A further analysis of participant contribution, as seen in Table 29, has revealed that most participants contributed to only one case study (n=63) with a much smaller cohort contributing to varying combinations of two case studies (n=13) and only two participants contributing to all four. The contribution to each study per clinical grade can also be seen in Table 29, showing a consistent participation across all case studies from paramedic and student paramedic grades. Moreover, case study 3 (Older adult with open head wound) attracted the greatest participation of non-registered grades, case study 2 (older adult with history of head injuries) was the only case study to feature a contribution from a doctor, with most multiple contributions coming from the ‘paramedic’ and ‘clinical specialist paramedic’ grades.

Table 29 - Case study participation per clinical grade, including overlap.

		Single Contribution				Multiple Contribution						
	Case Studies	CS 1	CS 2	CS 3	CS 4	CS 1+2	CS 1+3	CS 1+4	CS 2+3	CS 2+4	CS 3+4	CS 1+2+3+4
	Participants	11	14	26	12	3	4		3	1	2	2
Contribution by clinical grade	HCA			1								
	NRAC	3	3	1								
	Student Paramedic	1	3	4	4			1			2	
	NQP	1		1					1			
	Paramedic	4	4	10	5	3			2	1		
	Specialist Paramedic (C)		3	4	2		2					2
	Specialist Paramedic (E)			1	1							
	Specialist Paramedic (L)	1					1					
	Advanced Paramedic	1		5			1					
	Hospital Doctor		1									

Transcripts of the contributions to the case studies revealed a total of 14,670 words and 2,792 unique word forms. The vocabulary density of each reflection (ratio of words in each reflection compared to the number of unique words) can be seen in Table 30 and Figure 34.

Table 30 - Case study structural analysis

	Comments for analysis		Case study word length		Vocabulary Density		Average words per sentence	
Case Study 1	108		3224		0.317		16.6	
Case Study 2	114		3473		0.312		17.4	
Case Study 3	130		3684		0.283		20.8	
Case Study 4	82		4289		0.292		19.5	
	Mean 108.5	Median 111	Mean 3667.5	Median 3578.5	Mean 0.301	Median 0.302	Mean 18.575	Median 18.45

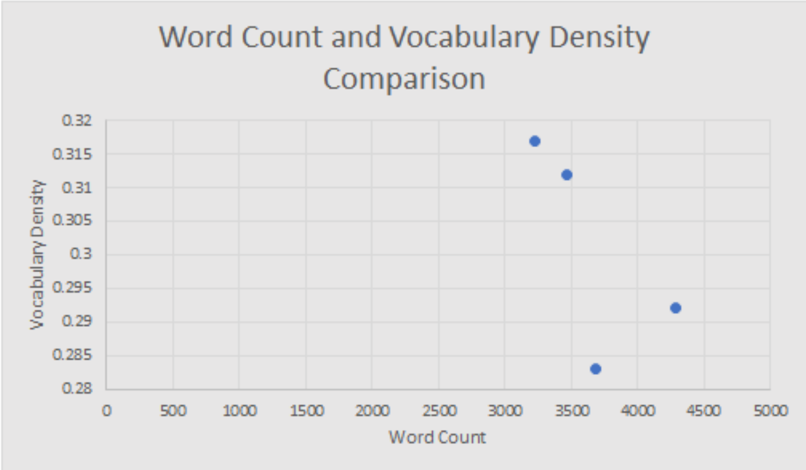


Figure 34 - Case Study Word Count and Vocabulary Comparison

Once again, this vocabulary density analysis shows a potential relationship between lower word count and higher vocabulary density, suggesting that the higher word count case study contribution transcripts are more complex texts with an increased number of unique words.

4.3.3.6 Phase 3 Post Case Study Questionnaire Structural Analysis

The questionnaire asked the participants to declare clinical grade and also answer the following two reflective questions after they had taken part in one or more of the case studies:

1) Why did you decide to contribute to this case study?
2) What has been the impact of, or what have you gained from, contributing to this case study?

Of the 78 participants who consented to their contribution being analysed, 33 participants further responded to the post case study questionnaire. A breakdown of respondent by clinical grade can be seen in Table 30.

Table 31 - Clinical grade analysis of questionnaire submission

Clinical Grade	Number of Respondents
Student Paramedic	2
NQP	4
Paramedic	15
Specialist Paramedic (clinical n=4 (C), research n=0 (R), education n=1 (E), or leadership n=2 (L))	9
Advanced Paramedic	3

The findings within the table above show that most of the respondents are from the clinical grade of ‘paramedic’. The questionnaire had a limited and simple design allowing participants to write as little or much as they chose for each of the two qualitative answers. A breakdown of document length and average word count per answer for each questionnaire can be found in Table 32. This table also highlights the clinical grade of each participant, further specifying specialist paramedic by dominant practice pillar using the following additional code:

- Clinical Specialist (C)
- Educationalist (E)
- Research Specialist (R)
- Lead or Manager (L)

Table 32 - Questionnaire structural analysis

Questionnaire Number	Clinical Grade	Document Length	Ave Word per Sentence	Average Words per answer	Vocabulary Density
Q1	NQP	54	27	27	0.746
Q2	Paramedic	64	32	32	0.776
Q3	NQP	38	19	19	0.825
Q4	Specialist Paramedic (C)	62	37.9	154.5	0.62
Q5	Advanced Paramedic	276	8	8	0.882
Q6	Paramedic	15	4	4	1
Q7	Paramedic	62	32.25	46.5	0.656
Q8	Specialist Paramedic (C)	53	14.5	14.5	0.724
Q9	Paramedic	44	16.25	24.5	0.796
Q10	Paramedic	23	11.5	11.5	0.87
Q11	Paramedic	35	21	21	0.907
Q12	Paramedic	64	15.8	47.5	0.745
Q13	Student Paramedic	97	27	85.5	0.640
Q14	NQP	154	32.5	32.5	0.785
Q15	Advanced Paramedic	50	12.75	20	0.775
Q16	Paramedic	69	23	98	0.609
Q17	Specialist Paramedic (C)	169	13	13	0.923
Q18	Specialist Paramedic (C)	22	33.5	33.5	0.731
Q19	Paramedic	81	15.5	15.5	0.871
Q20	NQP	37	19.75	52	0.717
Q21	Paramedic	102	20.75	27.5	0.836
Q22	Paramedic	39	10	10	0.95
Q23	Specialist Paramedic (E)	34	25.75	39	0.782
Q24	Paramedic	159	41.75	101.5	0.662
Q25	Specialist Paramedic (C)	111	17	17	0.794
Q26	Advanced Paramedic	30	11	11	0.818
Q27	Student Paramedic	17	11.5	11.5	0.87
Q28	Paramedic	73	18.65	65.5	0.644
Q29	Student Paramedic	93	21.5	21.5	0.814
Q30	Paramedic	29	4.5	4.5	0.75
Q31	Paramedic	62	25.75	40	0.738
Q32	Specialist Paramedic (L)	41	29.5	29.5	0.847
Q33	Specialist Paramedic (L)	71	26.5	38	0.697
		Mean (70.60) Medium (62)	Mean (19.8) Medium (19.3)	Mean (35.3) Medium (31)	Mean (0.781) Medium (0.782)

Table 32 has revealed that the contribution with the highest word count (n=276) came from an Advanced Paramedic, compared to the contribution with the lowest word count (n=15) coming from a Paramedic. The same findings can be found when analysing the average word count and answer contribution per clinical grade, as seen in Table 33. However, despite having the highest average word count, the contribution from the grade of advanced paramedics had the lowest average words per sentence and per answer. Moreover, Table 34 shows a structural analysis for each answer, showing that on average the lengthier answers are within the second reflective question relating to impact or gain from participation. This second reflective question has a combined word count almost three times that of the question relating to why the participants decided to take part.

As can be seen in Figure 35, unlike in previous phase 1, 2 and 3 analyses, the vocabulary analysis of the post case questionnaires, showed no clear relationship between word count and vocabulary density. In contrast to the previous corpus analysed in this way, the questionnaire had much shorter document lengths which may be a contributing factor to an absence of pattern occurring.

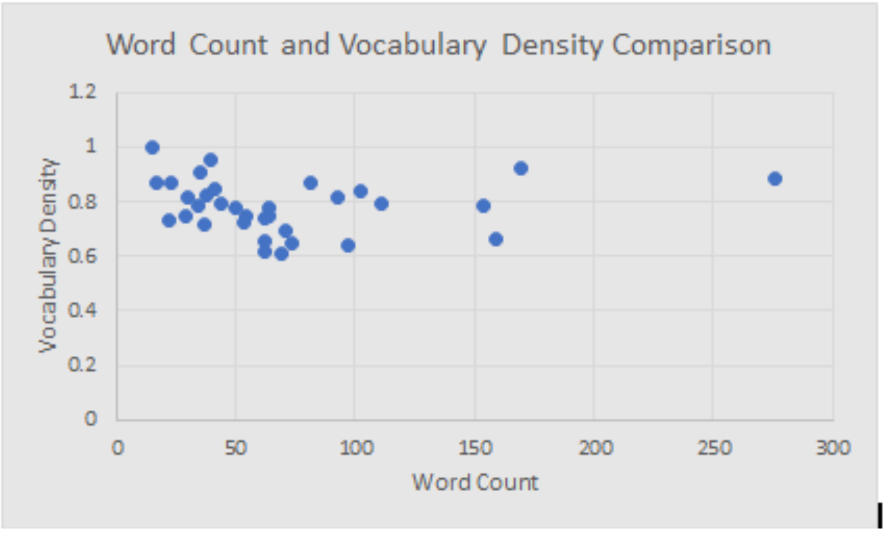


Figure 35 - Post Case Study Questionnaire Word Count and Vocabulary Density Comparison

Table 33 - Questionnaire structural comparison per clinical grade

Grade	Ave document word count	Ave word per sentence	Ave words per answer
NQP	70.7	24.56	32.6
Student Paramedic	69	20	39.5
Paramedic	61.4	19.51	36.6
Specialist Paramedic	70.3	24.7	42.3
Advanced Paramedic	115.3	10.58	13

Table 34 - Questionnaire structural analysis by question

Question	Total word count	Ave Word count per sentence	Ave Word count per answer
Why did you decide to contribute to this case study?	587	18.1	26.5
What has been the impact of, or what have you gained from, contributing to this case study?	1455	23.1	44.7

4.3.4 Clarification on Implementation of ONSD Ultrasound and ResQpod

Initially, this research considered the potential implementation of ONSD ultrasound and the ResQgard as innovative tools for improving the assessment and management of head injury patients. These ideas were explored in the background and early stages of the study to evaluate their feasibility and potential impact on paramedic practice.

However, as the research methods and fieldwork evolved, it became clear that a different approach was needed to address the research aims and objectives effectively. The focus shifted towards understanding current practices, decision-making processes, and the role of reflective practice in enhancing quality improvement. This shift was driven by several factors:

1. Feasibility and Scope: Implementing and evaluating new technologies like ONSD ultrasound and the ResQpod would require extensive resources, training, and a controlled study environment, which were beyond the scope of this research.
2. Evolving Research Focus: As the methodology evolved, the importance of reflective practice became more apparent. This approach provided a practical and immediate pathway to achieving the research objectives by focusing on improving existing paramedic practices through reflective discourse and mediated actions.
3. Practical Insights: As data collection and analysis progressed, it became evident that addressing the barriers and enablers of current practices would yield more actionable insights for quality improvement and implementation science.

Therefore, while the initial exploration of ONSD ultrasound and the ResQpod provided valuable context, the methodology was adapted to better align with the research aims and the practical realities of the study. This decision ensured a coherent and focused approach, ultimately contributing to a more meaningful and impactful set of findings.

4.3.5 Justification of Methodology

The research design for this PhD was purposefully crafted to leverage the strengths of qualitative methods, recognising their benefits in capturing the nuanced experiences and perspectives of paramedics. The chosen methods of semi-structured interviews, written reflections, and modified 'talk aloud' case studies were selected to provide a comprehensive exploration of paramedic practice in the assessment and management of head injuries.

4.3.5.1 Purposeful Design

The use of semi-structured interviews allowed for guided reflection and in-depth exploration of participants' experiences and decision-making processes. This method facilitated a conversational approach, enabling the researcher to probe deeper into specific areas of interest and gather rich, qualitative data.

Written reflections provided an opportunity for participants to engage in reflective practice, documenting their thoughts and experiences in a structured manner. This method captured the reflective processes that paramedics undergo, offering insights into their clinical decision-making and personal development.

The modified 'talk aloud' case studies, conducted in a closed social media group setting, allowed for real-time interaction and peer discussion. This method provided a dynamic platform for participants to share their perspectives, ask questions, and engage in collaborative learning.

4.3.5.2 Recognising the Potential for Direct Observation

While the chosen methods were purposeful and effective, it is important to acknowledge that the potential for a fourth phase involving direct observation was recognised. Direct observation could have provided additional insights through real-time observation of paramedic practice in the field. However, due to the constraints imposed by the COVID-19 pandemic, direct observation was not feasible.

Despite this limitation, the three-phase design remained robust and provided valuable data. The use of virtual platforms and written reflections allowed the research to continue while adhering to social distancing guidelines. These methods offered a viable alternative, ensuring the safety of participants and the researcher while still capturing meaningful data.

4.3.5.3 Benefits of the Chosen Methods

The chosen methods offered several benefits:

- Depth of Exploration: Semi-structured interviews and written reflections allowed for in-depth exploration of participants' experiences and perspectives.
- Reflective Practice: Written reflections encouraged participants to engage in reflective practice, enhancing their clinical decision-making and personal development.
- Peer Interaction: The modified 'talk aloud' case studies facilitated peer interaction and collaborative learning, providing a dynamic platform for discussion and knowledge sharing.

4.3.5.4 Limitations

While the research design was purposefully crafted to leverage the strengths of qualitative methods, it is important to acknowledge certain limitations. The use of virtual platforms and written reflections, although effective, may have limited the depth of interaction and the ability to observe non-verbal cues. Additionally, the reliance on self-reported data in written reflections introduces the potential for bias. The constraints imposed by the COVID-19 pandemic prevented the inclusion of direct observation, which could have provided additional insights through real-time observation of paramedic practice in the field. Despite these limitations, the three-phase design remained robust and provided valuable data, ensuring the safety of participants and the researcher while capturing meaningful insights.

4.3.5.5 Addressing Cognitive and Social Desirability Bias

In qualitative research, cognitive biases and social desirability biases can influence participants' responses. Cognitive biases, such as those described by Nisbett and Wilson (1977), can affect decision-making processes and the accuracy of self-reported data. Social desirability bias, where participants provide responses, they believe are expected or favourable, can also impact the validity of the data (Grimm, 2010). Recognising these biases is crucial for interpreting the findings and understanding the limitations of self-reported information. Strategies such as triangulation and reflexivity were employed to mitigate these biases and enhance the credibility of the study (Patton, 2015).

4.3.6 Ethics and Bias

Ethical approval was received from Birmingham City University Research and Ethics Committee for each of the three phases of the research:

- Phase 1 - semi-structured interviews (Hosznyak /Jan /2017 /RLRA /0789) (Appendix 14).
- Phase 2 - written reflections (Hosznyak /2034 /R(A) /2019 /Jan /HELS FAEC) and **(**Hosznyak/2034/Am/2019/Jun/HELSFAEC) (Appendix 15 and 16).
- Phase 3 - case studies (Hosznyak/3462/R(A)/2019/Jul/HELSFAEC and Hosznyak/3462/Am/2020/Mar/HELSFAEC) (Appendix 17 and 18).

These ethical applications and subsequent approvals recognised potential ethical issues for consideration pertaining to the research design of each phase, in particular ethical dilemmas associated with internet mediated research (Markham and Buchanan, 2012) as well as general recommendations for research integrity (UKRIO, 2009). Overall ethical considerations of the researcher as a practicing paramedic governed by the HCPC were also considered (HCPC, 2016).

Recognised areas for researcher bias in this PhD were related to the analytical process, given the qualitative methods used and direct researcher involvement of data collection, but also a single researcher analysis process (Choy, 2014). However, although the use of more than one analyst can prove beneficial in triangulation of data, there are also counter arguments to the appropriateness of inter-rater reliability in qualitative research (Armstrong *et al.*, 1997; Belotto, 2018; McDonald, Schoenebeck and Forte, 2019). Moreover, good quality data analysis in qualitative research relies on the integrity, skill and vision, and unique expertise and experience of the researcher conducting the analysis, thus meaning a single researcher may be sufficient (Dingwell *et al.*, 1998; McDonald, Schoenebeck and

Forte, 2019). There was also a potential bias in this PhD research given the researchers pre-existing knowledge and personal experiences of the profession and subject matter which could affect their input into the processes or view of the results (Choy, 2014; Gao, 2020; Wadams and Park, 2018).

The issue of consent was also one of significant consideration given the online platforms used for recruitment and data collection and the ability to gain consent and allow for withdraw in a virtual setting, but also potential complications with gaining consent pre a ‘live’ event open to a large population of potential participants (Salmons, 2022). These issues of bias, consent, methods, and environment will now be further discussed.

The researchers aim was to observe as opposed to directly participate. However, given the researchers subject matter knowledge and their direct interaction with participants within phase 1 as a sole interviewer, and phase 3 case study moderating, it was possible to introduce a ‘horns or halo effect’ (Forgas, 2011; Thorndike, 1920; Nisbett and Wilson, 1977; Radeke and Stahelski, 2020). The horns effect meaning the researcher’s involvement may negatively influence the participants contribution through impression formation between researcher and participant based on factors such as visual impressions or social status, or a ‘halo’ effect, where the influence may be deemed more favorable; either way noted as a bias within the data collection and subsequent analysis of results (Forgas, 2011; Thorndike, 1920; Nisbett and Wilson, 1977; Radeke and Stahelski, 2020). However, the researcher within nexus analysis arguably needs to be within the nexus to enable the necessary navigation and ultimate change of the nexus of practice. However, the researcher must account for how their involvement has influenced the actors, interaction orders and overall social action (Jones, 2013; Scollon and Scollon, 2004b; Dordah and Horsbol, 2021). The researcher has taken several steps within each phase to enable an emic lens to the data collection, while minimising bias (Mostowlansky and Rota, 2020). Within phase-1 the researcher excluded participants known to them to reduce bias through influence during interviews. Within phase-2 the researcher did not stipulate any form of reflective writing template, any specific writing style, or any specific patient interaction as preferable for reflection; as well as allowing for greater analysis of writing as well as subject content, this also reduced bias in the form of researcher preference or preconceived ideas regarding reflective writing as an academic. Within phase-3 the researcher co-designed all four case studies with three other clinicians. While three of the case studies were facilitated by the co-designers, the fourth case facilitated by the researcher was also overseen by the other 3 administrators to ensure no personal bias was evident throughout the live construction. However, it is noted that there was also the possibility of the 'Hawthorne effect' during phase-3, where the participants may change their behaviour as a result of knowing they are being observed (Segwick and Greenwood, 2015).

When designing phase 3, the researcher recognised that it would not be possible to send out a consent form and receive the consent form from each participant before they contributed to the case study, as the case studies were in real time and an online equivalent of observational ethnographic research. As previously explained however, there was an opening statement to each case study which made it clear to the participants that these case studies were research activities, unlike the previous case studies on the Facebook group, and that each participant would be contacted after the close of the case study with further information and a chance to withdraw their comments from analysis. On reflection, the researcher recognises this decision was made to secure this consent with written evidence, however previous literature on ethnographic ethics has recognised that this is not always necessary or desirable and that researchers in this field may feel under pressure to do so, to 'protect themselves' or that the absence of such forms may be perceived as non-consensual (Mookherjee, 2012; Lambeck M, 2012; Mapedzahama and Dune, 2017). Rather, it is noted that informed consent is not easily adopted within the specificities of ethnographic research when viewed as a recognition of a problem rather than a solution, but rather it is both dynamic and continuous and it is the quality of the consent, rather than the format, that is important (Lambeck M, 2012; American Anthropological Association, 2012).

Triangulation, achieved through the research design, may help to eliminate, or reduce the bias created by single researchers, single methods, or single theories (Patton, 2015). In this research, the researcher has acknowledged the potential for bias as a single researcher and thus employed a design method allowing for triangulation as described in subsection 4.3.7.

4.3.6.1 Managing Disclosures of Poor or Undesirable Practices

In qualitative research, it is common for participants to disclose poor or undesirable practices. As a registered paramedic, the researcher had a duty to report any dangerous practice, in accordance with the Health and Care Professions Council (HCPC) guidelines (HCPC, 2016). Participants were made aware of this duty at the outset of the study.

The HCPC provides clear guidance on the responsibilities of registered paramedics, including the duty to report concerns about the safety and well-being of patients (HCPC, 2016). To manage potential disclosures during interviews and reflections, the following steps were taken:

1. **Informed Consent**: Participants were informed about the researcher's duty to report any dangerous practice during the consent process. This information was included in the participant information sheets and at the beginning of each interview.
2. **Confidentiality and Anonymity**: While confidentiality and anonymity were assured, participants were made aware that any disclosure of dangerous practice would need to be reported to the appropriate regulatory body. This was done to ensure transparency and maintain ethical standards.
3. **Supportive Environment**: Interviews were conducted in a supportive and non-judgmental manner, encouraging participants to share their experiences openly. The researcher emphasised the importance of learning from mistakes and improving practice.
4. **Reporting Mechanism**: In the event of a disclosure of dangerous practice, the researcher would have followed a clear reporting mechanism, in line with HCPC guidelines. This would have involved documenting the disclosure and reporting it to the relevant governing bodies while maintaining the participant's confidentiality as much as possible.

By implementing these measures, the study ensured that ethical standards were upheld, and participants were aware of the researcher's duty to report any dangerous practice. This approach aligns with the HCPC's guidance on maintaining patient safety and professional integrity. No dangerous practice was identified during the data collection process that directly related to a participant and / or met the requirements for reporting under the HCPC guidance.

4.3.7 Triangulation and Validity

A multiple phase qualitative methodological approach to this research has allowed for a greater credibility, dependability and confirmability of findings, Figure 36 below gives a visual representation of how the three phases finally come together (Guba, 1981; Thurmond, 2001; Patton, 2015). On completion of all three phases the strands of key underpinning theory can be seen in orange, as social networking pedagogy, quality improvement (through the 'so what' and 'now what' design within each phase) and clinical decision making (through the 'what' and 'so what' design within each phase). While the link between the 'Now what' and 'what' stages of phases 1 and 2 have no direct link, it is possible the participants have gone on to further reflect and complete the cycle. However, there is a direct link between these stages in phase 3, through the post event questionnaire thus encouraging this continued reflection after the initial event; the difference in the relationship through the phases is depicted in this figure using broken and complete lines respectively. Figure 36 also demonstrates how perceived barriers to clinical decision making and quality improvement flow throughout the three phases, as well as the depiction of the use of 'On' and 'In' action reflection both within individual phases and across the overall research design.

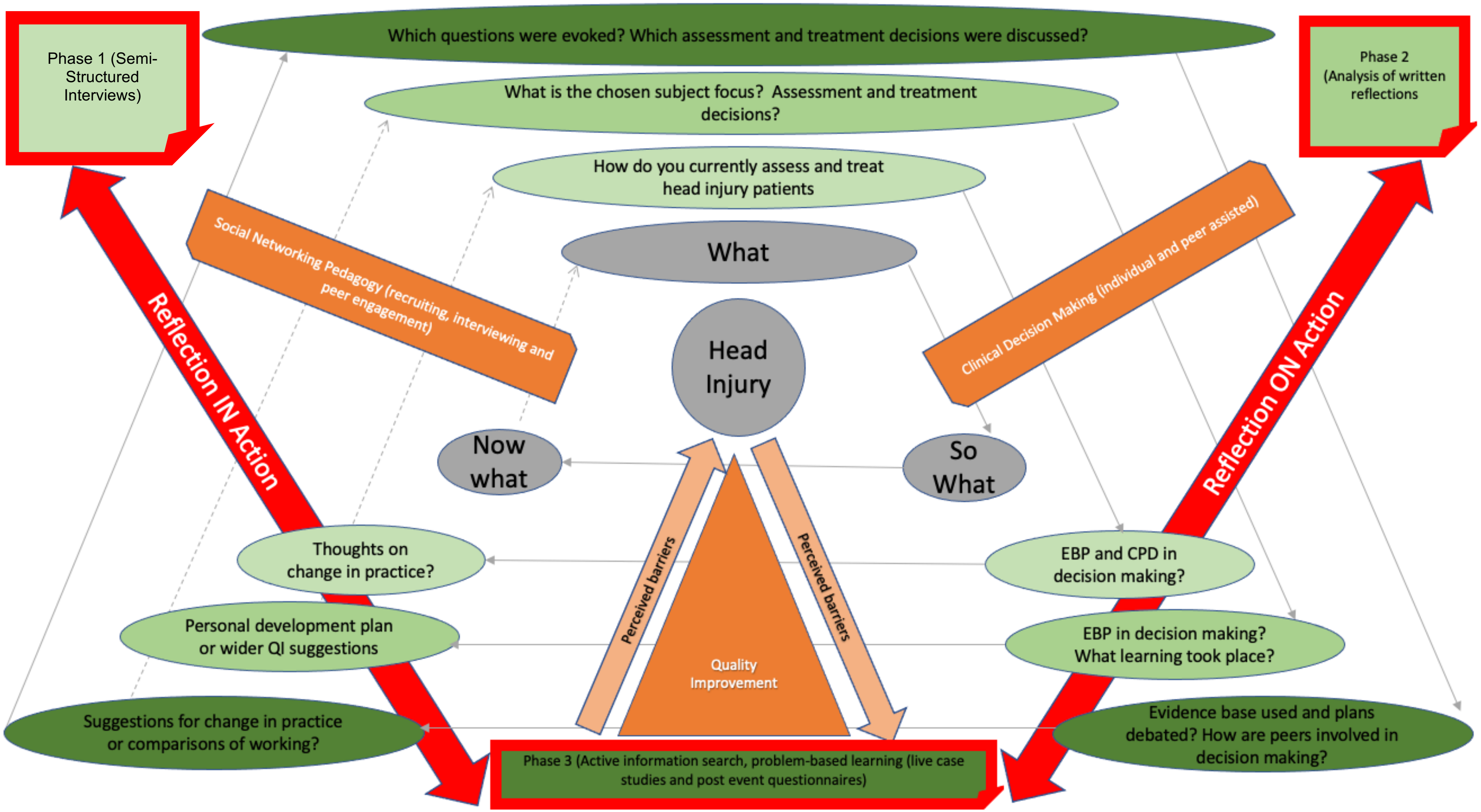


Figure 36 - Combined 3 Phased Design

This 3-phased approach has allowed for triangulation through the use of a variation in qualitative methods, time, space, facilitators and participants; of which each phase contributes its own insights and understanding (Bogdan and Biklen, 2015; Ritchie *et al.*, 2013). The variation within each phase and subsequent overall research can be described as a modified multi-triangulation approach as depicted in Figure 37 below (Denzin, 1970).

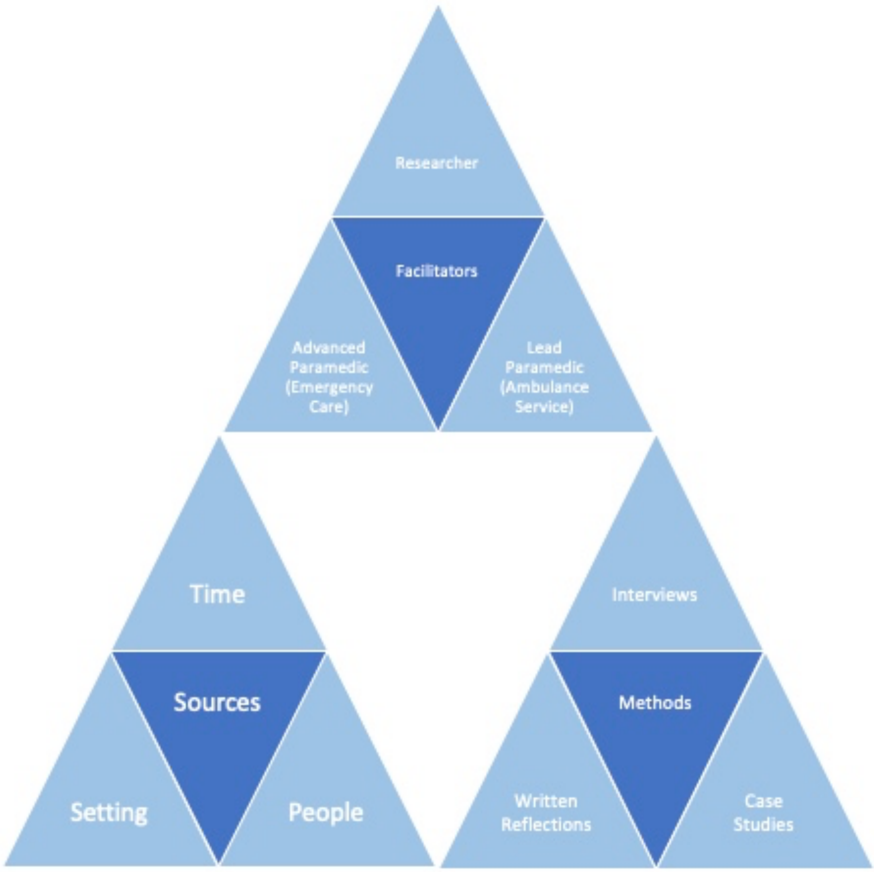


Figure 37 - Modified multi-triangulation approach.

As this research is in essence a study of human behaviour, this combination of data and methodological triangulation was designed to better understand the richness and complexity of the subject matter by giving a more detailed and balanced picture of the situation. The term ‘triangulation’ may now be popular within research, however its history is that of nautical and land survey origins and serves to explain the concept of determining ones position through the measurements taken from two other distinct points, thus the effects of this research design will allow for cross-checking of data between the three studies, during the analysis process, to confirm a pattern in findings, with increased trustworthiness, in a similar way to the origins of the term 'triangulation' allowed for navigators to confirm their physical position with confidence (Thurmond, 2001; Halcomb and Sharon, 2005).

A triangulation of settings was achieved using social media, the elongated timeline of the combined three phases and the combination of reflection both 'In' and 'On' action. The use of social media to recruit participants and the wide ranging members of the 'closed' Facebook group, meant there was a higher likelihood of participants from across multiple ambulance services and other settings; thus increasing the transferability of subsequent results (Guba, 1981).

4.3.7.1 Synthesis of data structure across the phases

A synthesis and comparison of the clinical grades of participants across the three phases can be seen in Table 35. As can be seen here and within the inclusion and exclusion criteria, not all phases were open to all participants. However, all sections of all three phases were open to NQP, Paramedic, Specialist and Advanced Paramedics and so a comparison is possible.

Table 35 - Synthesis and comparison of clinical grades of participants across the 3 phases

	Hospital HCA	Non-registered ambulance clinician	Student Paramedic	NQP	Paramedic	Specialist Paramedic	Advanced Paramedic	Hospital Doctor	Total Participants per phase component (n)
Interviews	N/A	N/A	N/A	0	7	5	0	N/A	12
Reflections	N/A	N/A	N/A	1	7	2	0	N/A	10
Case Studies	1	7	15	3	28	17	6	1	80
Questionnaires	0	0	2	4	15	9	3	0	33
Total Participants per grade (n)	1	7	17	8	57	33	9	1	

As can be seen from Table 35 above, paramedic grade clinicians formed most of the participants in each of the phases. Only the case study was open to non-registered paramedic grades and even with this inclusion, there were minimal multi-disciplinary participants. All three phases were open to all paramedic grades and two of these phases had participation from the range of NQP, paramedic, specialist and advanced. The reflections did not have any NQP participants.

As can be seen from Table 36 and previous analysis, vocabulary density analysis in phase 1 (interviews), phase 2 (reflections) and phase 3 (case study transcripts), showed a potential relationship between lower word count and higher vocabulary density, suggesting that the higher the word count within these corpora, the more complex the texts were in terms of an increased number of unique words. The data from the interview analysis also shows a connection between length of interview and word count. Thus, suggesting that to achieve an interview narrative which has a breadth of vocabulary, time is required. Moreover, this data is suggestive that an interview of over 51 minutes is needed for a significant difference to be noted. However, the vocabulary analysis of the post case questionnaires, showed no clear relationship between word count and vocabulary density. In contrast to the previous corpus analysed the completed questionnaire had much shorter document lengths which may be a contributing factor to an absence of pattern occurring.

Table 36 - Synthesis and comparison of document length and vocabulary density across the 3 phases

	Total words analysed	Ave Document Length	Vocabulary Density	Number of Participants
Interviews	31890	Mean (2657.5)	Mean (0.2685)	12
		Median (2228.5)	Median (0.2505)	
Reflections	16564	Mean (1656.4)	Mean (0.369)	10
		Median (1524.5)	Median (0.387)	
Case Studies	14670	Mean (3667.5)	Mean (0.301)	78
		Medium (3578.5)	Medium (0.302)	
Questionnaires	2330	Mean (70.60)	Mean (0.781)	33
		Medium (62)	Medium (0.782)	
	65454			**113**

Participants were able to submit a reflection on any subject relating to an adult head injury patient. The overall focus would appear to be complex decision making in the assessment and management of head injury patients with a high GCS.

Despite there being no requirement for participants to use a model for reflection, four of the ten reflections declared the use of an intentional model of reflection within the text, however a model was evident within eight of the ten discourses. Those reflections with a declared model or identified structure had the greater percentage of critical reflective writing verses descriptive content. The data is therefore suggestive that the purposeful use of a reflective model can allow for criticality within reflective writing. A relationship between reflective models and references was also noted in the findings. All reflections utilising a reflective model have included references whereas only 50% of the reflections with no evident model have references cited. There also seems to be a relationship between the presence of a reflective model, and the presence of ‘EBP Implementation decision making’ discussion within the reflections

Chapter 5 - Analysis Framework

5.1 Introduction

This chapter outlines the analytical framework used in this research, focusing on the integration of Mediated Discourse Analysis (MDA) guided analytical questions, content analysis, and computer-mediated discourse analysis (CMDA). The purpose is to provide a detailed explanation of the methods and questions that guided the analysis of the data.

The MDA guided analytical questions are crucial for understanding the complex social actions and interactions involved in the assessment and management of head injury patients by paramedics. These questions help to uncover the underlying structures and practices that shape paramedic decision-making and reflective practices.

Nexus analysis allows for the exploration of social action across varying timescales and within complex and evolving processes, although not solely a strategy for MDA, it is deemed suitable within this methodology (Livari *et al.*, 2014; Wohlwend and Medina, 2012; Halkola *et al.*, 2012; Izadi, 2017; Izadi, 2020).

(Scollon and Scollon, 2004b) provide the researcher with three defined steps to achieve nexus analysis, which are:

1) Engaging in the nexus
2) Navigating the nexus
3) Changing the nexus

This sub section will briefly introduce the three steps of nexus analysis and the way in which they have been related to this thesis.

5.1.1 Clarifying Improvement and Implementation

In this research, improvement and implementation are used to address different aspects of enhancing paramedic practice in the assessment and management of head injuries.

Improvement Science (ImpS) focuses on increasing the adoption of existing evidence-based practices. This involves identifying current best practices and ensuring they are consistently applied in clinical settings. For example, improving the adherence to guidelines for head injury management, such as the use of appropriate immobilisation techniques and accurate assessment methods.

Implementation Science (ImpR), on the other hand, is concerned with introducing new evidence into practice. This involves evaluating new interventions or technologies and integrating them into clinical workflows. For instance, exploring the potential of new non-invasive techniques for assessing intracranial pressure (ICP) in the pre-hospital setting.

The research aims to address both aspects:

- **Increasing the Adoption of Existing Evidence**: By understanding the barriers to compliance with current guidelines and developing strategies to enhance adherence among paramedics.
- **Introducing New Evidence**: By evaluating the feasibility and effectiveness of new assessment tools and techniques, such as the use of optic nerve sheath diameter (ONSD) ultrasound for ICP estimation.

The phrase ‘in to’ clinical practice refers to the introduction of new evidence, while ‘how paramedics practice’ pertains to the adoption of existing guidelines and evidence. This distinction is crucial for understanding the dual focus of the research on both improving current practices and integrating new innovations.

5.2 Engaging the nexus.

As opposed to attempting to address the importance of social issues through an individual momentary or repeatable social action, MDA attributes importance to recognition of the presence of broad social discourses in all moments throughout contemporary human life. Thus, MDA exploration of social action as a central point within a nexus of practice may prove more meaningful than first thought. To explore those broader social discourses, it has proven to be beneficial through nexus analysis, to explore the three essential material components of any social action. The point at which social action occurs is recognised as the intersection between the historical body of the individual participating in the mediated action, the interaction order of individuals engaging in or present within a mediated action and the discourses in place. These three essential components and resulting point of social action, when combined with mediational means, allows for a mediated action to occur.

These three components and the resulting point of social action can be seen depicted in Figure 38 below (Scollon and Scollon, 2004b).

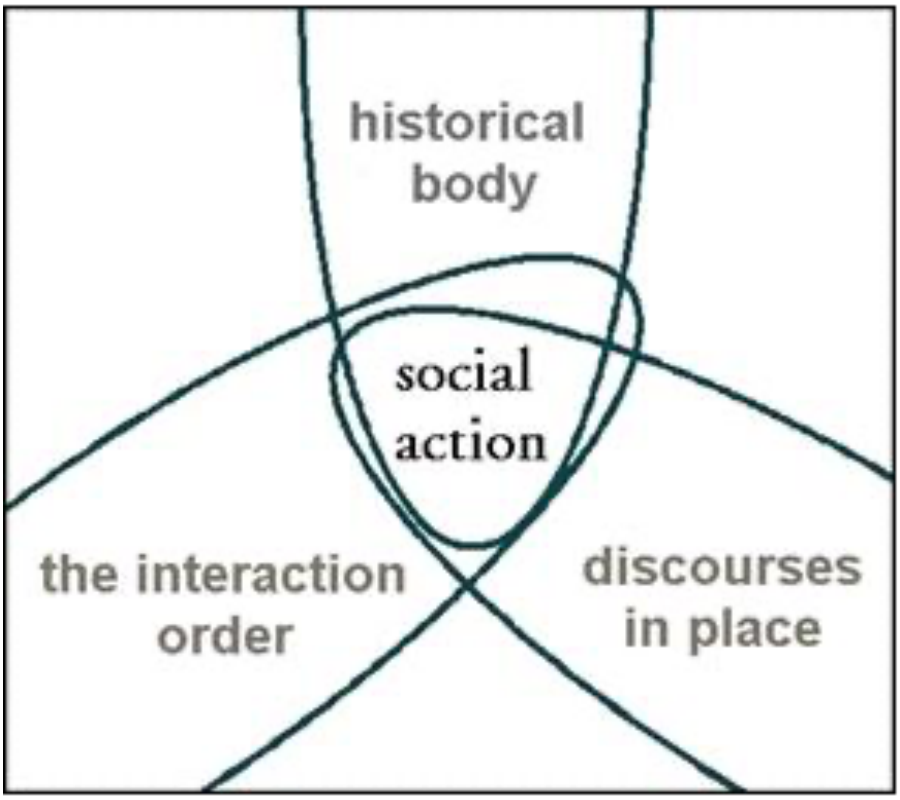


Figure 38 - The 3 components of nexus analysis (Scollon and Scollon, 2004a).

This engagement in the nexus, within this research, was achieved in three ways:

1) As a participant-analyst in the nexus, with a pre-conceived understanding and lived experience of paramedic practice, the researcher had personally engaged the nexus in their pre-contemplation of the need for change and subsequent research design.
2) A scoping of the nexus pre-data collection, utilising the three components of social action to guide this activity, resulting in a literature review seen within chapter 2.
3) Engagement in the nexus through the process of data collection using the 3-phase approach.

5.3 Navigating the nexus.

Navigation of the nexus aims to map how the three components of nexus analysis (historical body, discourses in place, interaction order) flow through a social action with the aim of mapping the people, places, discourses and objects present at the moment when the social action occurs (Scollon and Scollon, 2004b).

The navigation of the nexus within this thesis was achieved in two ways:

1) The navigation of the nexus through analysis of findings in Chapter 6, using a mixed method analytical framework designed for this research, and,
2) The navigation of the nexus through discussion of the findings and the addressing of the research aims, in chapter 7.

To address the complex issues pertaining to social action, MDA is noted to combine frameworks when required (Scollon and de Saint-George, 2012). To navigate the nexus, the researcher analysed the data collected using a blend of content analysis and computer mediated discourse analysis. Further navigation of the nexus was then achieved in chapter 5 and 6 through the use of the MDA guided analytical approach as seen in Table 37 (Jones, Gold and Claxton, 2017), to identify themes within the research findings for discussion.

1.	What is the mediated action?
2.	What chain or chains of mediated actions are important
3.	What is the relevance or importance of the mediated action(s) in the sequence?
4.	What is the hierarchy of mediated actions?
5.	What are the practices which intersect to produce this site of engagement?
6.	What histories in habitus do these practices have?
7.	In what other mediated actions are these practices formative?
8.	What are anticipatory and retrospective discourses – that could provide a meta-discursive structure?
9.	What mediational means are used in this / these mediated actions?
10.	What specific forms of analysis should be used in analysing the / these mediational means?
11.	How and when where those mediational means appropriated within the practice?
12.	How are those mediational means used in this / these mediated actions?

Table 37 - MDA guided analytical approach.

5.3.1 Content and Computer-mediated discourse analysis

MDA and Nexus analysis as a methodology provides the researcher with flexibility, including the choice of mediational means to be explored depending on the area of interest or concern, the choice of methods dependent on data collected, and flexibility in the chosen depth of focus relating to the practice being explored (Kuure, Riekki and Riikka, 2018; Scollon, 2001a). Various forms of data collection and analysis can and have been used within MDA and nexus analysis. These have included, conversation analysis, the ethnography of communication, activity theory, critical discourse analysis, social semiotics, anthropological linguistics, the New Literacy Studies, interactional sociolinguistics, and multimodal discourse analysis (Kuure, Riekki and Riikka, 2018; Scollon, 2001a). The flexibility in choice of analyse methods is suggestive that analysing complex social issues requires complex approaches (Dooly, 2017).

Therefore, to answer the proposed heuristic questions within the MDA analytical structure, the researcher created a modified mixed method analytical framework utilising a blend of conceptual and relational content and computer-mediated discourse analysis (CDMA) tools, as seen in Figure 39.

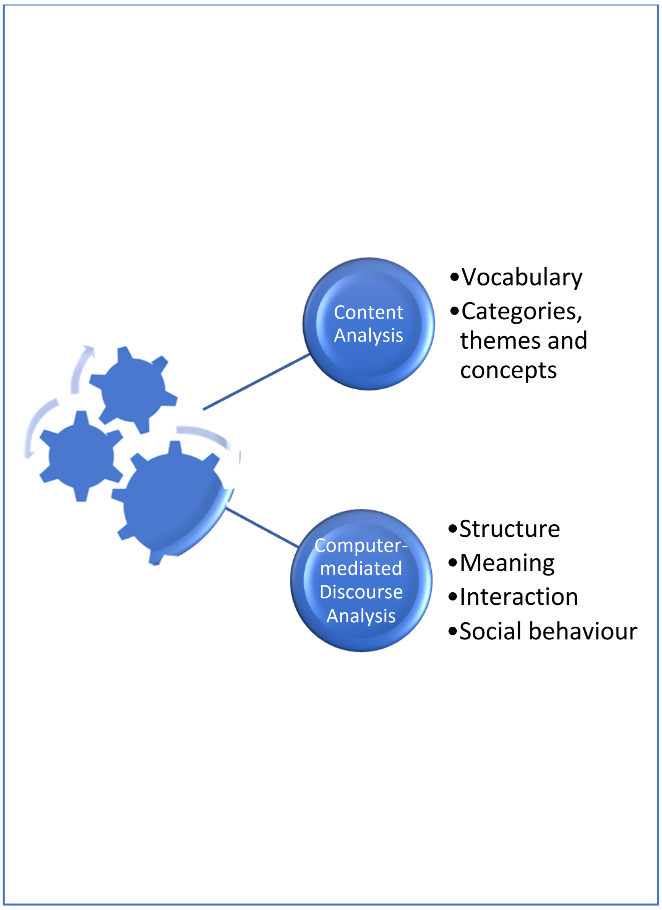


Figure 39 – Content and CMDA tools utilised in blended analytical framework.

As can be seen from Figure 39 above, conceptual and relational content analysis is recognised as having steps involving the exploration of vocabulary, categories, themes, concepts and relationships (Erlingsson and Brysiewicz, 2017) while CDMA is recognised as exploring structure, meaning, interaction and social behaviour (Herring, 2019).

The researcher used the (Erlingsson and Brysiewicz, 2017) approach when analysing content from the raw data to establish categories, themes and subsequent relationships , as seen in Figure 40 below and the use of 'Voyant Tools' to achieve the existence and frequency identification within content analysis (Anderson, 2014).

Higher levels of abstraction – Reflects the interpreted latent meaning of text	Overarching theme	Example
	Theme	Involving children in consultation process
	Category	Staff actions and non-actions
	Code	Confused and ignored
	Condensed meaning units	Spoke to parents, child felt confused and ignored
Lower levels of abstraction – Close to the text and manifest content	Meaning unit	They spoke to my parents and didn't listen to what I was saying, I was confused and felt ignored

Figure 40 - Example of content analysis leading to higher levels of abstraction; from manifest to latent content (Erlingsson and Brysiewicz, 2017).

Discourse from all three phases was subjected to content analysis to allow for an initial high-level overview and understanding of the data. This form of analysis has also enabled comparison and subsequent synthesis of findings, which may have otherwise been challenging given the various forms of data collection and resulting discourse throughout the three phases.

All three phases were analysed for general vocabulary use and then analysed again for specific clinical vocabulary. This focus purely on 'Clinical' vocabulary was intentional as it allowed for identification of types of assessment and treatment being provided by paramedics to head injury patients while also contributing to an overall balance of findings when synthesised with analysis through more inductive means (Hayes, 1997).

As part of the content analysis, a technique known as text-mining was utilised. This process of text-mining produced 'semantic' themes which aimed to present the findings and interpret patterns in the data but do not attempt to examine any underlying ideas from this data (Boyatzis, 1998). Text mining is often used to extract data from unstructured texts and as such the process is facilitated with the aid of purposeful software (He, Zha and Li, 2013). Text mining is noted as a non-traditional extension of content analysis, acknowledging that text mining is quantitative data driven, focusing on the emergence of patterns and trends within the data, which can then lead onto creating models for the interpretation of those trends or patterns (Tsantis and Castellani, 2001; Guo *et al.*, 2012; Romero, Ventura and Garcia, 2008). The addition of text mining in the conceptual content analysis of this PhD has facilitated a mixed analysis approach with both quantitative and qualitative interpretation of the data collected. In the PhD the researcher utilised an online platform called ‘Voyant Tools’ to achieve the text mining analytical element of the content analysis (Anderson, 2014).

As previously discussed, CMDA aims to focus specifically language use over networked devices, utilising a mediated discourse analysis approach (Herring, 2004; Herring, 2019). The CMDA methodological toolkit focusing on the analysis of ‘structure, meaning, interaction management and social behaviour’ within both the micro and macro level of online interactive exchanges (Herring, 2019).

CMDA has once again been used in this research to allow for a mixed method data analysis, thus further enabling the emergence of themes and patterns in the data. As previously discussed, the use of text mining has been a useful process with the content analysis but also the CDMA methods as an extension of the structural analysis. CMDA has also been a purposely inclusion in the analysis process to allow for the inclusion of the interaction management level of analysis in the data analysis of phase 3 – case study transcripts.

Table 38 - The computer-mediated discourse analysis 'toolkit' (Herring 2019)

Levels	**Issues**	**Phenomena**	**Methods**
Structure	Orality, formality, efficiency, expressivity, complexity, genre, etc.	Typography, orthography, morphology, syntax, discourse schemata, formatting conventions, etc	Structural / descriptive linguistics, text analysis, corpus linguistics, stylistics
Meaning	What is communicated? What is intended? What is accomplished?	Meaning of words, utterances (speech acts), exchanges, etc	Semantics, pragmatics
Interaction Management	Interactivity, timing, coherence, repair, interaction etc.	Turns, sequences, exchanges, threads, etc.	Conversation analysis, ethnomethodology
Social Phenomena	Social dynamics, power identity, community, cultural differences, etc	Linguistic expressions of status, conflict, negotiation, face management, play, discourse styles, etc	Interactional sociolinguistics, critical discourse analysis, ethnography of communication

5.3.2 Mixed method analysis

Qualitative and quantitative data was produced utilising a blended content and CDMA approach. Unlike a traditional mixed method study where the design is intended to collect qualitative and quantitative data; the data analysis tools and methods used within this PhD has allowed for quantitative data to be extracted from primary data collected through qualitative means (Tashakkori and Creswell, 2007). There is recognition that previous debate regards the distinction between qualitative and quantitative research is becoming increasingly unnecessary as it is recognised that an overlap in methods in order to be complimentary is more advantageous (Pope, Van Royen and Baker, 2002).

As previously discussed, both content analysis and CMDA both encourage elements of quantitative and qualitative analysis, thus leading to the mixed method results seen in this chapter. The use of various software platforms for digitally aided analysis including Voyant Tools, NVIVO and Excel, within this PhD has also enabled the production of both qualitative and quantitative data through analysis. The inclusion of these tools has aided to the validity of the results by introducing an algorithmic form of interpretation utilising the basic elements of the text, which can be presented in visual forms further enhancing the overall interpretation of results, rather than solely relying upon the researcher's subjective interpretation of the data (Scholz, 2018; McEnery and Hardie, 2012; Hamann and Suckert, 2018).

5.4 Content Vocabulary Analysis

Microsoft word documents were created for each of the research phase's, combining the data collected within each phase, thus creating a total of four documents for content analysis and phase comparison. These documents were:

1) A combined document of all interview transcripts in phase 1
2) A combined document of all written reflections in phase 2
3) A combined document of all transcripts from case studies in phase 3
4) A combined document of all questionnaires from phase 3

The documents were 'cleaned' first, before analysis, to remove terms that may breach confidentiality, such as hospital and trust names and to remove reference lists and in text citations from reflections as these will be analysed separately. However, words referring to guidelines within general sentence structure, such as 'NICE' referring to the 'National Institute for Clinical Evidence', and 'JRCALC' referring to the 'Joint Royal Colleges Ambulance Liaison Committee' were left in to allow for analysis within context of discussion. These documents were then entered into Tagcrowd.com and Voyant Tools where initial cirrus and terms analysis was completed.

Vocabulary was then grouped by category and edited allowing for a combination of similar words (such as plural variations, or acronyms). This then allowed for further guided analysis within subsequent analytical steps, included a focused analysis of clinical words to allow for comparison to clinical guidelines. This also allowed the researcher to highlight the assessment and management options delivered by clinicians.

Within Voyant tools the function 'global stop-words' was selected before analysis unless otherwise stated. Stop-words are determiners or prepositions that may be

considered to have less meaning and often referred to as functional words such as I, a, from, in, to, etc.
The analysis will be presented in the following sub-sections:

- 5.4.1 Interviews (sub divided into vocabulary overview, clinical content analysis and references sources)
- 5.4.2 Written Reflections (sub divided into vocabulary overview, clinical content analysis and references sources)
- 5.4.3 Case Studies (sub divided into vocabulary overview, clinical content analysis overall focus and references sources)
- 5.2.4 Post Case Study Questionnaires (sub divided into the two separate qualitative questions)

5.4.1 Interviews

5.4.1.1 Vocabulary Overview

To further understand the density of vocabulary, as previously explored and to support later coding of the interviews, the documents were combined to analyse the overall types of words used thus enabling an initial analysis of underlying themes. The top 50 words demonstrated a focus on the patient and reflective thought, highlighting an emphasis on words such as '**think'** (393)**,** '**head'** (228), **'injury'** (224), **'patient'** (177) and **'really'** (115).

To compare the emphasis on patient verses self in the interview of clinicians, the researcher disabled stop-words to compare the use of the word patient or patient's (n=177) and 'I' or alternatives such as 'I'm' (n=1054). With stop-words being enabled, the word 'I' was ranked 5th most common, only being succeeded by 'the', 'to', 'and' 'a', with a difference in occurrence between the word groups, thus demonstrating a significant focus on the participant throughout the semi-structured interview process.
Subsequent analysis of each reflection was then made for distinctive words in comparison to the rest of the corpus and compared to educational route to registration and current level of practice, the results of which can be seen in Table 39 below.

Table 39 - Distinctive Word Content Analysis of Interview Transcripts

Interview Participant Number	Distinctive Words				
P1	IHCD educated		Specialist Paramedic (Research)		
	Population (8)	Stroke (8)	Opposed (4)	Application (3)	Leaving (4)
P2	FdSc educated		Specialist Paramedic (Education)		
	Okay (25)	Play (7)	Position (8)	Oh (16)	Particularly (10)
P3	IHCD educated		Paramedic		
	Imagine (10)	Okay (11)	Palm (6)	Neuro-trauma (6)	Centres (8)
P4	FdSc educated		Paramedic		
	Anticoagulants (3)	Adrenaline (3)	Falls (2)	Invasive (3)	Neck (2)
P5	IHCD educated		Specialist Paramedic (Clinical)		
	Okay (15)	Eventually (9)	Course (22)	Order (6)	Triple (4)
P6	Non-UK educated		Paramedic		
	Rolling (4)	Keeping (4)	Severe (8)	Reasonably (4)	Prolonged (2)
P7	DipHE educated		Paramedic		
	Cohort (4)	Tool (8)	Improve (3)	Dilated (3)	Actual (5)
P8	FdSc educated		Paramedic		
	Education (9)	Switched (4)	Management (9)	Severe (7)	Etc. (7)
P9	BSc educated		Paramedic		
	Offer (3)	Minimal (3)	Behaviour (3)	Treatments (3)	Spending (3)
P10	BSc educated		Paramedic		
	Suspecting (3)	Clinicians (5)	Order (3)	Grips (2)	Articles (2)
P11	IHCD educated		Specialist Paramedic (Clinical)		
	Collar (15)	He's (10)	Release (4)	Papers (4)	Gut (4)
P12	BSc educated		Specialist Paramedic (Clinical)		
	Hit (7)	Rolled (5)	Hitting (4)	Calling (4)	Bits n Bobs (4)

On analysis of table 40 above, it is evident that seven interviews feature distinctive words relating to colloquial language, these included '**Okay**', '**Oh**', '**Bits n Bobs**' '**he's**', '**gut**' (referring to gut feeling) and '**etc**'. On comparison to clinical grade and educational background, this colloquial language does not appear to have an identifiable link or pattern. The unique term 'play' in interview 2 is related to the greater term of 'stay and play', again a colloquial term which the researcher was aware of being used in practice to refer to the decision to stay on scene and treat the patient (treatment being referred to as ‘play’), or to go to hospital which is also colloquially referred to as ‘load and go’ (Navarro, 2020; Hobson, 2013). These are terms which the researcher has seen to be used less frequently in practice as the profession has become more graduate based. The interviewee using this language is a FdSc educated paramedic suggesting several years since qualification. Aside from the emerging theme of colloquial language, there also appears to be a theme of education emerging from the distinctive terms within five of the interviews with words such as ‘**course**’, ‘**cohort**’, ‘**education**’, ‘**articles**’ and ‘**papers**’ identified.

5.4.1.2 Clinical content analysis

The researcher further analysed the vocabulary to highlight words of clinical significance. To achieve this, the researcher highlighted words pertaining to clinical assessment or treatment, combining similar words. The result of this further analysis produced a more focused clinical lens through which to view the vocabulary used by the clinicians and aided later clinical thematic analysis found in section 5.5 and further explored in the findings in chapter 6.

This clinical analysis has demonstrated a focus on patient presentation or treatment centres, highlighting an emphasis on words such as **‘head’** (228), ‘**injury’** (224), **‘trauma’** (102) **‘hospital’** (57) and **‘critical’** (40), with a full break down in Table 40. Further analysis of content in Table 40 has allowed for other similarities to emerge as a result of the combination of similar words being further analysed; an example of such is the highlighting of ‘Collar’ as a unique word in interview 11, however featuring as the 7th highest word across the combined corpus when allowing for a combination of the plural.

Table 40 - Clinical content analysis from interview transcripts

Rank	Clinical Word	Count	Rank	Clinical Word	Count
1	Head	228	42	Drugs	7
2	Injury (injuries)	224	43	Fluids	7
3	Trauma (Traumatic)	102	44	Paediatric	7
4	Hospital	57	45	Cardiac	7
5	Ultrasound	45	46	Diagnosis	6
6	Critical	40	47	Midazolam	6
7	Collar (s)	37	48	Monitoring	6
8	NICE	37	49	Neuro	6
9	Blood (Bleed (s))	35	50	Neuro-trauma	6
10	HEMS	30	51	Oxygen	6
11	Pressure	30	52	Palm	6
12	GCS	27	53	Intubation (tubed)	6
13	Brain	26	54	Chest	5
14	JRCALC	23	55	Fractures	5
15	Fallen (fall)	19	56	Invasive	5
16	CT	18	57	Resuscitated (resuscitating, resuscitation)	3
17	ICP	16	58	Pupillary (pupils)	2
18	Old (older)	16	59	Sats (Saturation)	2
19	Sedation (sedate)	16	60	Prophylactically	1
20	Vomiting (vomited)	15	61	Pseudo	1
21	Elderly	14	62	Pulse	1
22	Scan	14	63	Radiation	1
23	Stroke	12	64	Scoop	1
24	RSI (RSIs)	12	65	Seizure	1
25	Scanner (scanned)	12	66	Skin	1
26	Mannitol	11	67	Spinal	1
27	Position	11	68	Stomach	1
28	Intracranial	11	69	Swallow	1
29	Age	10	70	Systolic	1
30	Degree	10	71	Tablets	1
31	Eye	10	72	Tissue	1
32	Symptoms	10	73	TXA	1
33	Warfarin (Warfarinised)	9	74	Vasodilation	1
34	Hypertonic	9	75	Venous	1
35	Mechanism	9	76	Verbal	1
36	Flags	9	77	Vertigo	1
37	Airway	8	78	Vitamin	1
38	Cerebral	8	79	Voice	1
39	Hands	8	80	Whiplash	1
40	Saline	8	81	Zoll	1
41	Cranial	7			

5.4.1.3 Reference sources influencing content.

As can be seen from the word analysis in Table 40 the terms ‘**NICE**’ and ‘**JRCALC**’ are used frequently in the combined interview corpus as sources of reference or influence. As this is a conversational corpus there are no citation references so otherwise there are no specific sources mentioned. However more general terms have featured frequently, such as ‘guidelines’ in the combined corpus and ‘articles’ as a distinctive term as seen in Table 39. Further targeted analysis for terms associated with sources of influence have highlighted the terms ‘**Twitter**’, ‘**Conferences**’, ‘**Textbooks**’, ‘**University**’, ‘**research**’ and ‘**pathways**’ as potentially significant and for further consideration in later forms of analysis.

5.4.2 Written Reflections

5.4.2.1 Vocabulary Overview

To further understand the density of vocabulary, as detailed, and to support later coding of the reflections, the documents were combined to analyse the overall types of words used enabling an initial analysis of underlying themes. The top 50 words demonstrated a focus on the patient and decision making, highlighting an emphasis on words such as ‘**patient’** (295)**,** ‘**injury’** (115), **‘head’** (101), **‘hospital’** (53) and **‘management’** (53).

In order to compare the emphasis on patient verses self in the reflections of clinicians, the researcher disabled stop-words to compare the use of the word patient and similar alternatives such as ‘pt’ (n=304) and I (n=176) and despite stop-words being enabled, the word patient was still ranked 8th most common, only being succeeded by ‘**the**’, ‘**to**’, ‘**and**’, ‘**of**’ ‘**a**’ ’**in**’ and ‘**was**’, thus demonstrating a significant focus on the patient throughout the reflective process.
Subsequent analysis of each reflection was then made for distinctive words in comparison to the rest of the corpus and compared to subject focus, the results of which can be seen in Table 41 below.

Table 41 - Distinctive word analysis from written reflections

Reflection Number	Distinctive Words				
R1	Sudden deterioration of patient and decision-making being questioned at ED				
	Pass (6)	Wife (5)	Leader (5)	Decided (9)	Board (4)
R2	Unable to access CCP or use advanced skills				
	Airway (20)	Meant (7)	Secure (6)	Inability (4)	Available (5)
R3	Decision making in elderly trauma (Query Ageist)				
	Patient's (11)	Tree (5)	Incident (14)	Thinking (4)	Oxygen (4)
R4	Decision to send to hospital from custody unit				
	Custody (4)	Forensic (3)	Intoxicated (3)	Returned (2)	Letter (2)
R5	Almost missing a head injury				
	Pt (12)	Ear (11)	Vision (6)	Diagnosis (6)	History (11)
R6	Beyond scope of practice and seeking support				
	Intoxicated (16)	TBI (17)	Ranges (6)	Pt (7)	Minor (7)
R7	Managing multi-trauma				
	Pub (4)	Bystander (3)	Chest (5)	Placed (3)	Unclear (2)
R8	Difficulties associated with festival medicine				
	Stage (6)	Got (4)	Quickly (3)	Frustrated (3)	Site (4)
R9	Head injuries complicated by anticoagulant medicines				
	Consent (22)	Capacity (14)	Mental (9)	Act (9)	Professional (8)
R10	Managing hemorrhagic shock and TBI together				
	Hypotension (7)	Shock (10)	Hypovolemic (5)	TBI (12)	Haemorrhagic (4)

From the analysis of these distinctive words, no unique patterns have emerged, however the words highlighted would seem to be related to the specific chosen subject matter, which shows a difference in subjects of importance for personal reflection. Area of unique focus would appear to be, location (such as 'police **custody'**, '**pub**lic house', 'festival **stage'**), elements of decision making and implementation (such as '**leader**', '**thinking**', '**decided**', '**inability**' and 'decision making **tree**'), and assessment and treatment (such as '**airway**' '**oxygen**', **intoxicated**', '**ear**', '**vision**', '**diagnosis**', '**history**', '**TBI**', '**minor**', '**chest**', **mental capacity act**', **consent**', '**hypertension**', '**shock**', '**hypovolemic**' and '**haemorrhage**').

<u>5.4.2.2 Clinical content analysis</u>

The researcher further analysed the vocabulary to highlight words of clinical significance. To achieve this, the researcher highlighted words pertaining to clinical assessment or treatment. The result of this further analysis produced a more focused clinical lens through which to view the vocabulary used by the clinicians and aided later clinical thematic analysis found in section 5.5 and later explored in the findings in Chapter 6.

This clinical analysis has demonstrated a focus on patient presentations or treatment centres, highlighting an emphasis on words such as '**injury'** (115), **'head'** (101), **'hospital'** (53) **'blood'** and alternatives (35) and **'TBI'** (35), a full breakdown can be seen in Table 42.

Table 42 - Clinical content analysis from written reflections

Rank	Clinical Word	Count	Rank	Clinical Word	Count	Rank	Clinical Word	Count	Rank	Clinical Word	Count
1	Injury (inc injuries)	115	28	Air	9	55	Combative	6	82	RSI	4
2	Head	101	29	Chest	9	56	Amnesia	5	83	Spine	4
3	Hospital	53	30	Death	8	57	Assault	5	84	Adult	4
4	Blood (inc bleed, bleeds, bleeding)	35	31	Haemorrhage	8	58	Agitated	5	85	Elderly	4
5	GCS (Glasgow-coma)	36	32	Oxygen	8	59	Deficit	5	86	Crystalloid	3
6	TBI	35	33	BP	8	60	Deformity	5	87	Drug	3
7	Intoxicated (inc intoxication)	25	34	CCP	8	61	Focal	5	88	Ears	3
8	Airway	23	35	Headache	8	62	Hand	5	89	Binder	3
9	Scan (inc Scans)	21	36	IV	8	63	Hypovolaemic	5	90	Boggy	3
10	Pain	20	37	Neurological	8	64	Infection	5	91	Fluids	3
11	CT	19	38	Old	8	65	Vomiting	5	92	Gait	3
12	HEMS	16	39	Pelvic	8	66	ABC	4	93	Hypertension	3
13	Brain	13	40	Rate	8	67	Wound	4	94	Neuroimaging	3
14	Collar	13	41	Response	8	68	Alcohol	4	95	Orthopaedic	3
15	ED	13	42	Warfarin	7	69	Bilateral	4	96	Paracetamol	3
16	History	13	43	Alert	7	70	Blunt	4	97	Teeth	3
17	Ear	12	44	Dizziness	7	71	Body	4	98	Temperature	3
18	Pressure	12	45	Fractures	7	72	Colour	4	99	Triage	3
19	Immobilisation (inc immobilised, immobilise)	12	46	Hypotension	7	73	Pulse	4	100	Resus	3
20	MTC	11	47	Scoop	7	74	Surgery	4	101	Sedation	3
21	NICE	11	48	Prehospital	6	75	Vertigo	4	102	Swelling	3
22	Signs	10	49	Skull	6	76	Medications	4	103	Abdominal	2
23	Fall (inc fallen)	10	50	Symptoms	6	77	Eyes	4	104	Analgesia	2
24	Pupils (inc pupillary)	10	51	Vision	6	78	Heartrate	4			
25	Neurosurgery (neurosurgical)	10	52	Diagnosis	6	79	ITU	4			
26	Anticoagulant	10	53	ICP	6	80	Respiratory	4			
27	Flags	9	54	Cervical	6	81	Resp Rate	4			

5.4.2.3 Reference sources influencing content.

As previous stated, the vocabulary content analysis of the written reflections was conducted after the removal of any reference lists included. This analysis, as seen in Table 42, has highlighted the terms '**evidence**', '**guidelines**' and '**NICE**' as featuring frequently in the combined corpus; in keeping with similar analysis of 'sources of influence' in the combined interview corpus in section 5.4.1.3.
However, in addition to this previously conducted 'term' analysis, a list of references within this corpus can be seen Appendix 19.

Analysis of the reference list in appendix 19 has revealed a total of 68 referenced sources across the 10 reflections, three of which have been used across more than one reflection, these were the JRCALC Clinical Guidelines, an audit of Traumatic Brain Injury in England and Wales published in the British Medical Journal, and NICE Head Injury Guidelines. The types of sources used have been categorised into 10 identifiable groups for further analysis; these were, Clinical Guidelines, Non-Clinical Guidelines, Articles, Books, Frameworks, Manuals, Legal Acts, Webpages, Consensus Statements and Legal Cases.
Most sources were published articles at 66%, clinical guidelines forming the next largest percentage at just under 15%, with a more even distribution of the remaining percentage across the various sources.

On revisiting the structural analysis of the reflection as previously seen Table 21 in section 4.3.2.5, it has been possible to compare references / sources, featuring within the reflections, with other structural components. An adapted version of this analysis can be found in Table 43 below.

Table 43 - Breakdown of written reflection reference analysis

Reflection number	Word Count	Declared Structure	Role / Clinical Grade	Specific reason for reflecting?	References Source Type										Total	Average reference per words
					Guidelines (Clinical)	Guidelines (non-clinical)	Article	Book	Framework	Manual	Legal Act	Webpage	Consensus Statement	Legal Case		
R1	1499	No	Trust Paramedic	X	1		1								**2**	**1/50**
R2	1754	No	Trust Paramedic	X	1	2	3								**6**	**1/292**
R3	2229	I.F.E.A. R	Trust Paramedic	X	2		5	1					1		**9**	**1/248**
R4	436	No	Forensic Paramedic	X											**0**	**0**
R5	1216	No	Trust Paramedic	X	2							1			**3**	**1/405**
R6	1925	Gibbs	NQP	NQP Portfolio			6								**6**	**1/321**
R7	704	No	Trust Paramedic	X											**0**	**0**
R8	783	(No) External CPD platform with reflective template	Event Paramedic	X											**0**	**0**
R9	4468	Rolfe	Trust Paramedic	Post Reg Uni Module	3	2	22	2	1	1	2	0	0	1	**34**	**1/131**
R10	1550	Willis	Trust Paramedic	X	1	1	9								**11**	**1/140**
					10	**5**	**45**	**3**	**1**	**1**	**2**	**1**	**1**	**1**		

This comparison in Table 43 has highlighted a relationship between reflective models and references; all reflections utilising a reflective model have included references whereas only 50% of the reflections with no evident model have references cited. There would also appear to be a potential relationship between word count, and number of references as can be seen in Figure 41 below, with one exception containing a significantly greater number of words and references also identifying as having a post registration university module' reason for reflecting and therefore may have academic expectation on the students regards both statistics. Using Table 43 the average reference per word's can be calculated across the combined reflective corpus, this is average is one reference per 82 words.

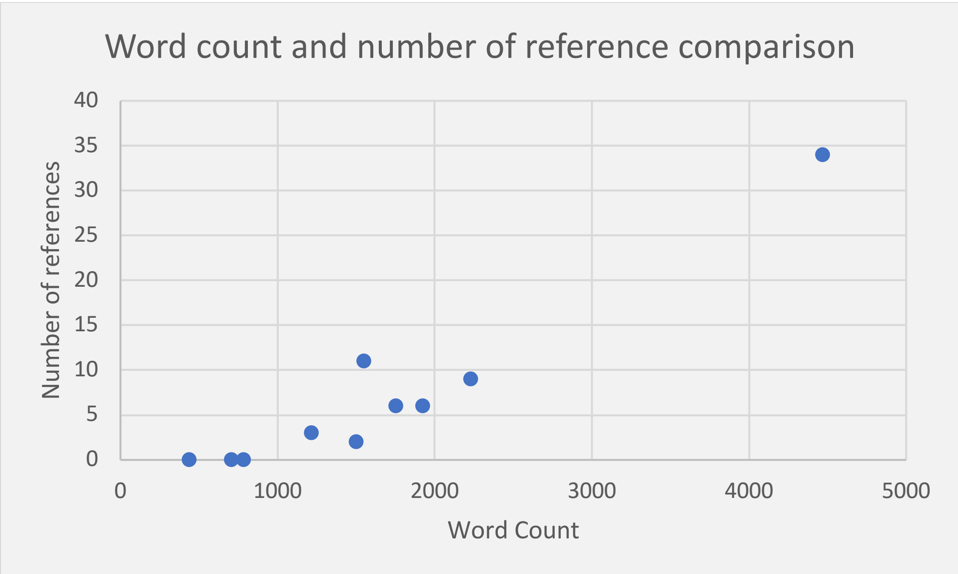


Figure 41 - Written reflection comparison of word count and number of references.

5.4.3 Case Studies

5.4.3.1 Vocabulary Overview

To further understand the density of vocabulary, as previously detailed, and to support later coding of the contribution to the case studies, the documents were combined to analyse the overall types of words used enabling an initial analysis of underlying themes. Analysis demonstrated a focus on the patient and decision making, highlighting an emphasis on words such as '**patient'** (112)**,** '**head'** (80), **'injury'** (72), **'think'** (47) and **'needs'** (44).

As a result of the purposeful creation of separate themed case studies addressing a range of clinical presentations, the four case studies were then analysed separately for the top 25 words present in each. While all case studies have a noticeable focus on head injury, the patient and assessment, there is a noticeable focus in case study 1 on decision making with commonly used words such as **think** (13), **reason** (11) **lead** (11) and **updated** (11). However, case study 2 is showing a more patient presentation focus with commonly used words such as blood pressure '**BP**' (15), **falls** (15), **confusion** (13) and **acute** (12). Case study 3, however, seems to have a focus on patient assessment, with the top four words showing conversation pertaining to **'patient / pt'** (41), **clopidogrel** (30), '**head'** (27) '**wound'** (21), Emergency Department '**ED**' (21). Finally, case study 4 seems to have a focus on airway management and decision making with commonly used words such as **Airway** (33), Major Trauma Centre '**MTC**' (29), '**injury'** (20), '**needed'** (19), and '**think'** (19)

Subsequent analysis of each case study was then made for distinctive words in comparison to the rest of the corpus and compared to subject focus, the results of which can be seen in Table 44 below.

Table 44 - Distinctive word analysis of individual case study transcripts

Case Study Number	Distinctive Words				
CS1	Young male, minor facial injury, intoxicated, GCS 15				
	Facial (9)	ECG (9)	Varicose (4)	Service (4)	Party (4)
CS2	Older Adult, regular faller, and previous head injuries, GCS 14				
	Dementia (11)	Confusion (10)	Acute (9)	Urine (7)	New (7)
CS3	Older adult, open head wound, GCS 15				
	Clopidogrel (29)	NQP (14)	EtOH (10)	Pp (9)	Validation (8)
CS4	Middle-aged male, pedestrian hit by van, GCS 3				
	Airway (31)	MTC (28)	RSI (17)	Tube (11)	Tu (10)

Seven of these 20 unique words are abbreviations that the researcher was familiar with as a registered paramedic. Although showing as distinctive terms in this vocabulary analysis, these are terms contributing to more frequent conversations as can be seen in later thematic analysis.

5.2.3.2 Clinical content analysis

The researcher further analysed the vocabulary to highlight words of clinical significance. To achieve this, the researcher highlighted words pertaining to clinical assessment or treatment, combining similar words. The result of this further analysis produced a more focused clinical lens through which to view the vocabulary used by the clinicians and subsequently aided later clinical thematic analysis found in section 5.5 and further expanded upon within the findings in Chapter 6.

This clinical analysis has demonstrated a focus on patient assessment, highlighting an emphasis on words such as '**head'** (80), **'injury'** (72), **'CT'** (34), **'Airway'** (33) **and 'BP'** (32), a full break down can be seen in Table 45.

Table 45 - Clinical content analysis from case study transcripts

Rank	Clinical Word	Count	Rank	Clinical Word	Count
1	Head	80	40	Hr	9
2	Injury (injuries)	72	41	ICP	9
3	CT	34	42	Infection	9
4	Airway	33	43	Intubation	9
5	BP	32	44	Pupils	9
6	Wound	32	45	TBI	9
7	Fall (s)	31	46	Admission	8
8	Clopidogrel	30	47	BVM	8
9	MTC	29	48	Monitor	8
10	Alcohol (EtOH)	28	49	Neurology	8
11	Hospital	26	50	Pulse	8
12	Trauma	25	51	Unwell	8
13	Face (facial)	24	52	Veins	8
14	Signs	22	53	Arrest	7
15	NICE	21	54	Bloods	7
16	Scan	21	55	Bypass	7
17	Bleed (bleeding, blood)	20	56	Cranial	7
18	Neuro	19	57	Guidelines	7
19	Obs	17	58	Hx	7
20	RSI	17	59	Urine	7
21	Monitor (monitoring)	15	60	Brain	6
22	Headache	14	61	Breathing	6
23	Chest	13	62	Cardiac	6
24	ECG	13	63	Collapse	6
25	Symptoms	13	64	Collar	6
26	Convey	12	65	Colour	6
27	GCS	12	66	Deterioration	6
28	Pain	12	67	Etco2	6
29	Spine	12	68	Frailty	6
30	Hypertension (hypertensive)	12	69	Hypertension (hypertensive)	6
31	Dementia	11	70	iGel	6
32	Haemorrhage	11	71	Intoxicated	6
33	Tube	11	72	IV	6
34	Warfarin	11	73	PMH	6
35	Confusion	10	74	PRN	6
36	Mechanism	10	75	Seizure	6
37	Neurosurgery	10	76	SPO2	6
38	TU	10	77	Subdural	6
39	GP	9	78	Asymptomatic	5

5.2.3.3 Overall focus

Combining the distinctive word analysis (seen here in red) and top 25-word focus from each case study, the vocabulary focus of discussion can be summarised as seen in Table 46 below.

Table 46 - Individual case study vocabulary focus

Case	Overview	Potential discussion in design phase	Focus of discussion on vocabulary analysis	
1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	Impact of alcohol consumption on clinical decision making. Differentiating minor head injury from facial injury.	Injury	Patient
			Head	Think
			Facial	ECG
			Varicose	Service
			Party	Reason
2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	Delayed head injury in older adults, recognition, and management. Possible link of historic head impacts such as Rugby playing to Parkinson or Dementia presentation in later life. Cerebral T Waves on ECG.	Dementia	Confusion
			Acute	Urine
			New	Patient
			Assessment	Case
			BP	Falls
3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	Decision to close wound out of hospital or not. Head wound verse head injury discussion. Capability and role limitations discussion alongside accountability for clinical decision making.	Patient	Head
			Wound	ED
			CT	Clopidogrel
			NQP	Validation
			EtOH (Alcohol)	Pp
4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	Management of critically ill head injury trauma patient and use of critical care advanced clinicians, pre-alerts and trauma divert decisions.	Airway	MTC
			RSI	Tube (Intubation)
			Tu (Trauma Unit)	Patient
			Head	Injury
			Think	Needed

As can be seen from analysis of Table 46, the vocabulary focus of each case study has association with the potential areas for discussion highlighted in the research design phase. Within case study 1, words such as '**facial**' and '**party**' are particularly related to the case, however a distinctive or focused use of terms such as 'alcohol' do not seem to be present in the analysis at this stage. Within case study 2, the word '**Dementia**' is present as a strong link to the case design aims, however words such as 'Parkinson', 'rugby' or 'old' have not featured in this high-level overview. In case study 3, the connection can be seen with use of the following terms, '**NQP**', '**Wound**', and '**Validation**'. Finally, case study 4 has a suggested association to the case study through use of the term '**Tu**', and terms associated with advanced critical care paramedic skills.
Overall, the four case studies were designed to allow for discussion pertaining to assessment, diagnosis, treatment, and decision making across the spectrum on minor to major head injuries and across clinical grades; the analysis of vocabulary used has suggested this has been achieved, however this will be further analysed in the thematic analysis in section 5.5 and expanded on in the findings in Chapter 6.

5.2.3.4 Reference sources influencing content.

As can be seen from the word analysis in Table 45 and a full analysis of the content, the term '**NICE**' referring to the 'National Institute for Clinical Evidence', is used frequently in the combined interview corpus as a source of reference, in keeping with analysis from the other phases thus far. More general words such as '**guidelines**', '**study**', '**http**', '**evidence**' and '**research**' also feature frequently as potentially significant and for further consideration in later forms of analysis.
Analysis of the transcripts also revealed that three of the four case studies had links to reference sources within the conversation as recommended reading between the participants; a list of these sources can be seen in Appendix 20.

A total of 11 sources were shared across the case studies, with no sharing in case study 1, three sources shared in case study 2, five sources shared in case study 3 and three sources shared in case study 4. There was no duplication of sources across the case studies and a clear link to the case study topic in all but one source where the article was pertaining in Covid-19 Vaccines in the case study discussing an older adult with a long-standing history of falls and head injuries. There was one duplication of source used in the case studies with the references used within the written reflections and that was the NICE Head Injury and Assessment Guidelines, the only guidelines in the case studies to be shared, the remaining 10 sources being articles.

5.4.4 Post Case Study Questionnaire Content Analysis

Unlike the previous analysed discourse, the questionnaire is guided in a more educational and self-reflective direction through the pre-set questions. However, these questions were designed to be open and allowed for a variation of content and length of answer. Within the questionnaire the participants were asked two qualitative questions, these were:

1. Why did you decide to contribute to this case study?
2. What has been the impact of, or what have you gained from, contributing to this case study?

Thematic analysis of these answers can be found in section 5.5 however an analysis of commonly used vocabulary can be found below. To enable this analysis the questionnaire documents were combined to reveal the overall types of words used enabling an initial analysis of underlying themes. Analysis demonstrated a focus on the process and ‘self’, highlighting an emphasis on words such as ‘**interesting’** (22)**,** ‘**case’** (22), **‘studies’** (22), **‘paramedic’** (19) and **‘injuries’** (19).

Further division of the corpus into the two separate quantitative questions has revealed a differing focus which can be seen below.

5.4.4.1 Why did you decide to contribute?

Analysis demonstrated a focus on content and the participant, highlighting words such as ‘**interesting**’ (16), ‘**studies**’ (15), ‘**case**’ (14), ‘**paramedic**’ (8) and ‘**contribute**’ (8).

5.4.4.2 What has been the benefit or gain?

Analysis demonstrated a focus on patient care, highlighting words such as '**injuries**' (16), '**different**' (14), '**head**' (14), '**management**' (13) and '**patient**' (11).

5.5 Categories and themes analysis

The interview transcripts were first analysed to establish elements of conversation pertaining to the researcher's initial suggested areas of change (ONSD Ultrasound and ResQgard) as this section of the interview was a guided QI conversation where the interviewer was specifically looking for the participants thoughts on these proposals; this section was coded using open inductive thematic analysis.
The thematic analysis of the remaining transcripts was divided into three areas of predefined focus using a deductive approach. These three areas were, assessment and treatment, EBP implementation decision making and quality improvement. Within these predefined area of focus, an inductive open and subsequently axial coded technique was then utilised to allow for the identification of 'higher level themes' and 'sub-themes'.

This sub-section will now be presented in the following structure, each sub divided into the 3 pre-defined areas of focus as mentioned above, apart from the questionnaires which have been analysed and sub divided by qualitative question:
5.5.1 Interviews
5.5.2 Written Reflections
5.5.3 Case Studies
5.5.4 Post Case Study Questionnaires

5.5.1 Interviews

Through open and subsequently axially coded data, the split between discussion focused upon assessment and treatment, EBP implementation decision making, and quality improvement has been analysed.

The division of codes within interviews, excluding the guided QI conversation, can be seen in Figure 42 below. An almost equal focus can be seen between 'assessment and treatment' with 149 coded references, and 'implementation' with 155 coded references. QI had a lesser share of the discussion with a total of 62 coded references.

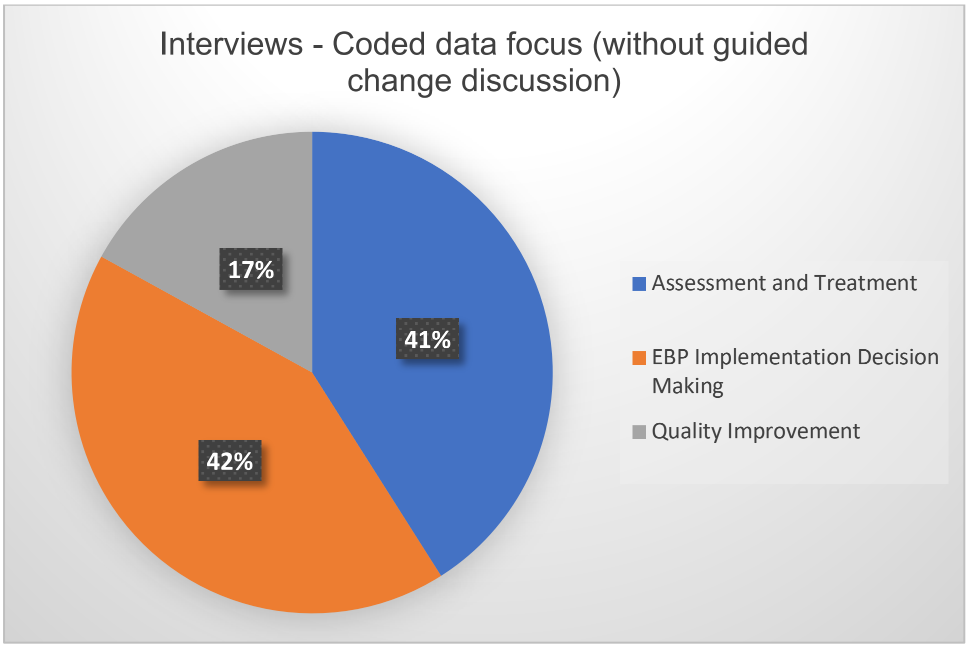


Figure 42 - Interviews - Coded data focus (without guided change discussion)

A breakdown of the codes per interview transcript can be found below in Table 47, compared to transcript word count and length of interview for comparative analysis.

Table 47 - Interview code analysis per transcript and combined corpus

	Assessment and Treatment Coded Data	Implementation Coded Data	QI Coded Data	Total coded data	Word count in transcript	Length of time of interview
Interview 1	11	10	4	25	2485	45.51
Interview 2	20	24	7	51	5244	51.01
Interview 3	8	20	22	52	5527	72.57
Interview 4	10	9	5	24	913	33.49
Interview 5	24	15	3	42	2570	38.19
Interview 6	5	8	1	14	1522	24.22
Interview 7	17	9	6	32	1934	35.22
Interview 8	14	13	6	33	2860	47.34
Interview 9	9	10	2	21	1905	36.40
Interview 10	10	5	0	15	1454	33.35
Interview 11	8	25	4	37	3504	53.08
Interview 12	13	7	2	22	1972	32.59
	149 (41%)	155 (42%)	62 (17%)	366		

As can be seen from table 48, there is an almost equal split between participants with regards to the main coded focus of their interviews, six of the participants had most codes under assessment and treatment and five of the remaining six had most codes under implementation; in keeping with the overall emerging data as previously discussed regards distribution of codes across the combined interview corpus. The remaining interview transcript (interview 3) was an outlier with the focus suggested as being within QI; however, the balance between implementation and QI was close, albeit an outlier, with a much higher QI focus than the other 11 interview transcripts.

As can be seen from the comparison between word length and interview time, interviews 2 and 3 are outliers in terms of higher word count, moreover, interview 3 was an outlier in terms of a much longer time of interview, perhaps suggestive of a link between time needed to allow for in depth conversation to include idea generation or QI.

5.5.1.1 Assessment and Treatment

Analysis of the interviews revealed 41 assessment and treatment themes which have been categorised into seven higher-level themes in keeping with an assessment and treatment cascade, as seen in Table 48 below.

Table 48 - Assessment and treatment themes within interviews

Higher Level Theme	Sub-Theme
Initial Assessment / Cue acquisition	• Mechanism and kinematics of injury • Head injury in older adult. • Head injury in pediatrics. • Intoxicated Patients • Associated medical event. • Delayed presentation of head injury • Multi-system trauma assessment • Primary and secondary Survey
Airway	• RSI
Breathing	• Oxygen Therapy and targeted SPO2 • Rhinorrhea • Ventilation and hypoxia
Circulation	• Pre-existing coagulation therapy • IV Access • Permissive hypotension and target Blood pressure • Bradycardia • Catastrophic Haemorrhage
Disability	• GCS • Vomiting as a neuro red flag • Cognition and behaviour, including amnesia and confusion. • Cranial nerve assessment including a focus on pupil assessment, double vision, and vertigo. • FAST test • AMTS (Abbreviated mental test score) • Cushing's Triad • Cerebral T-Waves on ECG • Ataxic • Lethargy • Prevent secondary brain injury and 'neuro protection'.
Evacuation and exposure	• External head injuries and skull fractures • Other injuries, including distracting injuries. • Pain • Clothes off • Cervical Collar and cervical injury • 30 degrees head up positioning. • Handover and pre-alert • Wellbeing assessment
Pharmacological Management	• IV TXA • IV Hypertonic Solution / Saline • Avoid morphine. • IV Paracetamol

5.5.1.2 EBP Implementation Decision Making

Analysis of the reflections revealed five higher level's themes pertaining to EBP implementation decision making, of which there were several sub themes. These can be seen in Table 49 below.

Table 49 – EBP Implementation Decision Making Themes within Interviews

Higher Level theme	Sub-Theme
Difficulties in providing evidence base assessment and treatment	• Difficult to achieve 30 degrees head up positioning. • Don't have equipment necessary for assessment. • Guidelines difficult to read and follow, and not relevant to 'real life' challenges. • Pathway development issues • Unable to follow JRCALC guidance on Midazolam and sedation. • Difference in equipment, policies, and skills within different trusts • Conflicting guidelines on head injury management and priorities in multi-system trauma • Limited treatment options • No time for CPD • Too big a gap between MTC's
Attitudes towards EBP Decision Making	• Keeping up with peers (comparison of IHCD and Graduate clinicians) • Recognising importance of paramedic colleagues contributing to profession specific research (grateful and thankful) • Perception that head-injury management has stagnated where other presentations have moved forward. • Perception that clinicians are forming interests away from trauma. • Negative attitudes towards JRCALC (Fad) • Using trust guidelines but lack of confidence in evidence • Research difficult to access and read. • Perception that differing clinical registration's view EBP and decision making differently which may negatively impact team working
Decision making process	• Moving away from JRCALC • Using social media and virtual platforms for CPD, such as twitter, Facebook, podcasts, YouTube, personal blog and webinars • Contributing to research as a source of CPD • Usefulness of conferences for CPD • Lack of confidence in 'original' head injury training / teachings • Peer guided, support and recommendations
What guides decision making?	• JRCALC and NICE guidelines • MTC divert tool. • Assessment tools • No dominant EBP source for head injuries • Unsure of guidelines influencing regular decision making • Descriptive and prescriptive decision making influenced by experience and hindered by restrictive nature of some guidance. • Risk associated with discharge on scene or transfer decision making. • Cue acquisition. • Utilising HEMS and other specialist or senior colleagues for additional skills and peer guided decision making. • Red flags • Gut feeling

Decision Making Bias	• Decision making error due to drug names. • Head injury decision making ‘rough and ready.’ • Decision making fear in head injuries

5.5.1.3 Opinions on suggested implementations

Analysis of the interviews revealed 49 positive and negative comments relating to the suggestion of implementing ONSD Ultrasound into pre-hospital clinical practice, which have been categorised into six higher-level themes, as seen in Table 50 below.

Table 50 - Opinions on the suggested implementation of ONSD Ultrasound into pre-hospital practice

Higher Level theme	Sub-Theme
Potential impact in patient cohort	• Concerned there may not be enough relevant patients to warrant its use (either in an assist to discharge, or assist in advanced care pathway model) • Would the amount of use / relevant patients justify the cost? • Expensive, would it be value for money for number of patients seen? • Is there the justification for introducing this, i.e., enough patients and making enough difference? • Could have a place with HEMS as see this type of patient often enough to make a difference. • Impact verses input into new initiative. Would money, time and training be better focused on something else? If huge impact…. think it's great. • Likes the idea, not sure about overall need and impact
Training in the skill	• Seen ultrasound in use and worried it may be tricky to train in • Thinks training is a small investment for a huge gain. • Seen it in use in hospital and seemed a simple procedure which the Dr said only required a 1-day course so interviewee felt it would be an easy skill to learn. • Seems easy to learn. • Most clinicians would be happy to learn new skills, might find it hard initially to get measurement correct though.
Changing patient pathways	• May be a place for using it to confirm head injury in trauma patient already being admitted. • Doesn't think it will help with leaving patients at home decision making. • Thinks it has a place in bypass decision making. • Doesn't think it will change any pre-alert decision making as would be difficult to get Neurosurgeons on board and A&E don't give a damn what we do or say or give a monkeys…there's an awful lot of dick swinging! • Wouldn't like to see it restricted to HEMS as waiting for their arrival can delay transport time. • Might not help in elderly patients as perception that they won't be treated for severe head injury anyway – ethics discussion point. • It would be awesome to see it included in the regional MTC divert guidelines to justify a longer divert. • Could be used to justify divert to neuro-specialist centre and avoid repatriation. • Could be used in hypertonic saline PGD to increase inclusion criteria. • Would enable a quicker CT where needed.

	• Could speed up treatment after CT. • Could be used by CCP's to diagnose but also other paramedics to decide if CCP's are needed
Deskilling from the skill	• Wouldn't want to see it restricted to CCP's as this could be part of larger issues where paramedics are further deskilled. • Would be worried about deskilling so thinks it should be a CCP skill only. • Thinks de-skilling would not be an issue with CCP's as they already have ultrasound. • Skill decay with advanced skills in certain geographic areas so need to facilitate further training and support to avoid this. • Run the risk of trying to do too much and not be good at anything. • Might not be used often and could have skill decay
Multiple uses and expansion of current use	• I think that's absolutely fantastic. And I think the advantage is multi-faceted because if pre-hospital ultrasound is available, then it's not just available for one thing. And I think that would be, for me, the biggest advantage. • Ultrasound already in use so thinks it would help to expand the use as opposed to introduce as something new as less financial or organisational impact to introduction. • Positives to introduction for many clinical reasons like cardiac arrest • If it's reliable, it's great because it would be another reason for ultrasounds to be more available in every single ambulance. • Would like to see ultrasound on each ambulance as seen it in use by CCP's. • Although it is expensive, believes paramedics will use it lots, compared to change in practice with introduction of 12-lead ECGs over the years. Thinks the fact it has potential multiple uses would support the introduction of the equipment.
Implementation in practice	• Small size is a big pro. • Would be difficult with 2 people, would need 3, maybe CCP. • Worried it will be used unnecessarily and delay on scene time, just because its available • Ultrasound pre-hospital not taken off despite evidence. • Older paramedics may not be as keen as newer ones to learn and introduce new equipment. • Needs to be targeting to the right group of staff who are willing to use it correctly. • How long would it take, and could you do it on the move? I'm thinking about delays on scene and that sort of thing. • Need to get the right clinicians upskilled and involved. • Need to target a small selection of clinicians for a trial who are likely to be on shift when needed. i.e., specialist and advanced paramedics • May be difficult in an agitated head injury patient but if the skill were given to teams who could RSI, this would overcome that problem. • Would be good to trial in clinical practice to establish benefits. • Expensive so suggests rolling them out to specialists first to see how they are used and then more wide scale later. • Good idea but would need to have a clear patient criterion and subsequent decision-making tool after test

Analysis of the interviews revealed 30 positive and negative comments relating to the suggestion of implementing ONSD Ultrasound into pre-hospital clinical practice, which have been categorised into seven higher-level themes, as seen in Table 51

Table 51 - Opinions on the suggested implementation of ResQgard into pre-hospital practice

Higher Level theme	Sub-Theme
No or little options currently	• Something to actively do, very little to do currently, this will help prompt people to think head injury and options and make them feel like they are doing something. • No other treatment options for reducing ICP so open to changes and as its non-invasive and not causing harm…. why not? • Minimal options now for head injury patients so ‘I'd use it all the time'.
Concerns regards cost	• Concerned may be expensive given awareness of ResQpod. • Hopefully, if it's not hugely expensive and going to bankrupt and ambulance service,
Easy to use and train in use	• Positive that it is simply and quick to use and breakable / chuck able. • Straightforward device so limited training needed in device but some on when to use it. • I like the fact you can administer oxygen through it as well. • Seems reasonably straightforward to implement. • Simply to learn and less likely to have skill decay than more complex assessment and treatment skills. • Very easy to use, simple piece of equipment. • Easy to use, straightforward, like existing equipment, easy to assemble. • Nice and easy – ambulance friendly piece of kit
Potential impact in patient cohort	• May be difficult to find enough relevant patients to trial. • Could have potential use with CCP's who see enough appropriate patients to justify implementing. • No animal research specific to use of ResQgard for cerebral benefits – would this be needed before clinical trials?
Difficult to use in patient cohort	• Worried it would be difficult to use in agitated pt group and make ICP increase as opposed to decrease as a result. • Worried a head injury patient wouldn't be able to use the device effectively as non-invasive. • Confusion could be a factor in terms of compliance
Need for larger package of care and pathway	• If not part of a larger package of care, could cause problems…example given is introduction of LUCAS device without a package of care initiatives to support use. • Thinks it would need to be combined with sedation to be useful – bigger package of care. It has potential. • How on board would our in-hospital colleagues be – need to factor this in for a successful implementation. • Need to ensure hospitals are on-board to continue care post intervention as otherwise waste of money and not beneficial. • Not getting the basics right so should concentrate on that first like sitting up and collars off
Criteria for use	• Decision making could be difficult, remembering criteria. • Would need ‘tight' Criteria for use of ResQgard but sounds like something worth looking at. • Would paramedics recognise a severe head injury to know when to use it? • Great idea – would need a ‘little page' to implement successfully with indications and contraindications. • Would need a simple guideline to follow but wouldn't need to know ICP. • It could have more uses like management of hypotension which is a benefit

5.5.1.4 Quality Improvement

Quality improvement suggestions featured in all the interviews conducted. On analysis 25 themes were identified which could be combined under six categories, the largest of which was that of 'education' with eight themes, as can be seen in Table 52 below.

Table 52 - Quality Improvement themes within interviews

Categories	Themes
Equipment	Introduce pre-hospital CT scans (scanners in vehicles)
	Introduce point of care testing, i.e., Near infra-red device to detect surface bleeds and alcohol detection
Assessment tools	Introduce using cerebral fluid imbalances in the brain as an indicator of injury (as within stroke assessment)
	Opportunity to introduce screening for dementia (memory / cognition problems) within ambulance service
Research	Need for more paramedic profession specific research
	Work with MTC's to understand how many patients are not being taken to an MTC due to distance but would benefit from this and work on joint solutions
Guidelines	Quick reference pages such as in JRCALC aid quick reference
	Need for guidelines to be clearly written or organised
	Smart devices on scene to help with quick reference to guidelines
	Major trauma tools need to be older adult sensitive
	Need guidelines to reflect collar guidance
	Need GCS tool for paediatrics
	JRCALC needs updating more frequently as becomes out of date with other guidance between versions
	Need for 'better' assessment tools for head injuries
Treatment options	Allow and support paramedics to use JRCALC guidance on sedation and midazolam
	Straight to CT Scan pathway
	Need for specific head injury pathways to bypass the emergency department
	Pathways need to be developed by clinicians and piloted before official launch
	Introduce mannitol and hypertonic solution
Education	Integrate diagnostic reasoning into degree teaching
	Encourage and support greater joint training between HEMS and non-critical care paramedics
	Improve head injury focus within education to increase sensitivity of detection
	Imbed subconscious decision making in university education
	Need for more support, time, and space for CPD within work time
	Lack of feedback or follow up on patient for CPD

5.5.2 Written Reflections

Through open and subsequent axially coded data, the split between discussion focused upon assessment and treatment, EBP Implementation decision making and quality improvement, can be seen in Figure 43 below. Most of the focus pertained to the implementation or 'decision making' process with 80 coded data, however very closely followed by discussion around 'assessment and treatment' with 60 coded data. There is also evidence of a significant comparable 'quality improvement' discussion with 26 coded data.

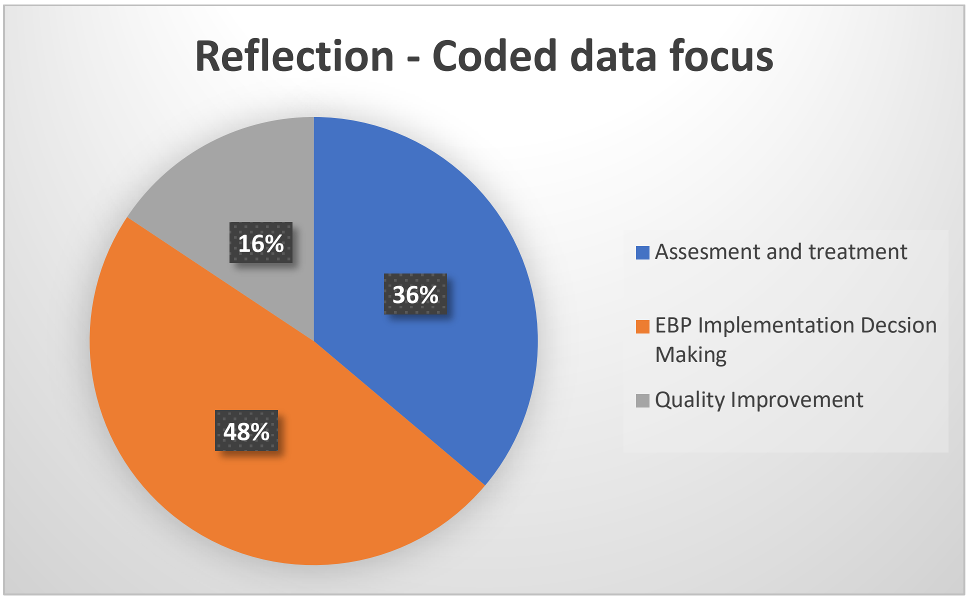


Figure 43 - Written reflections - Focus of coded data across combined corpus.

A further breakdown of the coded themes, in term of percentage and numbers, can be seen within each reflection in Table 53 below.

Table 53 - Written reflections - Focus of coded data per reflective corpus

	Overview	Assessment and Treatment Coded Data	Implementation Coded Data	QI Coded Data	Total coded data	Word count in transcript	Reflective Model
R1	Sudden deterioration of patient and decision-making being questioned at ED	7	3	0	10	1499	No
R2	Unable to access CCP or use advanced skills	4	4	0	8	1754	No
R3	Decision making in elderly trauma (Query Ageist)	4	17	1	22	2229	IFEAR[5]
R4	Decision to send to hospital from custody unit	8	5	7	20	436	No
R5	Almost missing a head injury	8	4	5	17	1216	No
R6	Beyond scope of practice and seeking support	8	6	4	18	1925	Gibbs[6]
R7	Managing multi-trauma	2	10	2	14	704	No
R8	Difficulties associated with festival medicine	9	5	0	14	783	CPD Template
R9	Head injuries complicated by anticoagulant medicines	2	20	3	25	4468	Rolfe[7]
R10	Managing hemorrhagic shock and TBI together	8	6	4	18	1550	Willis[8]
		54	**80**	**26**	**166**		

As can be seen from Table 53 above, there is a general relationship between the number of the codes within the corpus and the document length, however, there

[5] Smart, G. (2011) 'I.F.E.A.R reflection: an easy to use, adaptable template for paramedics', *Journal of Paramedic Practice,* 3(5).
[6] Gibbs, G. (1998) *Learning by Doing: A Guide to Teaching and Learning Methods.* Oxford: Further Education Unit: Oxford Polytechnic.
[7] Rolfe, G., Freshwater, D. and Jasper, M. (2001) *Critical reflection in nursing and the helping professions: a user’s guide.* Basingstoke: Palgrave Macmillan, p. 14.
[8] Willis, S. (2010) 'Becoming a reflective practitioner: frameworks for the prehospital professional', *Journal of Paramedic Practice,* 2(5).

does not appear to be a clear relationship between word count and one area of coding. There is a relationship between the presence of a reflective model, as previously established and a greater amount of coded data overall. However, when analysing the coded data per theme in relationship to the presence of a reflective model, there only appear to be a direct correlation between the 'EBP Implementation decision making' codes and a model of reflection.

5.5.2.1 Assessment and Treatment

Analysis of the reflections revealed 25 assessment and treatment sub-themes which have been categorised into seven higher-level themes in keeping with an assessment and treatment cascade, as seen in Table 54 below.

Table 54 - Assessment and Treatment themes within reflections

Higher Level Theme	Sub-Theme
Initial Assessment / Cue acquisition	• Delayed presentation of head injury • Head injury in the older adult. • Intoxicated patient • Patient Assessment Triangle
Airway	• NPA • RSI • Tri-pod Airway Maneuver • Assistance with BVM • I-gel
Breathing	• Oxygen therapy
Circulation	• Pre-existing Anti-coagulation therapy • IV Access for drug therapy • Target Blood Pressure
Disability	• GCS • Combative patient • Raised ICP signs. • Seizure
Evacuation	• Immobilisation • Cervical collar • 30 degrees head up positioning
Pharmacological Management	• IV Anti-emetics • IV Fluids • IV Morphine • IV Paracetamol • IV TXA

5.5.2.2 EBP Implementation Decision Making

Analysis of the reflections revealed four higher level themes pertaining to EBP implementation decision making, of which there were 19 sub-themes. These can be seen in Table 55 below.

Table 55 – EBP Implementation related Decision making themes within reflections.

Higher Level theme	Sub-Theme
Consent and Capacity	• No decision about me, without me • Mental Capacity Act • Consent • Ethics
Decision Making Bias	• Ageist Bias • Overwhelming Environment • Intoxication • Head injury not considered initially. • Multiple trauma – what takes priority. • Unaware of decision-making tools • Not enough shared decision making
Teamwork	• Assistance from Critical Care Paramedics / HEMS • Regular team members (practiced team) • Referring to other clinicians such as Doctors or Specialists
What guides decision making	• Decision making tools such as scores and algorithms. • Major Trauma Center Divert • Guidelines and frameworks • Red Flags • University Teaching into Practice

5.5.2.3 Quality Improvement

Eight out of the ten reflections featured QI discussions. Analysis of the reflections revealed six themes pertaining to areas of potential quality improvement. These can be seen in Table 56 below.

Table 56 - Quality Improvement themes within reflections

	Themes
1	Easy access to relevant guidelines and decision-making tools
2	Enabling the delivery of EBP and advanced clinical care
3	Ability to follow up patient outcomes for learning
4	Learning from incident reporting
5	Benefits of regular team members
6	Forum to disseminate learning

5.5.3 Case Studies

Through open and subsequent axially coded data, the split between discussion focused upon assessment and treatment, EBP Implementation decision making and quality improvement, can be seen in Figure 44 below. Most of the focus pertained to 'assessment and treatment' with 515 coded data, however closely followed by discussion around 'EBP Implementation Decision Making with 100 coded data. There was significantly less evidence of 'quality improvement' discussion within this phase and compared to other phases, with 14 coded data.

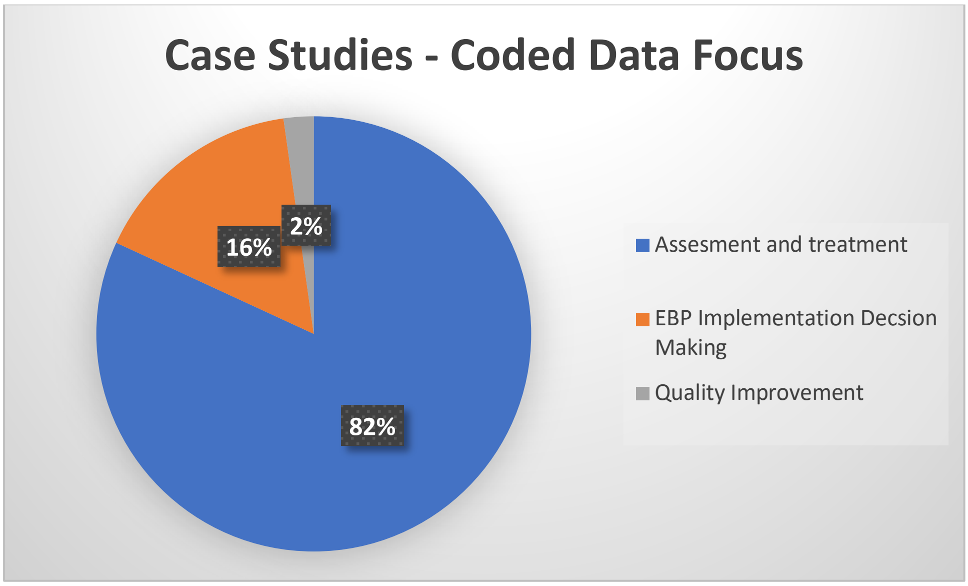


Figure 44 - Case Studies - Focus of coded data across combined corpus.

A further breakdown of the coded themes, in term of percentage and numbers, can be within each case study in Table 57 below.

Table 57 - Case studies - Focus of coded data per case study corpus

	Overview	Assessment and Treatment Coded Data	EBP Implementation Decision Making Coded Data	QI Coded Data	**Total coded data**
Case Study 1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	131	39	7	**175**
Case Study 2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	154	6	1	**161**
Case Study 3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	104	29	1	**134**
Case Study 4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	126	26	5	**157**
		515	**100**	**14**	**635**

As can be seen from Table 57 above, the split between themed codes is similar between case studies suggesting the breakdown is related to the type of corpus as opposed to the subject matter.

The remainder of this section will now summarise the areas of discussion within each of the coded themes in turn, subdivided by case study.

- 5.5.3.1 Assessment and Treatment
- 5.5.3.2 EBP Implementation Decision Making
- 5.5.3.3 Quality Improvement

5.5.3.1 Assessment and Treatment

The assessment and treatment codes were reviewed, and sub categorised as seen in Table 58 below. These categories started to emerge in alignment with either the Review of Systems (ROS) also known as the systematic enquiry (Douglas, Nicol and Robertson, 2013; Collen, 2018), with the addition of the 'patient assessment triangle' (Halliwell *et al.*, 2013) blended into a medical note taking model (Douglas, Nicol and Robertson, 2013) as seen within case study 1, 2 and 3. Or the CABCDE primary survey model (Halliwell *et al.*, 2013), as seen within case study 4. The use of these models was also evident in the way most participants structured their contributions when composing either their plans or questions relating to assessment and treatment.

Table 58 - Assessment and treatment codes and categories within the case studies

Review of Systems	Primary Survey	Note Taking Medical Model
Initial Appearance (also referred to as patient assessment triangle)	C – Catastrophic Haemorrhage	HPC (History of presenting Complaint)
C – Cardiac Assessment	A(c) – Airway considering C-Spine	PMH (Previous Medical History)
R – Respiratory Assessment	B – Breathing	DHx (Drug or medication history)
A – Abdominal Assessment including GI (Gastrointestinal) and GU (Genitourinary))	C – Circulation	Social History
N – Neuro Assessment	D – Disability (referring to Neuro)	Allergies
E – Exposure and Environment, sometimes referred to as 'Everything else'	E – Exposure and Environment, sometimes referred to as 'Everything else'	Consent / Capacity
EENTd (Eyes, Ears, Nose, Throat and Dental)		Imp (Clinical Impression or working diagnosis)
MSK (Muscular Skeletal System)		Plan (Management or treatment plan)

Table 59 below, shows the assessment and treatment codes to emerge from each case study.

Table 59 - Assessment and treatment discussion within the case studies

Case Study	Overview	Potential areas for discussion in design phase	Areas of discussion within thematic analysis
1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	Impact of alcohol consumption on clinical decision making. Differentiating minor head injury from facial injury.	HPC - mechanism, intoxicated (? Amount truthful), did he defend the fall, if not then why not? PMH (Inc. neurosurgery or neuro conditions, coagulopathies, previous head injuries, vasal vagal, hx LOC, hx over stimulus vagus nerve, Falls hx), DHx (inc anti-platelets /anticoagulants), recreational drug use? CABC, full trauma assessment C - 12-lead ECG, JVP, R - Auscultation A – Any signs or symptoms of a UTI? N - KO, LOC, amnesia, seizure, Neuro assessment, Pupils, headache, vomiting, cranial nerves, base of skull# signs, FAST-ve, E - Other injuries, Obs, resus, BP, Hr, temp, BM, SPo2, pain score, EENTd - Facial bones, epistaxis, otorrhea, rhinorrhoea, facial trauma, septal haematoma, Loose Teeth, bite, dentition intact MSK - C-Spine, Spine, Mobilising? Imp – Facial Injury or Head Injury (debated) Plan - Pain relief, OTC analgesia PRN, Advise - no more alcohol today, wound care, follow up GP advice, worsening advice, possible maxfax referral

2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	Delayed head injury in older adults, recognition, and management. Possible link of historic head impacts such as Rugby playing to Parkinson or Dementia presentation in later life. Cerebral T Waves on ECG.	HPC - Any illnesses or viral symptoms recently, onset of headache and confusion? Memory of falling? PMH - Parkinson's hx? DHx - meds prescribed (inc benzodiazepines as falls risk and any OTC's such as pain relief) Social - engaging in any activities - is he doing so today as normal? Coping with ADL's, any safety concerns at home? Consent to examination. C - New chest pain? Heart Sounds, JVP, Leg swelling? Finger Clubbing? (Echo if in hospital), conjunctiva pallor, claudication? 12-lead ECG, R - Chest exam, auscultation, and percussion A (GI/GU) - Nausea / Vomiting? Noted smell of urine in house (non-offensive), any change in bowels or new urine symptoms, kidney pain? diet or appetite changes? risk of AKI assessment, incontinence assessment, urinalysis, fluid intake recently, N - Headache (describe pain and onset), Neuro Assessment, FAST Exam, Tone and Strength in arms and legs, altered sensation? visual disturbances? pupil assessment, nystagmus? Abbreviated mental test, mannerism, recollection, memory. concerns, orientation test, cranial nerves, (CT Head if in hospital), Amnesia? Any LOC, Vertigo? Slurred or slowed speech, dysdiadochokinesia, ataxia, intention tremor, scanning dysarthria, heel/skin test, cognitive assessment, ultrasound of ONSD where available, E - obs inc temp, pain, frailty score, MSK - Back pain? posture and gait assessment, Imp - Sepsis secondary to UTI. Primary UTI? malignant hypertension, collapse / fall with query cause, dehydrated, vascular dementia, CTBI from old rugby head injuries, Parkinson's, supra nuclear palsy, corticobasal degeneration, posterior CVE, delirium, Lewy body dementia, encephalopathy. Plan - Transfer to ED for CT scan to assess for subdural haematoma, reduction of BP with stat dose hypertensive (point argued in depth), bloods for infection markers and anaemia, OT assessment, social assessment for POC, if frailty high then query need to palliate, avoid Emergency Department, if possible, admit to a frailty ward where possible, refer to neurology as needed.

3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	Decision to close wound out of hospital or not. Head wound verse head injury discussion. Capability and role limitations discussion alongside accountability for clinical decision making.	HPC - History of events, mechanism, unwell before fall? Details of impact, how did he land and on what? Unwell since event? Was there a witnessed collapse? Concerns amount of alcohol consumed may not be truthful. PMH - Alcohol dependant? DHx - Lots of discussion regards NOAC's and DOAC's (firstly debate over the use of acronyms and then which would or wouldn't trigger a CT scan in a head injury and how local guidance doesn't always reflect NICE guidance). Specific mention regards warfarin and clopidogrel. Allergies - Any known? Social - Concerns regarding excessive alcohol consumption (ET0H). Lives alone. Consent and capacity - Does he understand and consent to plan? Initial Appearance - Initial impression, Initial ABC's? end of bed assessment, patient assessment triangle. C - 12 lead ECG, A - Nausea or vomiting? N - Neurology assessment. Headache? Head Exam, any signs of skull fracture (bruising, battle signs, blood of CSF, periorbital ecchymosis, bony tenderness of boggy mass) Amnesia post event, memory of event? Neck exam (ROM). Cranial Nerve exam. Balance Issues? Focal Neurology? Romberg test. Ataxia? E - Wound assessment, debate over whether to close wound at home. Any pain? Evidence of intoxication? EENTd - Damage to dentistry? Injury to tongue? Observations? MSK - Gait assessment? Imp - Need to rule out subdural bleed. Concerned not safe to leave at home due to ET0H and likely to drink again meaning any safety netting advice is unlikely be remembered or followed. Also increased risk of bleeding due to ET0H use and anti-platelet medication. Plan - Transfer to ED for further assessment / monitoring and possible CT. Debate regards wound closure - some in favour of closing and then transporting, however some feel unhelpful delay of transporting resource and some in favour of closing had the pt not needed ED. Also, a smaller opposing argument to close and leave at home with advice or refer to falls team. What does the pt want to happen? Pt may want help for alcohol dependency but not sure who to ask so consider in plan.

4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	Management of critically ill head injury trauma patient and use of critical care advanced clinicians, pre- alerts and trauma divert decisions.	C - catastrophic haemorrhage (external or internal). haemorrhage control. A(c) - airway patient, need adjunct? Suction available. Any trauma or haemorrhage which may compromise airway? C-spine needs controlling due to mechanism. Debate over c-spine collar or not (consider alternative) and if applied then not too tight due to potential increase in ICP. 2-person technique to manage airway. B - Rate, Rhythm, depth, equal rise and fall, any chest trauma? SPO2, cyanosis? thoracic examination. Treat with high flow (100%) 02. Airway control debated between Jaw thrust, OP airway (with nasal spec), 2x NPA's or Igel and intubation. Secondary debate over the need for drugs pre intubation and the lack of skill set and to do this - up to and including RSI (atropine, midazolam, ketamine, morphine, fentanyl and rocuronium), (3,2,1 approach, and PALM technique referred to regards intubation). Slightly hyperventilate with assisted BVM resps and aim to normalise ETC02 - lower side of normocapnia. C - Any haemorrhages? Hr, BP, cap refill, patient colour, radial and brachial pulse, pedal pulse. IV access (bilateral wide bore in ACF's), debate over no fluids or fluids at KVO (keep vein open rate), wound management. TXA not needed due to BP and isolated head injury. Monitor for worsening bradycardia and widening pulse pressure considering Cushing's triad. D - GCS, pupil size and reactivity. Attempt 30-degree head up but very difficult with immobilisation. Draw up diazepam or midazolam IV and prepare for seizure. E - temp, capillary blood glucose, examine spine, abdominal examination, pelvic examination, long bone examination, check for other injuries, scoop onto vacuum mattress for extraction (skin to scoop), apply pelvic binder. IV Ondansetron to prevent vomiting. Cut clothes off. Imp - Cushing's triad. Plan - MTC with pre-alert (ASHICE mentioned) debated against 'pit-stop' at nearest Trauma unit for intubation - however agreed patient needs neurosurgery. Discussion on whether HOTT Algorithm would be appropriate or successful in the event of a cardiac arrest in this patient.

5.5.3.2 EBP Implementation Decision Making

Table 60 below, shows the EBP Implementation codes to emerge from each case study.

Table 60 - EBP Implementation Decision Making discussion within the case studies.

Case Study	Overview	Potential areas for discussion in design phase	Areas of discussion within thematic analysis
1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	Impact of alcohol consumption on clinical decision making. Differentiating minor head injury from facial injury.	• NICE Guidelines used in decision making. • Unable to use NEXUS and Canadian C-Spine rules due to intoxication so cannot clear C-Spine • Checking Pupils for the 'Theatre' for the public as not going to provide any meaningful information. • Debate regarding whether ED would or would not scan and how this would be influenced by the grade of the Dr making such a decision – impression that junior doctors would scan, and seniors wouldn't but F1's cannot order anything without permission. • Debate over whether guidelines on head injury are appropriate in this case as arguably it is a facial injury not a head injury. • Suggestion that student paramedics want to perform too many investigations which are unwarranted
2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	Delayed head injury in older adults, recognition, and management. Possible link of historic head impacts such as Rugby playing to Parkinson or Dementia presentation in later life. Cerebral T Waves on ECG.	• Impression that paramedics can be too quick to make a query sepsis diagnosis based on a possible infection with altered observations. Described as "sepsis mad". • A debate regarding evidence to support high BP's being treated in ED to stabilise or being dealt with more slowly by GP. Pathway related debate. Evidence discussed in terms of articles but also peer discussions with ED and Acute Medical doctors. • Discussion regards the avoidance of ED in dementia patients • Discussion regards needing to find a 'sensible' GP who is not overly risk adverse and willing to support a non-conveyance plan

3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	Decision to close wound out of hospital or not. Head wound verse head injury discussion. Capability and role limitations discussion alongside accountability for clinical decision making.	• Discussion around the 'danger' of using abbreviations that others may not be aware of, or an expectation to be aware of such abbreviations in certain areas of practice. • Discussion around NQP's needing permission to discharge a patient on scene and the governance and process relating to this, including a high standard of patient records to support decision. Also, apparent differences locally in this national guidance. • NICE guidance used to support decision making. • Debate over whether patients on anti-platelets (as opposed to anti-coagulants) should be conveyed for a CT scan. Discussion over interpretation of NICE guidelines and how local guidelines vary from NICE, and why this may be. • Further discussion that even within the same ED, different staff will advise differently regards decision making on CT scans for anti-platelet patients. Difficult to therefore make decisions based on this information. • Discussion around addressing incorrect decision making of other ambulance clinicians, both junior and senior roles. Also, a peer led training opportunity through debrief. • Use of JRCALC guidelines in supporting decision making • Using senior colleagues (specialist paramedics) for pathway discussions over the phone.
4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	Management of critically ill head injury trauma patient and use of critical care advanced clinicians, pre- alerts and trauma divert decisions.	• Difficulty achieving the EBP regards 30-degree head raised in head injury patients when they are immobilised. • Debate regards using the trauma divert protocol and going to a MTC further from the local TU. Or whether to take a 'pit stop' at the local TU for intubation and delay time to definitive care. • Debate over whether to intubate on scene, with or without a mixture of drugs to assist intubation. Conversation extended to danger of using drugs for this reason at a paramedic skill level. Unable to deliver care needed as unable to RSI as a paramedic. • Unable to manage pain as GCS too low more morphine so again unable to provide necessary level of care as unable to sedate. • Lack of awareness of an arguable well used acronym. • Wanting a senior clinician to divert to the MTC – referred to as a 'grown up'. • Impression that a TU would not be happy or prepared if you 'pit stop' for an RSI in a critical patient. "Poo will hit the fan". • Discussion regards lack of options to treat the 'c' in ABC as a non-registered ambulance clinician. • Discussion about risk taking in decision making and a perception by some that risk taking is a recognised part of ambulance work. • Scope of practice not including all drugs needed for head injury management, including mannitol and hypertonic saline.

5.5.3.3 Quality Improvement

Table 61 below, shows the QI codes to emerge from each case study.

Table 61 - QI discussion within the case studies

Case Study	Overview	Potential areas for discussion in design phase	Areas of discussion within thematic analysis
1	Young male, minor facial injury after fall, small amount of alcohol, GCS 15.	Impact of alcohol consumption on clinical decision making. Differentiating minor head injury from facial injury.	• Prescriptive proformas have a negative impact on patient care. • Assessments in some trusts are unnecessarily overly prescriptive and this is an issue. • There is a need for something to fill the time with a patient on long transfer so repeated observations and unnecessarily extended history taking are sometimes used inappropriately to fill this void. • We need to be more robust in challenging student decision making. • Need for otoscopes available to paramedics to rule out hemotympanum in head injuries. • Some calls may reach a paramedic which should have been redirected by call handers and dispatchers.
2	Older adult more confused and unsteady recently, family concerned. Several falls reported over past couple of months and history of possible head injuries when younger. GCS 14	Delayed head injury in older adults, recognition, and management. Possible link of historic head impacts such as Rugby playing to Parkinson or Dementia presentation in later life. Cerebral T Waves on ECG.	• The separation between community care and hospitals is suboptimal therefore leading to admission to the ward post ED unnecessarily. A need for better pathways out of ED and back into the community.

3	Older adult with an open head-wound to the back of his head from a minor fall. GCS 15	Decision to close wound out of hospital or not. Head wound verse head injury discussion. Capability and role limitations discussion alongside accountability for clinical decision making.	• Requests for a specialist paramedic should be discussed with the SP by the referring paramedic and not agreed via a call handler, to ensure decision making is correct.
4	Middle-aged male involved in Road traffic accident as a pedestrian hit by a van at 50mph. GCS 3.	Management of critically ill head injury trauma patient and use of critical care advanced clinicians, pre-alerts and trauma divert decisions.	• Need mannitol and hypertonic saline to manage head injuries. • Need drugs and training to assist intubation / RSI and sedate patients. • Need more research on the best approach for airway management in head injury patients – should we use nasal intubation in head injury patients?

5.5.4 Post Case Study Questionnaires

Within the questionnaire the participants were asked two qualitative questions, these were:

1. Why did you decide to contribute to this case study?
2. What has been the impact of, or what have you gained from, contributing to this case study?

The thematic analysis has been divided into these questions below.

5.5.4.1 Why did you contribute?

The 33 responses could be categorised into one of the seven themes seen within Table 62 below. This table also further breaks down the responses by theme and response per clinical grade.

Table 62 - Post case study contribution breakdown

Identified theme	**Number of responses**						**Word count**	
	Student Paramedic	**NQP**	**Paramedic**	**Specialist Paramedic**	**Advanced Paramedic**	**Total Responses**	**Average word count per response**	**Total Words**
Improve personal clinical practice	2	2	1			5	26.8	134
Reflect on personal practice				2		2	27.5	55
Specific area of clinical interest			3		1	4	30.25	121
Contribute to research and development of profession			5	1	1	7	10.4	73
Benefit from peer learning	1	1	5	2		9	39.1	352
Contribute to peer learning		1	1	1	1	4	18.25	73
Combining a contribution to peer learning and research with personal benefits			1	1		2	34	68

The table above therefore shows that the theme with the greatest number of comments was that of ‘benefit from peer learning, followed by the theme ‘contribute to research and development of the profession’. Although contributing to research and the profession appears to have a high importance, the word count analysis of these comments suggests a more direct and simplified response than comments in

other themes. Moreover, the highest number of responses in the 'benefiting from peer learning' theme also has the highest word count analysis, thus suggesting a greater depth of detail in the responses. Overall, the depth of responses was evenly distributed between most of the remaining themed responses.
The themes with the most widely spread contribution across the clinical grades were those relating to 'peer learning', either contributing to or benefiting from. A comparison across lower to higher grades suggested a swing from a focus on 'improving personal practice' in the lower grades, compared with a focus on 'contributing to research and the profession' among the higher grades.

Comments within each of the seven themes, from all participants, can now be seen below.

Improve personal clinical practice.

"I'm a big advocate for trying to prevent hospital admission but I know when not to push the limits, I've not contributed to any of the other posts before and it's something I have come across before." (Questionnaire Participant 3 – Newly Qualified Paramedic)

"Because it was an interesting study which allows me to think about potential treatments. As a student, I find these cases good for broadening my knowledge and giving me, albeit virtual, exposure to rare/complex jobs which I may not experience before being qualified." (Questionnaire Participant 7- Student Paramedic)

"I decided to participate due to being a newly qualified Paramedic I feel it is important to contribute in things that can excel ones learning ability." (Questionnaire Participant 16 – Newly Qualified Paramedic)

"Enjoy participating in case studies on Facebook as part of CPD to further my knowledge and benefit the care I give to patients." (Questionnaire Participant 12 – Paramedic)

"As an opportunity for CPD." (Questionnaire Participant 17 – Student Paramedic)

Reflect on personal practice.

"It was something that made me think & look at myself now that I'm approaching my half century & how much importance is put on book learnt smart skills rather than practical real-life hands-on experience." (Questionnaire Participant 18 – Custody Paramedic)

"I find active involvement in case studies, and feedback from my involvement, to aid in internalising best practice." (Participant 12 – Clinical Team Mentor)

Specific area of clinical interest

"Interested in Muscular-Skeletal Presentations" (Questionnaire Participant 2 – Advanced Clinical Practitioner)

"Felt that the role of ethanol consumption had not been fully explored in relation to a head injury. Thought that people were taking things on face value and not considering adequate history taking in this regard, specifically around guidance given in relation to alcohol toxicity and the effect this may have on the cause of a fall." (Questionnaire Participant 24 – Paramedic)

"I decided to contribute to this case study, as it was one of a particular interest. I recognised the signs and symptoms suggestive of a hemiplegic migraine, therefore put my clinical diagnosis across." (Questionnaire Participant 15 – Paramedic)

"I feel that practice varies across the nation and feel that there may be a variation with experience. Given my enthusiasm towards trauma, I decided to contribute." (Questionnaire Participant 25 – Paramedic)

Contribute to research and development of profession.

"Contribute to research" (Questionnaire Participant 1 – Paramedic)

"To assist in further research and development." (Questionnaire Participant 13 – Paramedic)

"Ongoing education of paramedic practice is important to me." (Questionnaire Participant 14 – Critical Care Paramedic)

"I am interested in research with a personal interest in trauma." (Questionnaire Participant 21 – Paramedic)

"Supportive of paramedic progression led by 'in house' paramedic researchers." (Questionnaire Participant 9 – Advanced Paramedic)

"Contribute to research" (Questionnaire Participant 31 – Paramedic)

"I was running this case study in conjunction with the study to explore paramedic and other HCP approaches and attitudes to a simulated head injury case study via social media." Questionnaire Participant 4 – Lead Paramedic)

Benefit from peer learning.

"I wasn't entirely sure if my practice was in line either with my peers or with recognised best practice. So, I thought I'd put my view out there and see what the consensus was." (Questionnaire Participant 28 – Paramedic)

"Often enjoy contributing to case-studies to compare clinical practice and methods to other clinicians." (Questionnaire Participant 29 – Newly Qualified Paramedic)

"Because I was interested in the cases and feel you learn lots from seeing the comments of others." (Questionnaire Participant 23 – Paramedic)

“As a form of CPD, to further my knowledge on this topic”. (Questionnaire Participant 8 – Paramedic)

“As appeared interesting and wanted to see if others agreed with my comments, or if they would do things differently”. (Questionnaire Participant 8 – Paramedic)

“To learn and be the best paramedic I can.” (Questionnaire Participant 8 – Paramedic)

“Initially it was due to the risk we encounter as frontline clinicians around head injuries and their management in the community. I was interested to see how others would have managed the patient in ways similar or different to me.” (Questionnaire Participant 22 – Paramedic)

“I like to maintain my clinical decision-making skills by participating in online case studies and viewing contemporary Paramedic thought processes in an open forum.” (Questionnaire Participant 27 – Paramedic Lecturer)

“To try to see how other clinician s approach a patient, in a formal sense, to many ‘break room’ chats involve ‘catchphrases’ such as make their own, way, fob them off etc. all just decompression but I find the online open case studies to be helpful and more importantly provide my own self-assessment on key areas I find as my own weaknesses. I also sadly see occasional attitudes that I am keen to avoid. (Questionnaire Participant 5 – Paramedic)

“It is also an insight into what I will have to do in my future as a paramedic as I have aspirations of further studies over the next 2-4 years.” (Questionnaire Participant 5 – Paramedic)

“I found the case study interesting, particularly in regard to the viewpoints from different grades of staff.” (Questionnaire Participant 19 – Student Paramedic)

“I take an interest in developing my career, and the use of the Facebook ‘Parameducate’ page has run a series of interesting case studies. I found the posts and subsequent replies interesting and engaging. Seeing the replies from different people, with varying levels of experience, work locations and clinical back grounds made the learning experience more valued.” (Questionnaire Participant 10 – Paramedic)

Contribute to peer learning.

"I felt I could offer a pertinent point to the on-going discussion thread that some participants may have overlooked." (Questionnaire Participant 26 – Paramedic)

"General interest and clinically question some information contained in the discussion." (Questionnaire Participant 32 – Paramedic)

"I enjoy contributing to many of the case studies. This particular case caught my eye as it involved an NQP (my grade) and an area of interest (substance misuse)." (Questionnaire Participant 6 – Paramedic)

"It was an interesting topic that I felt I could share my views on." (Questionnaire Participant 20 – Specialist Paramedic)

Combining a contribution to peer learning and research with personal benefits

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"To enrich the learning of others, and also to learn new things myself." (Questionnaire Participant 30 – Specialist Paramedic)

"I find online case studies an interesting opportunity to explore my decision making and also compare it to that of others. I have often found the process very informative and enjoy the perspectives brought by those working in other jurisdictions. I was further motivated to participate knowing that the studies were a part of research." (Questionnaire Participant 11 – Paramedic)

5.5.4.2 What has been the impact or gain?

The 33 responses could be categorised into one of the seven themes within Table 63 below. This table also further breaks down the responses by theme and response per clinical grade.

Table 63 - Post Case Study Impact or Gain Theme Analysis

Identified theme	Number of responses						Word count	
	Student Paramedic	NQP	Paramedic	Specialist Paramedic	Advanced Paramedic	Total Responses	Ave word count per response	Total Words
Personal development in topic covered	1	3	8	2	1	15	41.8	627
Reflection on the changes within the profession			1	1		2	144	288
Peer supported learning	1	1	2	4		9	43	387
Prompted further CPD after the event			1			1	23	23
Reflection on how others practice	1		1	1	2	4	23	92
Satisfaction of contributing to research			1			1	6	6
Mixed benefit of personal development, CPD after the event and a reflection on accessing future CPD			1			1	54	54

The table above therefore shows that the theme with the greatest number of overall comments was that of ‘personal development’ however when analysing the depth of contribution through word count, the theme with the greatest contribution by this measurement was that of ‘reflection on changes in the profession’, this response also appeared to have the greatest emotional response within analysis of the comments, perhaps explaining the greater number of words within the responses. The second highest number of responses and average word count per answer was the subject of ‘peer supported learning’ suggesting a relative importance also placed on this aspect of impact or gain from contribution.

The themes with the most widely spread contribution across the clinical grades were those relating to ‘personal development’ or ‘reflection on others practice’. This even spread of ‘personal development’ as an impact or gain’ is not in keeping with analysis of the similar theme within reasons for contributing where ‘personal development’ was a theme more closely aligned to the lower clinical grades; perhaps suggesting that the higher grades did not participate expecting to gain personal development, however recognised this this after reflection on the event. A comparison across lower to higher grades within this question however did not suggest a clear pattern from lower to higher grades, however the gain of a ‘satisfaction of contributing to research’ was only mentioned once by a ‘paramedic’ grade clinician, featuring as the middle grade in the analysis. This contrasts with ‘contributing to research, as previously mentioned, being an important reason for contribution among higher grades in the analysis of the previous question, once again suggesting a potential realisation upon reflection that the impact or gain of participation may have been different from the importance placed on ‘taking part’.

Comments within each of the seven themes can now be seen below.

Personal development in topic covered.

“Some interesting discussion surrounding the impact of medications other than direct anticoagulants on the risks associated with head injuries, and how this risk is addressed especially in systems where an appreciation of that risk is not always shared across the board.” (Questionnaire Participant 11 – Paramedic Clinical Team Mentor)

“A change in why of approaching the management of head injuries, how to treat and assess, and what is an appropriate care pathway.” (Questionnaire Participant 10 – Paramedic)

“Gained increased awareness of the assessment and management of head injuries, and increased confidence with this patient demographic.” (Questionnaire Participant 17 – Student Paramedic)

“I have gained an insight into other clinicians’ way of thinking, and it has helped me to learn other pathways and suggestions I could make use of in the future.” (Questionnaire Participant 3 – Newly Qualified Paramedic)

“I now feel a lot more confident that I was practicing well, and I’ve got a deeper knowledge of some aspects of the case.” (Questionnaire Participant 28 – Paramedic)

“A greater understanding of ‘slow’ ICH in elderly patients and the delay in symptoms presenting, particularly in the presence of

underlying conditions such as dementia." (Questionnaire Participant 29 – Newly Qualified Paramedic)

"Information from other participants has helped in my day-to-day practice." (Questionnaire Participant 2 – Advanced Clinical Practitioner)

"An increased awareness of ensuring appropriate history taking in assessing risk of head injury and that best interest and risk assessment should not default to A&E admission when an injury to face or head is sustained." (Questionnaire Participant 24 – Paramedic)

"Gained new and improved knowledge. People posted information which even if it wasn't relevant to the final answer, was good information". (Questionnaire Participant 8 – Paramedic)

"I have considered how as ambulance clinicians we manage head injuries. Due to fear of complications and reprisals it seems that they are managed in a very risk-adverse manner, often making a lot out of things which are unlikely to be a real problem. On looking deeper at my own practice, I use phrases like 'Although everything seems fine', we can't see inside your head so it would be best for you to come with us to make sure that there is nothing wrong'. Or 'Just to rule out <insert problem> we will take you to hospital'. Although this is not always a bad thing especially where appropriate safety netting is not available it sometimes occurs where it could be more appropriate to safety net the patient appropriately. I have looked also at how we tend to interpret guidance to make it fit what we would like the final outcome of the patient encounter to be." (Questionnaire Participant 22 – Paramedic)

"Better knowledge around the management of head injuries." (Questionnaire Participant 12 – Paramedic)

"The case studies help build a more well-rounded view of clinical practice across different areas/trusts. As there were different clinical grades/specialist clinicians that take part it is good to get their perspective and how this could influence my practice. I think the main take away from this study was reinforcing the idea to check guidelines and to ensure there is proper safety netting in place when referring or discharging a patient from my care." (Questionnaire Participant 6 – Paramedic)

"I gained an understanding into areas of head injuries that I was not aware, also had confirmation that many other participants

would do a similar management to myself." (Questionnaire Participant 25 – Paramedic)

"Deeper knowledge of Traumatic head injury presentations and differentials." (Questionnaire Participant 21 – Paramedic)

"The case study allows me to view the patient presentation from a variety of angles including other paramedics who may have a different scope of practice or an alternative management plan. I feel this allows me to think more widely about patient presentations and potential management of them which furthers my own practice." (Questionnaire Participant 27 – Paramedic Lecturer)

"I gained an insight and overall confirmation my own impression and management plan were within the general normal opinions, I still find myself in the position of what's right and what's right to protect myself, as there is still in my opinion a toxic attitude towards making your own decisions. With this case study I was interested to find a decent consensus were towards the general management of the injuries sustained and assess for underlying issues and still coming across clinicians (possibly misrepresented) suggesting hospital treatment is the definitive care for most patients and won't use local resources." (Questionnaire Participant 5 – Paramedic)

Reflection on the changes within the profession

"Different services work differently and have different equipment- by contributing I was made aware of different policies and why people work in different ways." (Questionnaire Participant 7 – Student Paramedic)

"I have gained an insight into mistakes that I could have made during Practice, the way in which people who were studied at different locations would have done things differently to myself. But also, a new perspective into things." (Questionnaire Participant 16 – Newly Qualified Paramedic)

"Reviewing how other approach head injuries and their clinical rationale for decision making." (Questionnaire Participant 30 – Specialist Paramedic)

“Assisting in imparting some of the knowledge and experience I have gained from dealing with and managing significant head injuries and the knowledge I have gained from working with consultant level experts who deal with these injuries in the hospital setting and being able to regularly see pt follow up which Is not something available to most paramedics.” (Questionnaire Participant 14 – Critical Care Paramedic)

“It’s made me realize that what I feel is a very simple job has been transformed into something I fail to recognize as emergency pre-hospital care. It was ingrained into me when I was vehicle crew staff that our job, whether it be technician or paramedic, was to prevent deterioration, promote recovery and transport to appropriate further care. All this advanced 12 lead ECG recognition, advanced paramedic practitioner, consultant paramedic etc is in my opinion pointless to vehicle-based paramedics. When I worked in A&E, when a crew ‘blued’ in a patient the staff weren’t interested in whether you thought it was Wolf Parkinson White syndrome or torsade de pointes, whether you felt it was a metabolic imbalance, they were interested in history, immediate interventions, drugs given & their effects. I’ve witnessed first-hand members of the receiving team glaze over when a crew has tried to tell them what they should do because of their advanced training when they have no readings, blood gasses etc to support their claims/impressions, but likewise I have heard them hang onto to every word an experienced/known crew have to say about their patient. To me a paramedic will in quite simple terms . . . breathe for you if you can’t, pump your blood if you can’t, support your systems & stop them collapsing for as long as possible while trying to get you somewhere that can hopefully build on what I’ve done prior to your arrival at Resus, all while trying to maintain an air of calmness & control. Which is why I’m probably now irrelevant in this new super paramedic era ! !” (Questionnaire Participant 18 – Custody Paramedic)

“A glimpse of how different roles manage different scenarios and the importance of shared decision making.” (Questionnaire Participant 13 – Paramedic)

Peer supported learning

"I found the overall experience beneficial both in terms of my own learning and exploring the abilities, skills, and approach of others. I find case studies are useful in terms of mental modelling, safe discussion of approaches, exploring evidence, improving knowledge, and interacting with other clinicians." (Questionnaire Participant 4 – Lead Paramedic)

"I quite enjoyed working through the cases on my own and exploring my own decision-making processes. I feel that the greater benefit came from then comparing this to the comments of other contributors and seeing the different perspectives presented. It allowed for constructive debate around both key and nuanced aspects of care that I would otherwise not have a chance to access. Knowing that the cases were also curated for accuracy and realism was also satisfying." (Questionnaire Participant 11 – Paramedic)

"I always feel I learn from other people's comments and practice." (Questionnaire Participant 23 – Specialist Paramedic)

"I have gained a more in depth understanding of other people's clinical reasoning and differential diagnosis." (Questionnaire Participant 15 – Paramedic)

"It has allowed me to hypothetically look at how I would treat this patient and how this differs or is similar to my peers. It reinforced that my thought process is very similar and that my practise would be correct and safe. It also allowed peers to suggest/share knowledge I was unaware of, broadening my own knowledge base". (Questionnaire Participant 7 – Student Paramedic)

"By discussing ideas with others without being face to face, it allows you to think, change and edit your responses, allowing conversation/debate to occur more succinctly- by contributing in this case study you gain better quality responses than you may do by talking in a crew room." (Questionnaire Participant 7 – Student Paramedic)

Prompted further CPD after the event.

"Following my contribution, I re-visited JRCALC guidelines around head injury assessment and management, therefore refreshing my own understanding of the latest guidance." (Questionnaire Participant 26 – Paramedic)

"Given me topics to further research and learn about in my own time." (Questionnaire Participant 8 – Paramedic)

Reflection on how others practice

"I have gained an insight into a wider range of viewpoints, which I find useful because I rarely work with somebody of a higher clinical grade." (Questionnaire Participant 19 – Student Paramedic)

"Seen other HCP decision making." (Questionnaire Participant 1 – Paramedic)

"Shows paramedics still over triage and over treat some conditions. Shows paramedics use unnecessary assessment tools in simple injuries. Shows paramedics may require more initial training on head injuries." (Questionnaire Participant 32 – Paramedic)

"It was interesting to read other clinicians views and evidence from multiple sources, it was a valuable piece of CPD." (Questionnaire Participant 20 – Specialist Paramedic)

"More of a view and understanding of others' views in the profession." (Questionnaire Participant 9 – Advanced Paramedic)

Satisfaction of contributing to research

> *"Satisfaction from contributing to research." (Questionnaire Participant 31 – Paramedic)*

Reflection on accessing future CPD.

> *"Appreciated that social media can be a useful platform to learn clinically and develop – it isn't just for socialising." (Questionnaire Participant 8 – Paramedic)*

5.6 Computer-mediated Discourse Analysis

Each case study was mapped for conversational analysis. The analysis focused on the type of interaction within each case study comment. These comments were categorised into either a 'question', 'reply / answer' or statement and this was then sub-categorised into either 'Admin to participant', 'peer to peer' or 'Participant to Admin'. The following abbreviations had been used to allow for identification of these categories, as seen in Table 64 below.

Table 64 - Abbreviations within case study analysis

Response	Interaction	Code
Questions	Admin to Participant	Qq
	Peer to Peer	qq
	Participant to Admin	qQ
Reply / Answer	Admin to Participant	Rr
	Peer to Peer	rr
	Participant to Admin	rR
Statement	Statement by Admin	SA
	Statement by Participant	SP

Each comment was then further categorised into the type of language used and theme for which the comment identified with. The researcher made the decision that each comment could be coded multiple times to allow for recognition of the complexity of some comments.

A matrix of the full analytical mapping for each case study can be found in appendix 21, 22, 23 and 24. However within this sub section is a summary of the findings from each case study analysis.

5.6.1 Case Study 1

As seen in Table 65 below, most comments within the conversation were peer-to-peer replies (n=40). The tone of conversation was mainly either neutral (n=49) or supportive (n=35). The conversation was mainly focused on assessment and treatment (n=46), closely followed by implementation (n=34). Emoji's' were used in six of the analysed comments.

Table 65 - Conversational analysis of case study 1

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
6	8	24	21	40	20	1	12	49	24	7	35	16	6	46	34	7

Case study 1 would appear to develop across four phases of conversation as can be seen through pattern interpretation within appendix 21. Initially the pattern would suggest that conversation was developed mainly through questioning of the moderator with a mostly neutral or supportive tone and themed predominantly around assessment and treatment. As the conversation progresses in the 2nd quarter, the conversation is much more evenly spread between contributions peer to peer as well as directed to and replies from the moderator. In this 2nd quarter the tone also starts to involve a noticeable element of defensive or opposing language between peers and codes start to include implementation conversation with a few QI related comments. In the 3rd quarter the conversation would appear to be evenly divided between assessment and treatment and implementation, the tone is now further expanded to balance defensive and opposing with an almost equal amount of use of humorous language. Once again, the 3rd quarter seemed to focus on peer-to-peer conversation but now with a noticeable reduction in new questions and a greater flow of conversation. Finally, the 4th quarter of the conversation is themed around implementation with a small amount of QI conversation, most comments are peer to peer and there is an almost equal balance between opposing and supportive language.

5.6.2 Case Study 2

As seen in Table 66 below, most comments within the conversation were either questions to the moderator (n=30) or peer-to-peer replies (n=30), closely followed by moderator to participant replies (n=23) and stand-alone participant statements (n=20). The tone of conversation was mainly neutral (n=80) with the next highest coded tone being supportive (n=24). Most of the conversation was focused on assessment and treatment (n=61). Emoji's' were used in one of the analysed comments.

Table 66 - Conversational analysis of case study 2

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
5	9	30	23	30	4	4	20	81	14	4	25	2	1	61	6	1

As see in appendix 22, like case study 1, case study 2 also seemed to move from initial questioning of the moderator with neutral language around assessment and treatment, towards a more peer-to-peer conversation with the introduction of some opposing / defensive language and supportive comments, now with the introduction of implementation coded comments. In a slightly different pattern to case study 1 however, case study 2 then moved in quarter three of the conversation back to an exchange between moderator and participant with a neutral tone and assessment / treatment themed conversation. Quarter four of the conversation then seemed to feature a large amount of stand-alone participant comments with some distributed conversation and a strong presence of supportive tone among predominantly neutral language.

5.6.3 Case Study 3

As seen in Table 67 below, most comments were stand-alone participant statements (n=39).   The tone of conversation was mainly neutral (n=95) with the next highest coded tone being supportive (n=19). Most of the conversation was focussed on assessment and treatment (n=51). Emojis' were used in six of the analysed comments.

Table 67 - Conversational analysis of case study 3

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
7	6	23	24	23	16	1	39	95	13	9	19	4	6	51	27	1

As seen in appendix 23, like case study 1 and 2, case study 3 also started with questioning of the moderator and a neutral tone. However, the conversation seemed to move more quickly into implementation and peer-to-peer conversation than the previously two studies. As before the conversation started to introduce other language. This included defensive and opposing and occasionally supportive comments. Once again, as seen in case study 2, the conversation then seemed to have a strong presence of stand-alone participant comments with a distributed peer-to-peer and participant to moderator conversation. As the conversation then entered the final phases the interactions became predominately peer-to-peer with a variation of tone and an almost equal divide between implementation conversation and assessment and treatment comments.

5.6.4 Case Study 4

As seen in Table 68 below, the greatest number of comments were peer-to-peer replies (n=34). The tone of the conversation was mainly neutral (n=51) with the next highest coded tone being supportive (n=19). The conversation had an almost equal focus between assessment and treatment (n=32) and implementation (n=20). Emoji's' were used in three of the analysed comments.

Table 68 - Conversational analysis of case study 4

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
6	6	5	11	34	6	2	15	51	3	9	18	1	3	32	20	4

As seen in appendix 24, in contrast to the previous 3 studies, case study 4 started with less questioning of the moderator. Although like previous studies the initial tone was predominantly neutral and focused on assessment and treatment. An early introduction to implementation conversation was seen as was in case study 3, however in this study there was also an early introduction to QI conversation. Once again in the 2nd quarter of conversation the language started to introduce a supportive tone as seen in previous studies and a clear pattern of stand-alone participant comments secondary to a prominent peer-to-peer conversation. Towards the end of the conversation there was a presence of opposing comments in keeping with a move away from assessment and treatment and back to implementation conversation.

5.7 Synthesis of analytical results

"Learning how things are interconnected is often more useful than learning about the pieces" (Fraser and Greenhalgh, 2001, p. 799).

This section will synthesis and summarise the results within the analytical process. To achieve this synthesis this section is divided into the following sub-sections.

5.7.1 A synthesis of content analysis
5.7.2 A synthesis of thematic analysis
5.7.3 A synthesis of computer mediated discourse analysis

5.7.1 Synthesis of content analysis

In total a combined corpus of 65,454 words were analysed:

- Interviews (31890)
- Reflections (16564)
- Case studies (14670)
- Questionnaires (2330)

A synthesis of the top 50 words used across the three phases with a cross comparison of the top 25 words can be seen in Table 69 below.

Those words present across two of the 'top 25 lists' have been highlighted blue, and those across all three or four have been highlighted red, to allow for patterns of consistency to emerge.

Table 69 - Breakdown of content analysis synthesis

Rank	Interviews	Word Count	Reflections	Word Count	Case Studies	Word Count	Questionnaires	Word Count	Combined Overall Corpus	Word Count
1	think	393	patient	295	patient	112	Case	22	patient	598
2	head	228	injury	115	head	80	Interesting	22	think	456
3	injury	224	head	101	injury	72	Studies	22	Injury (s)	430
4	patient	177	hospital	53	think	47	Injuries	19	head	426
5	really	115	management	53	ED	44	Paramedic	19	trauma	168
6	people	113	care	45	needs	44	Different	18	care	147
7	yeah	110	decision	43	assessment	41	Head	17	hospital	140
8	trauma	102	due	40	CT	34	Practice	16	Assessment	135
9	going	94	trauma	39	airway	33	Management	15	People	135
10	quite	92	tbi	35	BP	32	Patient	14	Really	132
11	lot	90	assessment	34	case	32	Contribute	12	Paramedic (s)	129
12	bit	86	incident	33	wound	32	Knowledge	12	Management	128
13	probably	86	appropriate	29	Fall (s)	31	Clinical	11	Going	126
14	paramedics	78	reflection	29	going	31	Gained	11	Work(ing)	124
15	work	76	arrival	28	clopidogrel	30	Learn	11	Yeah	113
16	care	74	GCS	28	Pt	30	Clinicians	9	Probably	104
17	something	69	ambulance	26	MTC	29	Feel	9	Lot	102
18	things	67	working	26	agree	28	Allows	8	Bit	98
19	gonna	66	guidelines	25	etc	26	Others	8	Quite	95
20	hospital	57	scene	25	hospital	26	Research	8	Something	92
21	Ambulance	54	following	24	concerns	25	View	8	Guidelines	86
22	give	54	required	24	trauma	25	Work	8	Things	85
23	assessment	53	airway	23	based	24	Approach	7	Ambulance	84
24	used	53	consent	23	history	24	Assessment	7	Case	81
25	guidelines	52	feel	23	study	24	Care	7	Study (ies)	78

Table 69 has highlighted a comparable content across at least three forms of discourse pertaining to the overall subject matter **'Head'**, **'Injury'** and a focus on the **'patient'**, **'hospital'**, **'trauma'** and **'assessment and care'**. There is also a noted association across two of the forms of discourse (interview and reflections) highlighted through the term's **'care'**, **'ambulance'** and **'guidelines'**. There was also one other common term used across two forms of discourse, however this association was between the interview corpus and the case study corpus, and this term was **'think'**. Moreover, the remaining form of discourse, the reflections, had a similar, however opposing term featuring in the 'top 25' and this was the word **'feel'**. Similarity between the questionnaire corpus was also seen with the case study corpus in relation to the subject matter terms of '**case**' and '**study**' but also with the questionnaire corpus and the interview corpus via the term '**paramedics**' and the questionnaire and the reflection corpus via the term '**management**'. Of the previously discussed 16 correlating terms, 14 of these can be seen in table 70 as featuring in the top 25 of the overall combined corpora, six of which strongly related to the overall research subject matter **'head'**, **'injury'**, **'trauma'**, **'patient'**, '**Case**' and '**Study**', and the remaining are related to decision making, EBP and clinical care. On review of the combined overall corpus figures there are 9 terms which feature in the top '25' but are absent from the single corpus lists; these terms appear to be conversational and non-theme specific.

On analysis of the top 25 words within the combined research corpus, it is evident that each of the words in the top 25 are $\leq 1\%$ of the total word count, so despite initially showing as a high frequency of occurrence, the % is suggestive of an overall breadth of vocabulary throughout the corpus. Moreover, each of the words in the top 25 of the combined reflection corpora are also $\leq 2\%$ of the total wordcount and each of the top 25 within the case study corpus are $\leq 1\%$, therefore demonstrating a similar breadth of vocabulary across each of the three discourses and the overall combined corpus.

Removing stop-words from the vocabulary analysis of each phase allowed for the identification of focus on either self or others. This analysis identified a significant focus on the participant throughout the semi-structured interview process and a significant focus on the patient throughout the written reflective process. Generally, vocabulary analysis of the case studies revealed a patient focus, and the post case study questionnaires revealed a focus on ‘self’. However further analysis of the questionnaires showed that the contrast between the focus within both questions highlighted a change in the realised benefits of taking part in more senior staff. The reasons for taking part were very much focused on ‘others’, however on reflection they declared ‘personal gains’ not previously given as reasons for taking part.

A synthesis of the clinical content has then been performed and can be seen in Table 70 below. However, this synthesis has not included the questionnaire corpus given its non-clinical focus.

Those words present across two of the ‘top 25 lists’ have been highlighted blue, and those across all three have been highlighted red, to allow for patterns of consistency to emerge.

Table 70 - Breakdown of clinical content analysis synthesis

Rank	Interviews	word count	Reflections	word count	Case Studies	word count	Combined Corpus	word count
1	**Head**	228	**Injury (inc injuries)**	115	**Head**	80	**Head**	409
2	**Injury (injuries)**	224	**Head**	101	**Injury (injuries)**	72	**Injury (injuries)**	411
3	**Trauma (Traumatic)**	102	**Hospital**	53	**CT**	34	**Hospital**	136
4	**Hospital**	57	**GCS (Glasgow-coma)**	36	**Airway**	33	**Trauma (Traumatic)**	133
5	Critical	40	**Blood (inc bleed, bleeds, bleeding)**	35	Wound	32	**Bleed (s) (Bleeding, blood)**	90
6	Ultrasound	39	TBI	35	BP	32	**GCS**	75
7	**Collar (s)**	36	**Intoxicated (inc intoxication)**	25	**Fall (s)**	31	**CT**	70
8	**Blood (Bleed(s)**	35	**Airway**	23	Clopidogrel	30	**NICE**	65
9	**NICE**	34	**CT**	18	MTC	29	**Intoxicated (alcohol, EtOH)**	63
10	**HEMS**	30	Pain	18	**Alcohol (EtOH)**	28	**Airway**	63
11	Pressure	30	**Scan (inc Scans)**	18	**Hospital**	26	**Fallen (fall,falls)**	60
12	**GCS**	27	**HEMS**	16	**Trauma**	25	**Collar (s)**	55
13	**Brain**	26	**Brain**	13	Face (facial)	24	**HEMS**	46
14	**Scanner (scanned, scan)**	26	**Collar**	13	**NICE**	20	**Brain**	45
15	JRCALC	23	ED	13	**Bleed (bleeding, blood)**	20	TBI	42
16	**Fallen (fall)**	19	History	13	Neuro	19	Pressure	42
17	**CT**	18	Ear	12	Signs	18	Neuro (Neurological, neurology)	41
18	ICP	16	Pressure	12	Obs	17	Critical	40
19	Old (older)	16	Immobilisation (inc immobilised, immobilise)	12	**RSI**	17	BP	40
20	Sedation (sedate)	16	MTC	11	**Scan**	16	Ultrasound	39
21	Vomiting (vomited)	15	**NICE**	11	Monitor (monitoring)	15	MTC	39
22	Elderly	14	Signs	10	Headache	14	RSI (RSIs)	33
23	Stroke	12	**Fall (inc fallen)**	10	Chest	13	Wound	33
24	**RSI (RSIs)**	12	Pupils (inc pupillary)	10	ECG	13	Pain	30
25	Mannitol	11	Neurosurgery (neurosurgical)	10	Symptoms	13	**Scanner (scanned, Scan)**	30

As can be seen from Table 70 the overall combined corpus featured eight terms in the top 25 terms, which also featured in all three of the individual phase corpus; these being '**Head**', '**Injury**', '**Hospital**', '**Bleed**' or alternative terms, '**CT**', '**NICE**', '**Fallen**' or alternative terms and '**Scanner**' or alternative term. This revealed a common discussion of potential significance in these areas.

There were also terms featuring in two of the phase corpora top 25 which were also significant in their frequency to feature in the overall combined top 25 terms, and these were '**Trauma**', '**GCS**', '**Intoxicated**' or alternative term, '**Airway**', '**Collar**', '**HEMS**', '**Brain**' and '**RSI**'.

Of the remaining 32 terms featuring once in the phase corpora, nine of these were also present in the overall combined corpus due to frequency, these were, '**TBI**', '**Pressure**', '**Neuro**' and alternative terms, '**Critical**', '**BP**', '**Ultrasound**', '**MTC**', '**Wound**' and '**Pain**'.

The analysis of vocabulary across the phases has also highlighted a focus on 'familiarity' within the language used by participants. This familiarity can be found in the use of colloquial terms or 'sayings', humour, abbreviations, or acronyms and emoji's. The interviews demonstrated colloquial language such as '**Okay**', '**Oh**', '**Bits n Bobs**' '**he's**', '**gut**' (referring to gut feeling) and '**etc.**'. However, there was also evidence of 'sayings' presence within clinical practice such as the unique term '**play**' related to the greater term of 'stay and play', referring to the decision to stay on scene and treat the patient (treatment being referred to as 'play'), or to go to hospital which is also colloquially referred to as 'load and go' (Navarro, 2020). These are terms which the researcher has seen to be used less frequently in practice as the profession has become more graduate based. On comparison to clinical grade and educational background, this colloquial language does not appear to have an identifiable link or pattern, although it is noted that the number of participants is small and so a larger study would be needed to further analyse the significance of this. However other saying or phrases to which I am familiar with as a paramedic were also evident in the case study analysis such as 'end of the bed' or 'patient triangle', terms that may not be used of known outside of the profession.

Across the various phases there were multiple use of abbreviations or acronyms, such as **CPD**, **ICH**, **MTC**, **ED**, **TU**, **TBI**, **GCS**, **CT**, **NICE**, **ICP**, **IV**, **BP**, **CCP**, **ABC**, **ITU**, **RSI**, **JRCALC**, **TXA**, **Sats**, **Pt**, **NQP**, **Et0H**, **Pp**, **Obs**, **Hr**, **BVM**, **Hx**, **Etc02**, **iGel**, **PRN**, **SP02**, **PMH**, **GP**, **POC**, **AMTS**, **PGD**, **HEMS**, **A&E**, **NPA**, **UTI**, **JVP**, **KO**, **LOC**, **BM**, **OTC**, **DHx**, **ADL's**, **FAST**, **KVO**, **ACF**, **ASHICE**, **HOTT**, **OP**, **CVE**, **F1**, **NOAC** and **DOAC**. Most of the time this use of abbreviations, acronyms or 'sayings' did not cause any issues with conversation flow as many of these were recognised by participants, or the paramedic researcher, as regularly used abbreviations in clinical practice, there were however times where abbreviations caused either confusion, needed clarifying, or caused a debate regarding the appropriateness of their use. There were two debates within the case studies among peers where the use of abbreviations was challenged among participants. One debate focused on abbreviations for medication such as DOAC and NOAC and the possible danger associated with the wider use of abbreviations not known by others. While the other debate was regarding a more junior member of staff not understanding a regularly used abbreviation in general conversation. The change in structure of phase 3 compared to previously phases allowed for peer-to-peer discussion and with this came more evident use of humour within language structure including the additional familiarity indicated through the use of emoji's.

Direct comparison across the three phases of reference sources, or sources of influence, has been difficult given the various structures and types of corpora. However, emerging as a potential pattern of reoccurrence is the use of NICE and JRCALC, either in conversation or in citation and reference lists. Participants are also referring to evidence in the forms of, articles, webpages, peer-to-peer support (including senior clinicians), decision making tools, proforma, protocols, local guidelines, Twitter, blogs, conferences, university studies, textbooks and online CPD activities. Not all sources are discussed in favourable terms however, there are also conversations of how guidelines can often contradict each other, or not be focused on areas of patient care or cohorts of patients necessary and how they are not always updated frequently enough or are not considered the best source of reference for various reasons such as negatives perceptions regards the reasons or processes used in their creation. Overall, however there would seem to be a supported place by staff for the use of guidelines, especially when easy to access, and pathways when created in partnership with staff, trialled appropriately and considering patient, staff and service needs.

5.7.2 Synthesis of thematic analysis

The initial three sub sections (5.7.2.1, 5.7.2.2 and 5.7.2.3) will now consider a synthesis of each of the previously considered areas of focus. These three areas were, 'assessment and treatment', 'EBP implementation decision making' and 'quality improvement'. Finally sub section 5.7.2.4 will consolidate the themes emerging on the opinions of participants relating to the suggested implementation of ONSD Ultrasound and the use of the ResQgard.

A synthesis of thematically quantitative data from each phase, found in sections have allowed for a comparison across the phases as seen in Table 71. As seen from the table, the case study phase had many more codes identified within the data, in comparison to the other two phases. The case study phase produced one code on average within every 15 words, as opposed to 1 in 87 or 1 in 99 words in the other phases, thus suggesting that this type of activity may be more productive in engaging participants in reflective activity pertaining to patient interaction. However, when further analysed, the case studies had the fewest QI coded data in terms of numbers and percentage, with the other two phases having a similar share of the QI codes in terms of percentage. The case studies also had significantly less EBP Implementation data in terms of percentage, compared to the other two phases and as a result most of the conversation within the case studies was focused on the detail of assessment and management. Once again, the interviews and reflections had a similar share of the EBP Implementation codes in terms of percentage. Thus, although the case studies produced more coded data per word count, as the majority were focused on assessment and treatment, the benefit of each type of activity in terms of research and to the participant would appear to differ dependent on the focus of discussion desired.
Findings from interview analysis have also indicated a potential need for longer interview times to allow for in depth conversation to allow for QI discussion or idea generation.

Table 71 - Synthesis of thematically quantitative data across the phases

	Assessment and Treatment		EBP Implementation Decision Making		Quality Improvement		Total themes coded	Ave code per word count
	(n)	(%)	(n)	(%)	(n)	(%)		
Interviews	149	41	155	42	62	17	**366**	**1/87**
Written Reflections	60	36	80	48	26	16	**166**	**1/99**
Case Studies	515	82	100	16	14	2	**952**	**1/15**
	724		335		102			

5.7.2.1 A synthesis of Assessment and Treatment Themes

All three phases showed a similar pattern to the emergence of categories relating to assessment and treatment. These categories aligned to one of several medical or trauma assessment modules, as seen in section 5.5.3.1 and further explored in section 6.3 and 6.8.2. Table 72 below has been used to compare the emergent themes from each phase to highlight any further reoccurring themes of significance. Any themes occurring over two phases are coloured **BLUE** and any themes occurring over all three phases are coloured **RED**, these RED themes are then summarised in a mind map in Figure 45 below.

Table 72 - Synthesis of Assessment and Treatment Thematic Analysis

Interview Sub Themes	Written Reflection Sub Themes	Case Study Sub Themes
	Initial Assessment / Cue Acquisition (Higher Theme)	
• Mechanism and kinematics of injury • Head injury in older adult (delayed) • Head injury in pediatrics. • Intoxicated Patients • Associated medical event. • Multi-system trauma assessment • Primary and secondary Survey	• Delayed presentation of head injury (older adult) • Intoxicated patient • Patient Assessment Triangle	• Mechanism • Intoxicated • Previous neurological medical or trauma history • Recreational drug use • CABC full trauma assessment • CRANE Assessment • Associated medical event or illness recently. • Social focused history – coping with ADL's and POC needs. • Mental capacity and consent • Patient assessment triangle (also end of the bed assessment) • Multi-system trauma assessment • Delayed / slow subdural bleed in older adult
	Airway (Higher Themes)	
• RSI	• NPA • RSI • Tri Airway Maneuver • Assistance with BVM • I-gel	• Suction • Jaw thrust. • OP airway • Tri Airway Manoeuvre • Nasal specs

		• NPA (? X2) • I-gel • Intubation • RSI (3,2,1 and palm technique) • Assisted with BVM (possibly hyperventilate) • Targeted ETC02 (normalise or just below)
Breathing (Higher Themes)		
• Oxygen Therapy and targeted SPO2 • Rhinorrhea • Ventilation and hypoxia	• Oxygen Therapy	• Auscultation and percussion (full chest and respiratory exam) • High flow (100%) 02 • Facial Injuries including epistaxis, otorrhea, rhinorrhoea, septal haematoma, • Cyanosis (hypoxia)
Circulation (Higher Theme)		
• IV Access • Permissive hypotension and target Blood pressure • Bradycardia • Catastrophic Haemorrhage • Cerebral T-Waves on ECG	• IV Access for drug therapy • Target Blood Pressure	• New chest pain • Cardiac auscultation • JVP • Oedema • Conjunctiva pallor • Claudication • Finger clubbing • Management of Malignant hypertension • Catastrophic Haemorrhage • Cerebral T-Waves on ECG • IV Access for drug therapy
Disability (Higher Theme)		
• GCS • Vomiting as a neuro red flag • Cognition and behaviour, including amnesia and confusion. • Cranial nerve assessment including a focus on pupil assessment, double vision, and vertigo. • FAST test • AMTS (Abbreviated mental test score) • Cushing's Triad	• GCS • Combative patient • Raised ICP signs / Cushing's Triad • Seizure	• Signs of KO / LOC • Amnesia and confusion and memory of event, including orientation. • Seizure • Cranial nerve assessment including pupils, vision, and nystagmus, vertigo / balance / Romberg's / ataxia. • Headache • Base of skull fracture signs • FAST test

• Ataxic • Lethargy • Prevent secondary brain injury and 'neuro protection'. • External head injuries and skull fractures		• Speech assessment including slurred or slow speech, dysarthria. • Nausea and Vomiting • MSk assessment including limb assessment for strength, tone, and sensation, heel to toe test and back pain. Also, intention tremor, and gait assessment. • Abbreviated mental test, behaviour, and mannerisms. • Dysdiadokokinesia • ONSD ultrasound • Cushing's Triad • GCS
Evacuation or Exposure / 'Everything else' (Higher Theme)		
• Other injuries, including distracting injuries. • Pain • Clothes off • Cervical Collar and cervical injury • 30 degrees head up positioning. • Handover and pre-alert • Wellbeing assessment	• Immobilisation • Cervical collar • 30 degrees head up positioning	• Passing urine assessment. Signs of UTI / kidney pain (inc urinalysis) • Risk of AKI • Pain • Full set of obs • Cardiac arrest preparation • Frailty score • Dental injuries • C-spine and spinal immobilisation, also neck ROM • Change in bowels. • Change in appetite and food / drink intake. • Signs of sepsis • 30 degrees head up positioning. • Pelvic binder • Scoop (skin to scoop) • Clothes off • Vac mattress
Pharmacological history and Management (Higher Theme)		
• IV TXA • IV Hypertonic Solution / Saline (fluids) • Avoid morphine.	• IV Anti-emetics • IV Fluids • IV Morphine	• Pain relief taken or needed. • OTC analgesia advised PRN. • Pre-existing Anti-coagulation / anti-platelets

• IV Paracetamol • Pre-existing coagulation therapy	• IV Paracetamol • IV TXA • Pre-existing Anti-coagulation therapy	• DHx – history of prescribed and OTC meds, inc benzodiazepines • Drugs to allow for intubation / RSI (atropine, midazolam, ketamine, morphine, fentanyl and rocuronium) • IV TXA • IV Fluids (kvo) • Draw up diazepam or midazolam IV and prepare for seizure. • IV Ondansetron to prevent vomiting
Impression (Higher Theme)		
Nil	Nil	• Sepsis secondary to UTI? Primary UTI? • malignant hypertension, • collapse / fall with query cause, • dehydrated, • vascular dementia, • CTBI from old rugby head injuries, Parkinson's, • supra nuclear palsy, • corticobasal degeneration, • posterior CVE, • delirium, • Lewy body dementia, • Encephalopathy. • Cushing's triad

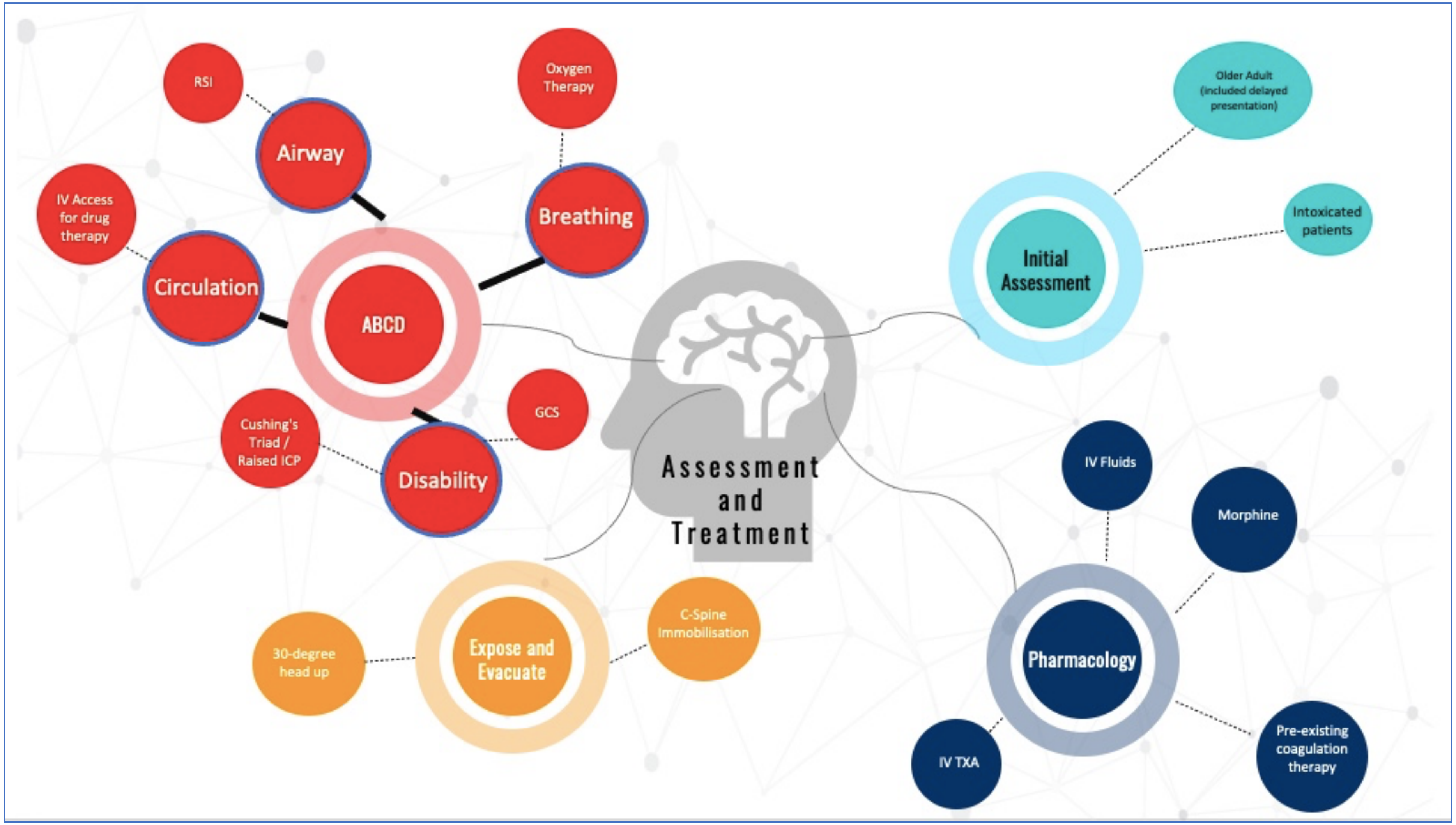

Figure 45 – Synthesis of Assessment and Treatment Mind map

5.7.2.2 A synthesis of EBP Implementation Decision Making Themes

Table 73 below has been used to compare the emergent EBP implementation decision making themes from each phase to highlight any further reoccurring themes of significance. Any themes occurring over two phases are coloured **BLUE** and any themes occurring over all three phases are coloured **RED**, these RED themes are then summarised in a mind map in Figure 46.

Table 73 - Synthesis of EBP Implementation Decision Making Thematic Analysis

Interview Sub Themes	Written Reflection Sub Themes	Case Study Sub Themes
Difficulties in providing evidence base assessment and treatment		
• Difficult to achieve 30 degrees head up positioning. • Don't have equipment necessary for assessment. • Guidelines difficult to read and follow, and not relevant to 'real life' challenges. • Pathway development issues • Unable to follow JRCALC guidance on Midazolam and sedation due to local protocol and training. • Difference in equipment, policies, and skills within different trusts • Conflicting guidelines on head injury management and priorities in multi-system trauma • Limited treatment options • No time for CPD • Too big a gap between MTC's	Nil	• Unable to use NEXUS and Canadian C-Spine rules (guidelines) due to intoxication so cannot clear C-Spine • Debate over whether guidelines on head injury are appropriate in an arguably facial injury not a head injury. • Debate over whether patients on anti-platelets (as opposed to anti-coagulants) should be conveyed for a CT scan. Discussion over interpretation of NICE guidelines and how local guidelines vary from NICE, and why this may be. • Further discussion that even within the same ED, different staff will advise differently regards decision making on CT scans for anti-platelet patients. Difficult to therefore make decisions based on this information. • Difficulty achieving the EBP regards 30-degree head raised in head injury patients when they are immobilised. • Debate regards using the trauma divert protocol and going to a MTC further from the local TU. Or whether

		to take a 'pit stop' at the local TU for intubation and delay time to definitive care (debate over time to MTC and impact on care). • Debate over whether to intubate on scene, with or without a mixture of drugs to assist intubation. Conversation extended to danger of using drugs for this reason at a paramedic skill level. Unable to deliver care needed as unable to RSI as a paramedic. • Unable to manage pain as GCS too low for morphine so again unable to provide necessary level of care as unable to sedate. • Discussion regards lack of options to treat the 'c' in ABC as a non-registered ambulance clinician. • Scope of practice not including all drugs needed for head injury management, including mannitol and hypertonic saline.
Attitudes towards EBP Decision Making		
• Keeping up with peers (comparison of IHCD and Graduate clinicians) • Recognising importance of paramedic colleagues contributing to profession specific research (grateful and thankful) • Perception that head injury management has stagnated where other presentations have moved forward. • Perception that clinicians are forming interests away from trauma. • Negative attitudes towards JRCALC (Fad) • Using trust guidelines but lack of confidence in evidence • Research difficult to access and read.	Nil	• Checking Pupils for the 'Theatre' for the public as not going to provide any meaningful information. • Debate regarding whether ED would or would not scan and how this would be influenced by the grade of the Dr making such a decision – impression that junior doctors would scan, and seniors wouldn't but F1's cannot order anything without permission. • Suggestion that student paramedics want to perform too many investigations which are unwarranted.

• Perception that differing clinical registration's view EBP and decision making differently which may negatively impact team working		• Impression that paramedics can be too quick to make a query sepsis diagnosis based on a possible infection with altered observations. Described as "sepsis mad". • A debate regarding evidence to support high BP's being treated in ED to stabilise or being dealt with more slowly by GP. Pathway related debate. Evidence discussed in terms of articles but also peer discussions with ED and Acute Medical doctors. • Impression that a TU would not be happy or prepared if you 'pit stop' for an RSI in a critical patient. "poo will hit the fan". • Discussion about risk taking in decision making and a perception by some that risk taking is a recognised part of ambulance work.
What guides decision making / Teamwork		
• JRCALC and NICE guidelines • MTC divert tool. • Assessment tools • No dominant EBP source for head injuries • Unsure of guidelines influencing regular decision making • Descriptive and prescriptive decision making influenced by experience and hindered by restrictive nature of some guidance. • Risk associated with discharge on scene or transfer decision making. • Cue acquisition. • Utilising HEMS and other specialist or senior colleagues for additional skills and peer guided decision making. • Red flags • Gut feeling	• Decision making tools such as scores and algorithms. • Major Trauma Center Divert • Guidelines and frameworks (inc NICE and JRCALC in references) • Red Flags • University Teaching into Practice • Assistance from Critical Care Paramedics / HEMS • Regular team members (practiced team) • Referring to other clinicians such as Doctors or Specialists	• JRCALC and NICE guidelines • Discussion regards the avoidance of ED in dementia patients • Discussion regards needing to find a 'sensible' GP who is not overly risk adverse and willing to support a non-conveyance plan. • Discussion around NQP's needing permission to discharge a patient on scene and the governance and process relating to this, including a high standard of patient records to support decision. • Discussion around addressing incorrect decision making of other ambulance clinicians, both junior and

		senior roles. Also, a peer led training opportunity through debrief. • Using senior colleagues (specialist paramedics) for pathway discussions over the phone. • Wanting a senior clinician to divert to the MTC – referred to as a 'grown up' (risks with decision).
Decision making process		
• Moving away from JRCALC • Using social media and virtual platforms for CPD, such as twitter, Facebook, podcasts, YouTube, personal blog, and webinars • Contributing to research as a source of CPD • Usefulness of conferences for CPD • Lack of confidence in 'original' head injury training / teachings • Peer guided, support and recommendations	Nil	Nil
Decision Making Bias		
• Decision making error due to drug names. • Head injury decision making 'rough and ready.' • Decision making fear in head injuries	• Ageist Bias • Overwhelming Environment • Intoxication • Head injury not considered initially. • Multiple trauma – what takes priority. • Unaware of decision-making tools • Not enough shared decision making	• Discussion around the 'danger' of using abbreviations that others may not be aware of, or an expectation to be aware of such abbreviations in certain areas of practice. • Lack of awareness of an arguable well used acronym by peers.
Consent and Capacity		
Nil	• No decision about me, without me • Mental Capacity Act • Consent • Ethics	• Mental Capacity Act • Consent

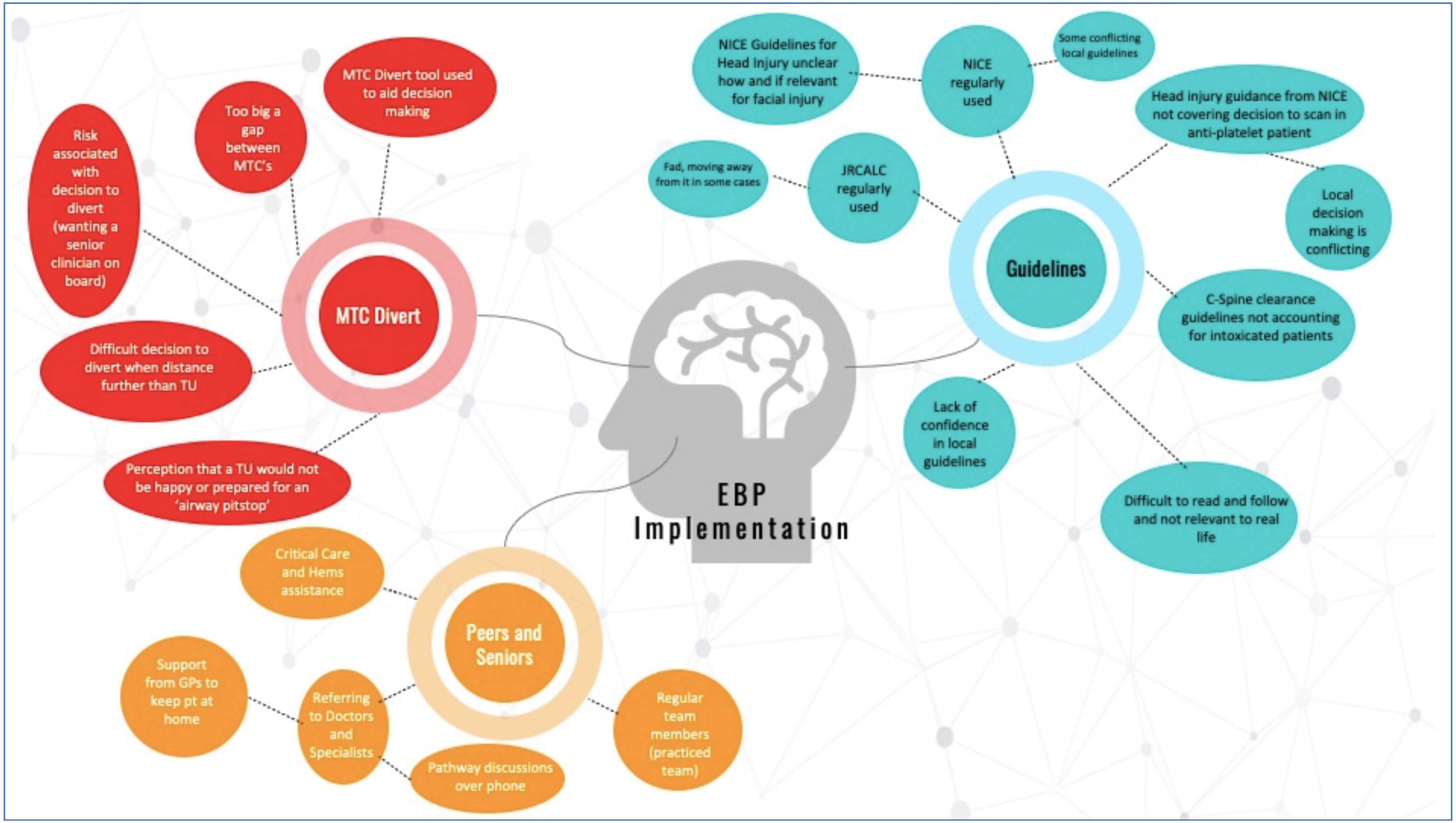

Figure 46 – Synthesis of EBP Implementation Mind Map

5.7.2.3 A synthesis of Quality Improvement Themes

Table 74 below has been used to compare the emergent Quality Improvement themes from each phase to highlight any further reoccurring themes of significance. Any themes occurring over two phases are coloured **BLUE** and any themes occurring over all three phases are coloured **RED**, the Quality Improvement themes to emerge can be seen in Figure 47.

Table 74 - Synthesis of QI Thematic Analysis

Interview Sub Themes	Written Reflection Sub Themes	Case Study Sub Themes
Assessment		
• Introduce pre-hospital CT scans (scanners in vehicles) • Introduce point of care testing, i.e., Near infra-red device to detect surface bleeds and alcohol detection. • Introduce using cerebral fluid imbalances in the brain as an indicator of injury (as within stroke assessment) • Opportunity to introduce screening for dementia (memory / cognition problems) within ambulance service. • Need GCS tool for pediatrics. • Need for 'better' assessment tools for head injuries	Nil	• Assessments in some trusts are unnecessarily overly prescriptive and this is an issue. • There is a need for something to fill the time with a patient on long transfer so repeated observations and unnecessarily extended history taking are sometimes used inappropriately to fill this void. • Need for otoscopes available to paramedics to rule out hemotympanum in head injuries
Treatment		
• Introduce mannitol and hypertonic solution. • Need guidelines to reflect collar guidance. • Allow and support paramedics to use JRCALC guidance on sedation and midazolam	• Enabling the delivery of EBP to achieve advanced clinical care.	• Need drugs and training to assist intubation / RSI and sedate patients. • Need mannitol and hypertonic saline to manage head injuries
Decision Making Tools / Pathways		
• Need for specific head injury pathways to bypass the emergency department. • JRCALC needs updating more frequently as becomes out of date with other guidance between versions.	• Easy access to relevant guidelines and decision-making tools • Benefits of regular team members	• The separation between community care and hospitals is suboptimal therefore leading to admission to the ward post ED unnecessarily. A need

• Work with MTC's to understand how many patients are not being taken to an MTC due to distance but would benefit from this and work on joint solutions. • Straight to CT Scan pathway • Need for guidelines to be clearly written or organised. • Major trauma tools need to be older adult sensitive. • Smart devices on scene to help with quick reference to guidelines. • Quick reference pages such as in JRCALC aid quick reference – need easy access		for better pathways out of ED and back into the community. • Some calls may reach a paramedic which should have been redirected by call handers and dispatchers. • Prescriptive proforma's have a negative impact on patient care. • Requests for a specialist paramedic should be discussed with the SP by the referring paramedic and not agreed via a call handler, to ensure decision making is correct.
	CPD / Education	
• Need for more support, time, and space for CPD within work time. • Imbed subconscious decision making in university education. • Encourage and support greater joint training between HEMS and non-critical care paramedics. • Integrate diagnostic reasoning into degree teaching. • Lack of feedback or follow up on patient for CPD. • Improve head injury focus within education to increase sensitivity of detection	• Ability to follow up patient outcomes for learning. • Learning from incident reporting • Forum to disseminate learning.	• We need to be more robust in challenging student decision making.
	Research	
• Pathways need to be developed by clinicians and piloted before official launch. • Need for more paramedic profession specific research	Nil	• Need more research on the best approach for airway management in head injury patients – should we use nasal intubation in head injury patients?

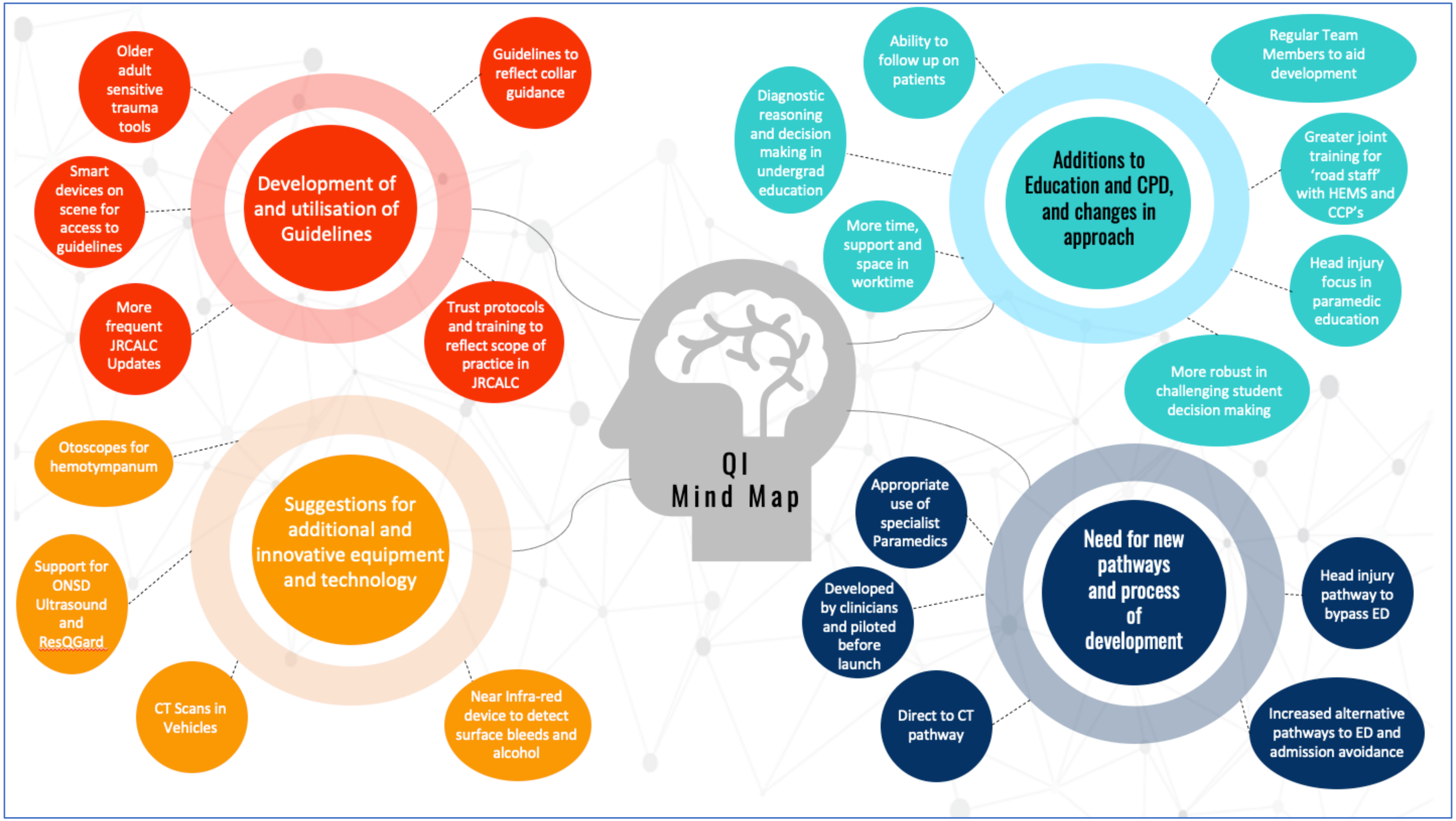

Figure 47 - Synthesis of Quality Improvement Mind Map

5.7.2.4 Synthesis of opinions on suggested implementations

Six higher themes emerged from analysis of opinions relating to the implementation of ONSD Ultrasound and a further seven themes emerged from the suggested implementation of the ResQgard. These higher themes can be seen in Table 75 below.

Table 75 - Synthesis of opinions on suggested implementations

ONSD Ultrasound Implementation Suggestion	ResQgard Implementation Suggestion
Potential impact in patient cohort	Potential impact in patient cohort
Training in the skill	Easy to use and train in use
Deskilling from the skill	No or little options currently available for head injuries
Implementation in practice (challenges)	Difficult to use in patient cohort
Changing patient pathway	Need for larger package of care and pathway
Multiple uses and expansion of current use	Criteria for use
	Concerns regards cost

These themes are further explored in section 6.7 leading to the creation of implementation cascade of considerations in section 6.7.2.

5.7.3 Synthesis of computer mediated discourse analysis

In comparison there were some variations across the case studies, however, overall, there appeared to be identifiable phases in the movement of the conversations. These phases would appear to start with neutral questioning of the moderator and appropriate replies focused on assessment and treatment conversation. The conversations them seemed to move more towards a peer-to-peer conversation and a change in language to include both opposing / defensive and supportive language. The conversations also then seemed to move into implementation with occasional QI comments and a presence of stand-alone comments from participants. The similarity in pattern and focus of conversation across all four case studies is also reflected in Table 76 below where the quantitative data can be directly compared.

Table 76 - Conversational analysis compared across case studies.

Case Study	Question			Answer / Reply			Statement		Language						Theme		
	Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
1	6	8	24	21	40	20	1	12	49	24	7	35	16	6	46	34	7
2	5	9	30	23	30	4	4	20	81	14	4	25	2	1	61	6	1
3	7	6	23	24	23	16	1	39	95	13	9	19	4	6	51	27	1
4	6	6	5	11	34	6	2	15	51	3	9	18	1	3	32	20	4

5.8 Chapter Summary and Transition

This chapter has outlined the analytical framework used in the research, focusing on the integration of Mediated Discourse Analysis (MDA), content analysis, and computer-mediated discourse analysis (CMDA). The chapter began by introducing the aims and objectives of the research, followed by a comprehensive explanation of the methods and questions that guided the data analysis.

The analytical framework was structured around the six central concepts of MDA, providing a robust approach to understanding the complex social actions and interactions involved in the assessment and management of head injury patients by paramedics. This chapter discussed the importance of engaging the nexus, navigating the nexus, and changing the nexus, and how these steps were related to the research.

Content analysis and CMDA were utilised to explore the vocabulary, categories, themes, and relationships within the data. The results from the analysis of the interviews, written reflections, case studies, and post-case study questionnaires were synthesised to provide a holistic understanding of paramedic practice. The chapter also included a detailed discussion of the conversational analysis of the case studies, revealing patterns and phases in the development of peer-to-peer discussions.

The synthesis of analytical results demonstrated a correlation between lower word count and higher vocabulary density, suggesting that higher word count within reflective activities produces more complex texts with increased numbers of unique words. The results also highlighted the importance of structured reflective models in enhancing the criticality of reflective writing and the relationship between reflective models and references.

Overall, this chapter has provided a comprehensive analysis of the data, offering valuable insights into the assessment and management of head injury patients by paramedics. These analytical results inform the findings presented in the next chapter, contributing to the understanding of clinical decision-making, reflective practice, and quality improvement in paramedic practice.

5.9 Transition to findings and Changing the nexus.

"What action can I take, as a participant-analyst in this nexus of practice, that will transform discourses into actions and actions into new discourses and practices?" (Scollon and Scollon, 2004a, p. 173)

The final part of nexus analysis involves changing the nexus, which will be addressed in the following chapters. Chapter 6 will present the findings related to current practices, decision-making processes, and engagement with reflective discourse among paramedics. These findings will provide a detailed exploration of how paramedics assess and manage head injury patients, and how reflective practice influences their clinical decisions.

Chapter 7 will build on these findings, interpreting them to offer insights into quality improvement and implementation science. This chapter will discuss contributions to knowledge, implications for practice, and strategies for changing the nexus. By transforming discourses into actions and actions into new discourses and practices, the research aims to enhance paramedic practice and improve patient outcomes.

Together, these chapter will provide a comprehensive understanding of how reflective practice can contribute to quality improvement and implementation science in paramedic science, ultimately leading to meaningful changes in clinical practice.

Chapter 6 – Findings

6.1 Introduction

This chapter presents the findings of the research, addressing the research question;

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

This chapter is structured around the four research aims:

1. Establish **What** treatment and assessment paramedics are currently providing in the management of head injury patients.
2. Understand **Why** paramedics are making the decision they are, in relation to the assessment and management of head injury patients.
3. Understand **How** paramedics are engaging with reflective practices and how this relates to their decision making.
4. Establish if reflective practice can contribute to healthcare quality improvement and implementation science **(QI)**.

To explore these themes, the researcher utilised the Mediated Discourse Analysis (MDA) guided analytical approach and MDA six Central Concepts, as can be in Figure 48 below. These themes will then be discussed in relation to the existing literature within chapter 7.

Each section will present the findings related to these aims, providing a comprehensive overview of the current practices, decision-making processes, reflective practices, and contributions to QI. This chapter builds on the analysis presented in Chapter 5, where the data was navigated using content analysis and computer mediated discourse analysis.

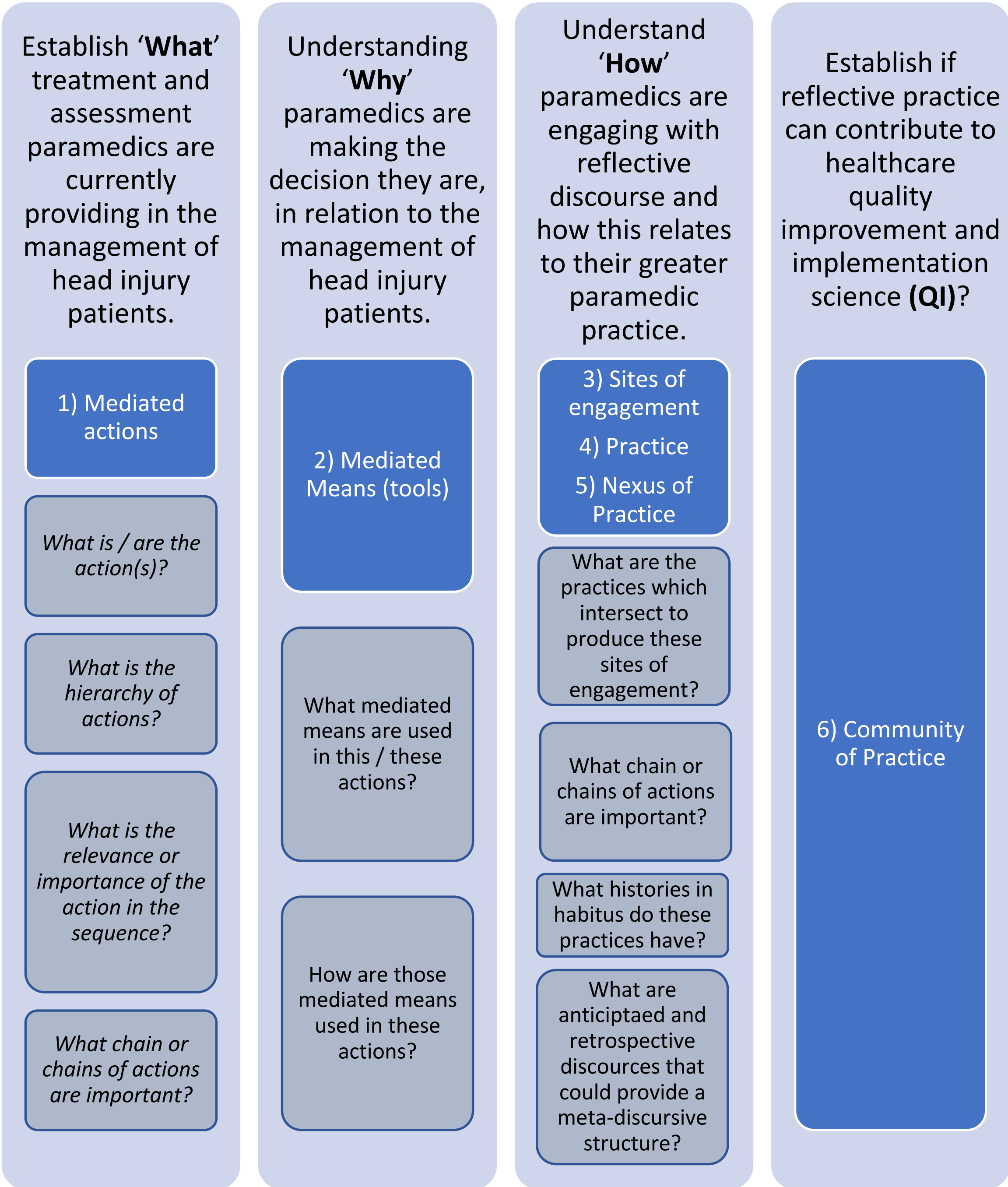

Figure 48 - Blended Nexus Analysis and the Six Central Concepts of MDA guiding the analytical approach to achieving the research aims.

6.2 Establish 'What' treatment and assessment paramedics are currently providing in the management of head injury patients?

The clinical practice under focus within this PhD research was '***the assessment and management of head injury patients by paramedics in the pre-hospital setting***'.

To understand the 'practice' it is necessary to understand the chains of actions which form this practice and the individual actions which make these chains.

MDA recognises that within a chain of action there are lower and higher level mediated actions, thus creating a potential hierarchy of steps within such chains which may be utilised within the analytical frameworks or methodologies (Scollon, 2001a).

As demonstrated in the pre-data navigation of the nexus in chapter 2, to achieve this in clinical practice, the paramedic would need to make a series of clinical decisions, enabled through education and CPD, then reflect on those decisions both during and post the event, participate in audit or clinical trials where appropriate and contribute to best practice through feedback and debrief mechanisms where available (**mediated actions**) using clinical guidelines, protocols, reflective tools, and professional conversations (**mediational means**).

The MDA guided analytical approach involves four questions which can be applied to support the discussion of mediated actions from the research data:

1. *What is / are the action(s)?*
2. *What is the hierarchy of actions?*
3. *What is the relevance or importance of the action in the sequence?*
4. *What chain or chains of actions are important?*

Within this finding chapter the researcher has identified the actions, chains of actions, and hierarchy of actions to allow for discussion of relevance and importance of these actions and chains within the discussion chapter.

6.2.1 What are the actions?

Analysis of the data in Chapter 5 revealed several specific areas of focus regarding ‘actions’ in the treatment of head injury patients, these can be seen in Figure 53 and are supported in the findings below. These were:

- C-Spine collars, immobilisation and the wider contribution to discussions pertaining to management of ICP and positioning of patients at 30 degrees head up / semi recumbent.
- Intoxicated patients and the difficulties pertaining to this.
- Oxygen therapy and Airway management, including various approaches with airways adjuncts up to and including discussions around sedation and RSI.
- Managing head injuries in the older adult.
- Discussions around the need for a CT, in particular the contribution to this decision of risk associated with Anti-coagulation or anti-platelet treatment.
- The use of pharmacological interventions in head injury patients, specifically IV fluids, IV TXA, Mannitol and Hypertonic Saline.
- The use of GCS scoring in head injury patients.

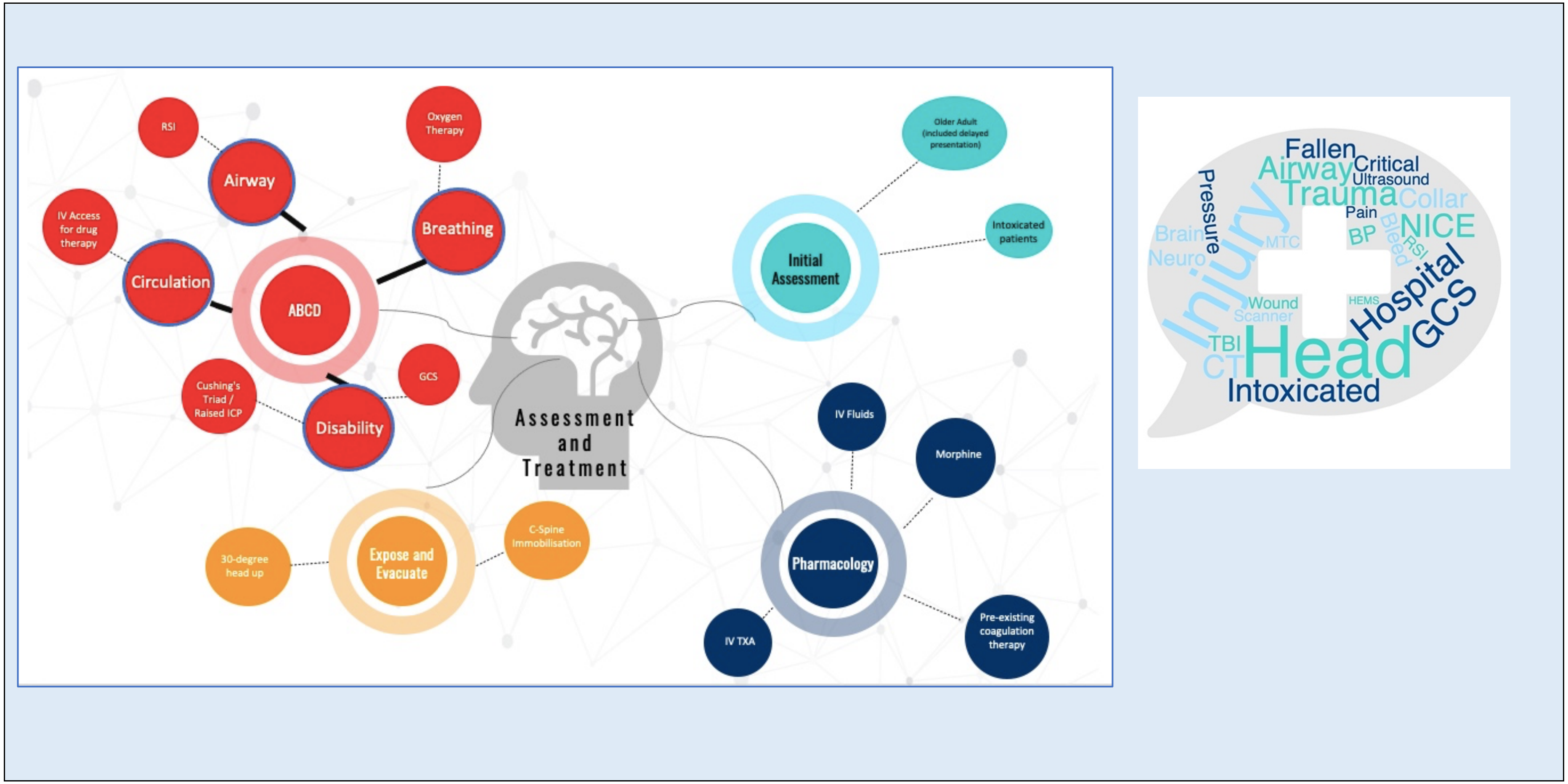

Figure 49 – What are the actions of importance specific to patient contact when assessing and treating head injury patients in pre-hospital car

6.2.2 C-Spine collars, Immobilisation and Positioning in the Head Injury Patient

Participants discussed the awareness of the need to reduce the use of cervical collars due to an increase in ICP and the suggested evidence that they are not as effective in c-spine immobilisation as previously thought. Quotes from participants highlight the challenges and considerations in using collars.

"So, if you think about head trauma, you need to think about C spine issues. You probably need to immobilise the patient. Of course, the cervical collar now, it's quite questionable because any will compress the jugular veins, so increase the intracranial pressure, so it will be also a no. But again, it all depends. If I think that the C spine isn't stable and the patient's unconscious, probably I can eventually immobilise. But again, if we have Cushing triad, probably I won't because I'll increase the ICP." (Interview Participant 1)

Quote 1

"Initially he was GCS 15 and lucid, however very quickly he became confused and agitated. Shortly after this, he started to try and sit up, shouting and swearing, trying to rip his collar off and subsequently vomited. He then settled down and dropped his GCS to 7". (Reflection Participant 8)

Quote 2

"Cervical collar application was omitted due to the concern for developing raised intracranial pressure, in this patient with a suspected head injury." (Reflection Participant 3)

Quote 3

"The patient was becoming combative, trying to remove the o2 mask and sitting up on the board. I decided not to collar him as I was concerned, I could become unable to maintain and that it would agitate the patient out further. This decision is supported by guideline CG31". (Reflection Participant 1)

Quote 4

"On our way to hospital, he lost consciousness on two occasions, and I had to remove his collar and manually immobilise him to keep him still as when he was lucid, he was trying to remove his collar." (Reflection Participant 8)

Quote 5

"They're uncomfortable and they're horrible and they're scary and I think somebody with a GCS of 14, if you release the collar, I think everyone just calms down a bit and it shows that reassurance. I'm a big believer in that. It must be scary. I'm a big believer in releasing the collar, it gives them the impression that things are not as bad". (Interview Participant 11)

Quote 6

"On securing C-spine, I would ensure that the collar isn't too tight due to the compression on the jugular veins." (Case Study Participant 78 – Case Study 4)

Quote 7

"On arrival at Hospital, the patient had improved to GCS10. We were met in RESUS by a full trauma team……. The Team Leader then questioned me as to why the patient was not fully immobilised, I explained that I had felt that the collar would make the patient more agitated and harder to manage and the right-hand head block had fallen off as we arrived." (Reflection Participant 1)

Quote 8

"I think we as the ambulance service are five to ten years ahead of the curve on a lot of these issues compared to A&Es." (Interview Participant 3)

Quote 9

"A Cervical collar was applied, alongside Head-blocks and tape. The head of the ambulance stretcher was raised slightly to tip the scoop

forward from a flat position. This was to limit choking on blood, but also to reduce ICP related risk." (Reflection Participant 2)

Quote 10

"Advice shows to place pt at a 30 degree heads up position to help reduce intracranial pressure, I am unsure on how to do this when doing c-spine? ….. try and elevate the stretcher head…. I don't think we will get to 30 degrees, but something is better than nothing". (Case Study Participant 78 – Case Study 4)

Quote 11

"It's a classic kind of old ambulance man, saying if you like "if you're red raise the head", but essentially, I've had it twice where I've had decent, decent head injuries, I'd have boarded…….. So essentially, I managed to put a few blankets underneath the board so it's up a little bit." (Interview Participant 2)

Quote 12

"I'm looking forward to NICE throwing collars out of the window cause I don't carry collars. I don't have the room. I kind of like the self-splinting ideas" (Interview Participant 11)

Quote 13

"In terms of choosing not to use a hard, cervical collar with this patient my reasoning was threefold. Primarily, I was concerned that I would then be unable to successfully manage the patient's airway. The patient was becoming more and more agitated I was worried that a hard collar would increase this level of agitation. Finally, I was concerned about raising the patients ICP. suggest that a patients ICP will rise in 90% of all hard collar applications. Having read trust policies, and various papers including it's very difficult to decide whether my decision was correct or not." (Reflection Participant 1)

Quote 14

“Consideration was given to Intracranial Pressure (ICP) whilst immobilised, however due to airway management issues, and the behaviour of the patient, it was incredibly difficult to achieve an appropriate level of pitch on the scoop whilst managing the airway and securing the scoop to the trolley. The AACE guidelines 2018 comment on the ability for pre-hospital clinicians to manage a Traumatic Brain Injury (TBI) patient at a 30degree upward pitch as ‘all but redundant’ in modern practice, and this is a result of other medical considerations, as well as equipment availability and transportation practicalities”. (Reflection Participant 2)

Quote 15

“The issue is because there’s two different ways paramedics are trained. There’s a lot of IHCD paramedics who are happy with, ‘The book told me to do it so I’m gonna do it and that’s what I’m always gonna do’. And you’ve got the university paramedics who are happy to read new evidence and not put uncomfortable, badly fitting, pointless neck collars on every patient for no reason.” (Interview Participant 4)

Quote 16

6.2.3 Intoxicated patients with head injuries

Participants referenced the intoxication of patients as a significant factor in the decision to convey to hospital. They expressed caution in less defined cases of intoxication or in patients who may drink alcohol after discharge. The following quotes illustrate the challenges and considerations in managing intoxicated patients with head injuries.

“Plus, alcohol dependant - JRCALC states intoxicated patients with head injury should be conveyed. Whilst he may not be intoxicated at the time of injury what’s to say he isn’t going home for a few which would mask symptoms.” (Case Study Participant 59 – Case Study 3)

Quote 17

“Needs A&E admission, long term alcohol use and the associated brain atrophy that brings about stretched subdural veins.” Case Study Participant 57 - Case Study 3)

Quote 18

“Another concern is the social situation (? lives alone) and alcohol dependence. Both may be indicators for a longer period of observation in ED.” (Case Study Participant 93 – Case Study 3)

Quote 19

“However, I'd be cautious around the patient's alcohol intake considering the effect alcohol has on blood clotting and long-term effects on blood vessels. I would be inclined to offer to take the patient to hospital as a precaution.” (Case Study Participant 67 - Case Study 3)

Quote 20

“Having read further about alcohol intoxication and TBI as a result of attending this incident I am more aware of the prevalent risks of hidden significant TBI in this patient cohort. This means that I would have a lower threshold of concern to ring for more clinically senior staff e.g., CCP/HEMS when presented with intoxicated head injury such as this patient again”. (Reflection Participant 6)

Quote 21

“Due to the patient being intoxicated it was difficult to assess for amnesia or whether the patients’ unsteady gait was due to intoxication or a head injury”. (Reflection Participant 4)

Quote 22

I asked myself if I had over diagnosed this patient. Why did the hospital not feel that a patient who presents intoxicated, with head *injury and with (to me) obvious red flags and hypertension should not sent for a CT scan? (Reflection Participant 4)*

Quote 23

"…. Clear c-spine (technically neither NEXUS nor Canadian rules can be applied due to the alcohol, but he's clearly not properly drunk, so I think they're reasonable to use anyway." Case Study Participant 2 - Case Study 1)

Quote 24

6.2.4 Oxygen Therapy and Airway Management

Oxygen therapy and the use of SPO2 monitoring were mentioned regularly by participants. However, there was no consistent discussion on when to administer oxygen or the target SPO2 levels. The following quotes illustrate the variability in practices and considerations in managing oxygen therapy and airway management.

"Obviously, we give oxygen therapy whether or not they have reduced saturation; it's something I would go with". (Interview Participant 12)

Quote 25

"But, yeah, and of course, oxygen if sats are below 95%." (Interview Participant 5)

Quote 26

"So basic airway adjuncts and BVM improve oxygen levels to 90-92% relatively quickly….. we are able to manage the airway reasonably and improve SPo2 to a satisfactory level." (Case Study Participant 77 - Case Study 4)

Quote 27

"If their ABCs are all fine, yes, I would treat with O2 but that's about it, really." (Interview Participant 12)

Quote 28

"…. ETCO2 on while you at it but priority is hypoxia. aim for lower side of normocapnia." (Case Study Participant 91 - Case Study 4)

Quote 29

"… BVM with O2 and ETCO2. Slightly hyperventilate." (Case Study Participant 2 - Case Study 4)

Quote 30

"…. slightly hyperventilate but closely monitor EtCO2," (Case Study Participant 59 - Case Study 4)

Quote 31

"Ideally, assist ventilations with a BVM rather than simply face mask oxygen, as this will help to normalise CO2. In the absence of a ventilator and closed circuit, just try to aim for an effective box waveform and near normal values on ETCO2" (Case Study Participant 89 - Case Study 4)

Quote 32

6.2.4.1 Intubation with or without pharmacological assistance

Participants discussed the challenges and considerations in intubating patients with or without pharmacological assistance.

"Anecdotally I would say it's because to be flat enough for a non-drug inserted tube you must have a significant TBI for a GCS to remain that low. Therefore, outcome likely to be bad from the outset.

That being said, I would like to see some evidence to support my belief". (Case Study Participant 19 - Case Study 4)

Quote 33.

"My view is intubation without premedication in alive patients is bad. Likely to alter vital signs in a negative way, after all it is a stimulus - HR will really go up." (Case Study Participant 8 - Case Study 4)

Quote 34

"Across the country, there are organisations tinkering with PALM techniques. I don't know if you've come across PALM – Pharmacologically Assisted Laryngeal Mask?" (Interview Participant 3)

Quote 35

"So, you give someone a lot of midaz or a lot of ketamine; you cause their own airway management to fail, and then you pop an igel in." (Interview Participant 3)

Quote 36

"There are paramedics who are doing PALM. There was a chap on Twitter who said he'd done a PALM last year, and it was like a grenade going off – there was a lot of criticism of it, but it had worked well, seemingly through Twitter." (Interview Participant 3)

Quote 37

"If we give people a little bit of gentle sedation, and really, at the moment, I can fill them up with morphine and paracetamol, and that might chill them out a little bit, but that's certainly not what those drugs are for." (Interview Participant 3)

Quote 38

"Now, with the new guidelines, JRCALC allows paramedics to use midazolam. But again, not all the Trusts; I think almost none at the moment are allowing paramedics to sedate patients. However, it depends on the Trust. Where we are, we can ask a HEMs or BASICS or CPP to get involved and do this on our behalf." (Interview Participant 5)

Quote 39

"I think this is medicolegally a big risk that JRCALC now are saying some patients with head injury should get midazolam to manage them, and we don't. And if JRCALC is the standard of care, and I can very much imagine standing in front of a coroner and them waving the JRCALC around, and them saying, as a service, and me personally, we've withheld what is agreed to be the national standard of care, and therefore, the patient's done more badly because of it." (Interview Participant 3)

Quote 40

"I think something needs to be given, something to blunt the response. Seeing as we don't carry fentanyl (a big mistake in my opinion), I'd go with pre medicate with morphine and quickly discuss with doc giving 10mg-ish diazepam - which is roughly 3-5mg midaz equivalent. diazemuls is licensed for sedation and premedication prior to general anaesthesia - amongst other indications." (Interview Participant 3)

Quote 41

"I wouldn't have tubed. If you somehow forced my hand so intubation was my only option, I'd pre-treat with atropine (AIUI not normally deemed valuable, but studies don't get done where a paramedic shoves a ham-fisted tube down the throat of a semi-conscious person!!) and crack on, then carefully use morphine as best I could to keep the tube in. Honestly though, I can't see a situation where tubing (or even an iGel) makes the situation anything other than 10x worse." (Case Study Participant 2 - Case Study 4)

Quote 42

*"This section of the thread worries me [*case study peer discussion*]. If we are talking about intubating without drugs then I do think that is a terrible idea - further raising ICP and it would be fraught with difficulties (decorticating posturing, airway tone, non-paralysed to name a couple). I'd also suggest concocting a mixture of drugs that we carry to facilitate a drug assisted intubation would be considered a bad idea from a legal point of view and would not be effective. It is definitely not something we should be doing. PHEA/RSI is a risky procedure that critical care teams drill regularly and should only be carried out by such a team. Currently in the UK this requires a signed off PHEM Doctor on scene with the patient." (Case Study Participant 94 - Case Study 4)*

Quote 43

6.2.4.2 Advanced Skill of RSI

Participants recognised the need for Rapid Sequence Intubation (RSI) as an advanced skill and discussed the challenges in implementing it.

"HEMS arrived, a double critical care paramedic crew. They were unable to RSI the patient and therefore refused to take the patient." (Reflection Participant 8)

Quote 44

"HEMS crew arrived and assessed the patient. They decided it was necessary to RSI (rapid sequence induction) the patient in order to manage his airway as a result of his reduced GCS (5)." (Reflection Participant 6)

Quote 45

"By doing our RSIs, spending perhaps 20 minutes longer on the scene but then getting them straight to a CT scanner, then straight to theatre, cutting out A&E." (Interview Participant 8)

Quote 46

"we've had a massive shift within that setup because, like I say, the MTCs, we used to be buggering around on scenes for ages and RSI and everything. Even that's gone out of the window now cause they're saying, "You're doing 15 minutes on RSI, and you've got 15 minutes journey to hospital in a scanner." So, they've had to swallow a bit of pride, and go, "Ok, that's a good point." …" (Interview Participant 11)

Quote 47

"More widely around sedation and ventilation, people are talking about delayed sequence intubation and the use of high-flow oxygen to avoid having to ventilate and really optimise the patient." (Interview Participant 3)

Quote 48

6.2.4.3 Stepwise approach and decision making between airway options

Participants discussed the importance of a stepwise approach and decision-making between different airway management options.

"The option of what type of airway device, or to what extent airway management was carried out was limited by the patients' ability to tolerate certain airway devices. Although their GCS was low, they were combative throughout the interaction, and this meant that on attempt to place an iGel Supraglottic Airway, they pulled it out and gagged on it. This created airway management issues for us as we had no way of sedating the patient enough to tolerate a secure airway device, and no way to change this as we explored all available avenues e.g., HEMS and Basics Responders and none were available. This meant settling for a less-secure option, and to secure all available options, we adopted a tripod-airway process which was bilateral nasopharyngeal placement and Oropharyngeal placement at the same time. Reasoning behind this was if one option became occluded by blood or other, we may still be able to oxygenate via one of the other 2 options whilst we suctioned the blocked route. A Doctor to the scene, or the ability for my colleague to carry out sedation as he was trained would have allowed for a much more secure form of airway management, being in line with

pre-hospital airway management "Gold Standard" guidelines." (Reflection Participant 2)

Quote 49

"Try basic airways first - OPA and / or a cautious NPA if OPA is not cutting it (I think the old blanket rule 'NPAs contraindicated in head injury' is a bit overboard from 1 historical case study)". (Case Study Participant 89 - Case Study 4)

Quote 50

"So, I suppose 2x NPA / OPA for best oxygenation / least detrimental option maybe?... I think we need more research TBH, but it's certainly standard practice NP+NP+OP.
In the US they'd probably consider Nasal Intubation for a case like this - which is interesting." (Case Study Participant 5 - Case Study 4)

Quote 51

6.2.5 Managing Head injuries in the Older Adult

Participants discussed the relevance of head injuries in older adults, complications, ethics, and the best place of care for this patient cohort. The following quotes illustrate the challenges and considerations in managing head injuries in older adults.

6.2.5.1 Prevalence and Complications

Participants highlighted the increasing relevance of head injuries in older adults and the associated complications.

"The majority of our trauma patients now are the elderly, so head trauma. The risk group now is above 60s, 70s, so it's a little bit different compared to 10 years or 20 years ago." (Interview Participant 5)

Quote 52

"We get a lot of elderly fallers bumping their heads." (Interview Participant 9)

Quote 53

6.2.5.2 Dementia

Participants discussed the additional challenges of managing head injuries in older adults with dementia.

"As for the elderly, whether or not they have any pre-existing mental health issues with dementia and bits and bobs like that, it's more difficult." (Interview Participant 12)

Quote 54

"… Hospital for CT. And discuss ward admission for frailty-linked assessments. My two main differentials are HI and worsening dementia, and whilst I'm normally anti admission for dementia pts, I don't feel like I can happily exclude red flag causes for falls or TBI." (Case Study Participant 38 - Case Study 2)

Quote 55

"….. interesting what are your thoughts on a subdural hematoma if it's worsening dementia, I'd be doing everything to try and avoid ED. it's a tough one isn't it. I agree, but then it depends entirely on the functionality scale they are with the dementia, and particularly without a formal diagnosis, I'm not sure I'd feel entirely comfortable non conveying." (Case Study Participant 38 - Case Study 2)

Quote 56

6.2.5.3 Decision-Making and Ethics

Participants highlighted the ethical considerations and decision-making challenges in managing head injuries in older adults.

"A lot of the time, going into more silver trauma and the warfarinised patient with AF who's fallen and banged their head, that branch of head injury, it's often about whether they're gonna benefit from being conveyed. And in lots of cases, there will be a benefit, but there are some patients who are probably in their last 90 days of life anyway, and after a reasoned discussion we decide that the benefits of going for a CT scan are not sufficient to create that level of fuss in a patient who seems to be neurologically asymptomatic". (Interview Participant 3)

Quote 57

"One cohort might be the elderly patient who traditionally is more likely to fall from standing height, below two metres. It's likely that they're going to have comorbidities, and they might be on anti-coagulants or no-ags. Of course, the NICE guidance on that one, that's a straight "in you go" …" (Interview Participant 7)

Quote 58

"…there's some nice guidelines with scans, with CT scanning people over, I can't remember what the age is, 65 or 75, that are warfarinised. From my experience, that's not really being done in hospital unless there's a clinical cause to do it. And I know my local hospital, the DGH tends to have a senior grade doc go and assess them to then sort of see, okay, is this actually going to be in their best interests, putting a load of radiation through them or not? And I'm happy with that as well." (Interview Participant 2)

Quote 59

"If you look at their comments on anti-platelets, they basically say we don't know enough especially with regards to age. Although younger patients on anti-platelets like clopidogrel may be perfectly fine they don't know what happens with regard to older patients and more research is needed. There have also been studies showing that clopidogrel can actually have worse outcomes than warfarin and I'll attach some shortly, none of the research is perfect and this is why it's not currently in the NICE guidelines but having requested CT heads in various ED's where I have been "advised" by the consultant and had to have them vetted by a consultant radiologist,

I've never had one refused." (Case Study Participant 69 - Case Study 3)

Quote 60

*"So ** has brought up an interesting point - Is this a 'head' injury? …… although it may not be, I would agree with an earlier commenter that these injuries in an anticoagulated patient would make me concerned about other potential head trauma and I'd have a pretty low threshold for conveyance." (Case Study Participant 1 - Case Study 1)*

Quote 61

<u>*6.2.5.4 Ethical considerations and Patient Pathways*</u>

Participants discussed the ethical considerations and the importance of appropriate patient pathways for older adults with head injuries.

"How many elderly do we go to who, no matter what their CT scan proves, that there's not going to be any interventions; they will just have their symptoms managed. I think with the elderly, there's a massive ethics thing we need to look at there, because a lot of people just won't treat them anymore, if you know what I mean." (Interview Participant 12)

Quote 62

"The patient's daughter had also criticised our decisions as being 'ageist'; implying they were formulated on an assumption that her advanced age would mean a poor clinical outcome and that the greater distance and time of transport to an MTC would therefore be unworthy. I found this accusation deeply hurtful and upsetting, due to the energy and emotional investment we had put into trying to improve this patient's condition and ease her suffering". (Reflection Participant 3)

Quote 63

"This is where the separation between hospital and community is suboptimal. I've had situations before where I've admitted patients

for R/O #NOF for example, and they've had a scan, no # been found, but they have been admitted for something I would have happily managed in the community." (Case Study Participant 2 - Case Study 2)

Quote 64

6.2.6 The need for CT imaging in Head Injury Patients

Participants recognised the potential to introduce changes in pre-hospital pathways to allow for head injury patients to go direct to a CT scanner. The following quotes illustrate the consideration and potential benefits of implementing CT imaging in pre-hospital settings.

6.2.6.1 Direct Pathways to CT Scanners

Participants discussed the benefits of having direct pathways to CT scanners for head injury patients.

"I think it needs to be a more military method with just straight to CT….and I think with major trauma, what annoys me, if you're wearing an orange flight suit, off you pop, no problem, you can go straight to CT. I understand they're more likely to tubed etcetera, etcetera, but it would be nice to be in a position where we're trusted to say, Okay, this patient is relatively stable and not gonna die immediately. They need to be in a scanner. Get them scanned," (Interview Participant 2)

Quote 65

"Until we get them [scanner] on the back of the ambulance -. I think that's what's gonna happen, we're gonna argue the toss about what we're gonna do with these people until we can scan them directly." (Interview Participant 11)

Quote 66

6.2.6.2 CT scans in Ambulances

Participants highlighted the potential benefits and challenges of having CT scans available in ambulances.

> *"I know that some countries, again, for strokes they now have CT scans inside of some ambulances. But again, it's a huge investment. They're initially about for strokes mainly, but it could also be probably an interesting tool for head traumas because we could spot bleeds and eventually can triage the patient and which hospital the patient should go." (Interview Participant 5)*

Quote 67

6.2.7 Pharmacological Management

Participants recognised a need for more advanced skills and decision-making pertaining to pharmacology options such as mannitol and hypertonic saline. The following quotes illustrate the considerations and challenges in using pharmacological interventions for head injury patients.

6.2.7.1 Mannitol and Hypertonic Saline

Participants discussed the potential benefits and limitations of using mannitol and hypertonic saline for managing intracranial pressure.

> *"Mannitol is great, again, for raised ICP. You know, it's a diuretic and can move the fluids away. Or hypertonic solution or sodium chloride is also a good idea. But again, it's not drugs accessible for paramedics to use in the UK." (Interview Participant 5)*

Quote 68

> *"….. Bilateral access and a fluid bag hung KVO just if its needed." (Case Study Participant 89 - Case Study 4)*

Quote 69

"I think the received wisdom, but I wouldn't be surprised if this gets challenged, is to aim for a systolic blood pressure of 110 with neurotrauma. I'm not sure if anyone's conclusively proved whether 110 is a magic number. That is with normal saline." (Interview Participant 3)

Quote 70

6.2.7.2 Tranexamic Acid (TXA)

Participants highlighted the consideration and challenges in using tranexamic acid (TXA) for head injury patients, particularly in relation to the CRASH 3 trial.

"I'm aware of the CRASH 3 trial, I think it is, on tranexamic acid use in head injuries. I've been caught out by giving tranexamic acid to a head injury patient. We had a discussion, one of our critical care paramedics met me on route and we had a discussion about, was it head injury in isolation or was it because there was external bleeding, which was my reason for giving it. Was it isolated in terms of internal head injury? Is that what it means? We had a bit of discussion, and I read various people's opinions on that and tried to gauge what the right thing to do is, but it's not very easy." (Interview Participant 9)

Quote 71

6.2.8 Glasgow Coma Scale

The term 'GCS' (Glasgow Coma Scale) featured frequently throughout all phases of the research and was quoted as a common observation in almost all patient interactions. Participants discussed the use of GCS scoring in assessing head injury patients and highlighted its limitations and considerations.

"I suppose anybody with a reduced GCS and a head injury is obviously going to be a bit of a red flag." (Interview Participant 1)

Quote 72

"I'm aware of the problems with it (GCS) and that we do get a lot of – you can get a lot of occult head injuries, particularly in the older

population, who are going to maintain the GCS. They're going to be GCS 14, maybe, beforehand and they're gonna stay GCS 14/15 until suddenly a crash. It's certainly more of a guide perhaps in a younger, previously healthy population. But I'd be more cautious about it in an older, more co-morbid population. But definitely as a rough starting point. If you turn up and there's somebody with a GCS of six, it's a very different case than somebody with a GCS of 14 but there's the big sick, little sick sort of stuff." (Interview Participant 1)

Quote 73

6.3 What is the hierarchy of actions?

These actions were discussed within a hierarchy of other actions within a consultation model. Participants were using a Review of Systems (ROS) also known as the systematic enquiry (Douglas, Nicol and Robertson, 2013; Collen, 2018), with the addition of the 'patient assessment triangle' (Halliwell *et al.*, 2013) blended into the medical note taking model (Douglas, Nicol and Robertson, 2013) or a CABCDE primary survey model approach to care (Halliwell *et al.*, 2013). The following quotes illustrate the hierarchy of actions in assessing and managing head injury patients.

"There's quite a lot of people that jump in, do obs straight away. There are the people that start probably pushing necks and checking the C spine straight away. I'm more of a sit back and kind of a chat, because if I'm looking at all the bystanders and everyone around and everything else, if this person's sat in a chair, they're an elderly person, they're sat in a chair, they're engaging with me, they're talking with me, I truly know they're GCS 15, then I kind of know quite a bit about the head injury already." (Interview Participant 2)

Quote 74

6.3.1 ABC Approach – A hierarchy of actions

"It's all around the ABCDE approach, with me. So, it's rule out catastrophic haemorrhage, firstly. And then look at getting your diagnosis

of a severe head injury through going through the ABCDE approach and then preventing a secondary injury." (Interview Participant 8)

Quote 75

"On reflection I feel that due to the absence of overt signs of serious head injury such as: CSF leakage, battle's signs or periorbital ecchymosis (Racoon eyes) and concern for the need for early management of potential ABC problems at the nearest Trauma Unit, I was complacent, overlooking the severity of the patient's presentation." (Reflection Participant 3)

Quote 76

"So, obviously it would be based on the ABC approach to assess the patient and then the head injury would probably be picked up on the secondary survey." (Interview Participant 10)

Quote 77

"So, I'd probably make sure that the ABCs were out of the picture before I focused too much on the head injury. Once we've got to that point, I would start narrowing myself down to doing basic neurological assessments to start with, and if we're talking major head injuries, all the red flags, really, which are in most of the guidelines." (Interview Participant 12)

Quote 78

6.4 What are the chains of actions?

Within the research, 12 chains of actions were highlighted in the assessment and management of head injury patients. These chains are arguably not distinctive to the singular patient presentation but are relevant to various patients' management scenarios. The following chains of actions were identified and are illustrated in Figure 54.

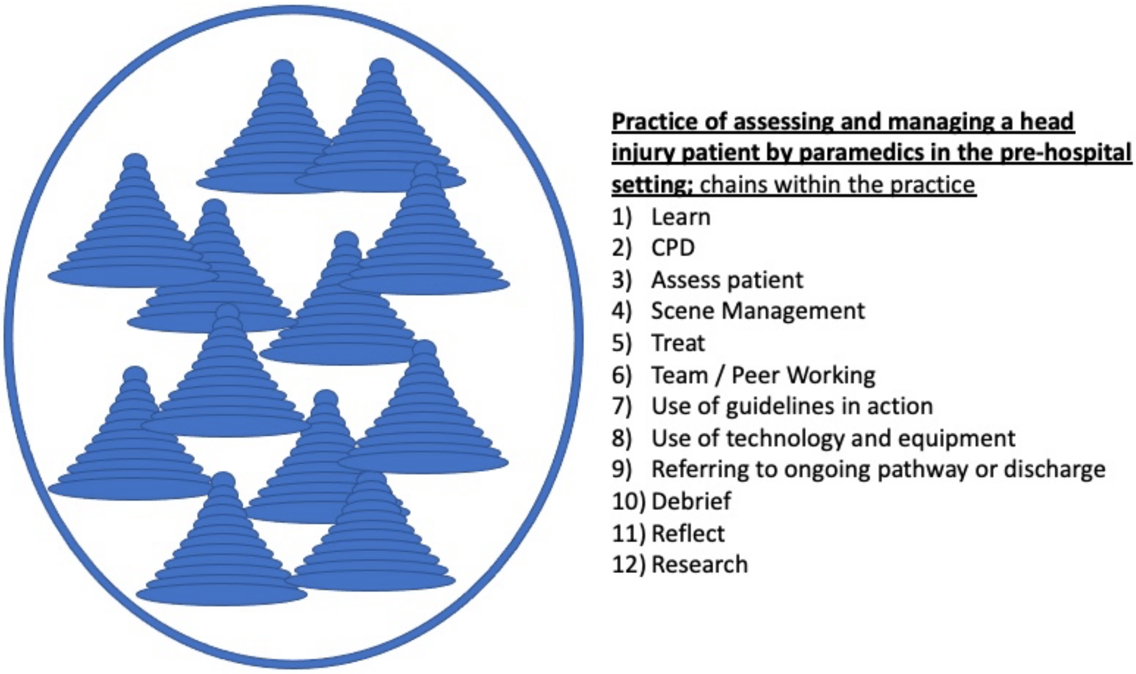

Figure 50 - Chains of action within the assessment and management of head injury patients.

The identified chains of actions include:

1. The process of Learning: Continuous education and training to stay updated with the latest practices and guidelines.
2. Continuing Professional Development (CPD): Engaging in CPD activities to enhance skills and knowledge.
3. Assessing the Patient: Conducting thorough assessments to determine the patient’s condition and needs.
4. Scene Management: Managing the scene to ensure safety and efficiency in patient care.
5. Treating the Patient: Providing appropriate treatment based on the assessment and clinical guidelines.
6. Team / Peer Working: Collaborating with colleagues and other healthcare professionals to provide comprehensive care.
7. Use of Guidelines in Action: Applying clinical guidelines and protocols in practice.
8. Use of Technology / Equipment: Utilising available technology and equipment to aid in patient care.

9. Referring to Ongoing Pathway or Discharge: Making decisions about the patient's ongoing care or discharge.
10. Debriefing: Conducting debriefing sessions to review and learn from the patient care provided.
11. Reflecting: Engaging in reflective practice to evaluate and improve clinical practice.
12. Research: Participating in or utilising research to inform and improve practice.

6.5 Understand 'Why' paramedics are making the decision they are, in relation to the management of head injury patients?

Of the mediated means mentioned by participants, JRCALC was discussed frequently and with intense focus in some elements of data collection. This section will now discuss how participants are using JRCALC in mediated actions and how this relates to some of their wider discussions around mediated means at various stages of the chain of mediated actions in practice.

Mediational means refers to the 'tool(s)' via which the mediated action and therefore practice is enabled. These semiotic means include language text and material objects as appropriate to mediate action (Scollon, 2001a). The MDA guided analytical approach has two questions which can be used to help discuss the mediated means within the research findings:

1. What mediated means are used in this / these actions?
2. How are these mediated means used in these actions?

As discussed in Chapter 2, pre-data collection nexus navigation identified several mediated means relevant to this research. Chapter 5 further analysed these means, revealing critical themes in paramedic decision-making.

6.5.1 What are the mediated means?

Participants frequently referenced NICE and JRCALC guidelines, articles, peer support, decision-making tools, and local guidelines. There were discussions on the contradictions and limitations of these sources.

"And if JRCALC is the standard of care, and I can very much imagine standing in front of a coroner and them waving the JRCALC around, and them saying, as a service, and me personally, we've withheld what is agreed to be the national standard of care". (Interview Participant 3)

Quote 79

"I think JRCALC is really useful, and I think there is a little bit of a danger at the moment where some people are super anti-JRCALC. And what I say to them is that when you've got, particularly when you've got a paediatric arrest, and that thing that I don't care how experienced you are, there's dilation in every part of your body. So essentially, that is extremely useful because -. Particularly with ALS, sometimes you just want to go to the page, and you want to just go and find, yeah, that's what I need to do." (Interview Participant 2)

Quote 80

"…because if you are to apply JRCALC as a rule, well, right now, the guidelines were written in March 2016. So, they're 13 months out of date." (Interview Participant 7)

Quote 81

6.5.2 Decision-Making Processes

Participants described their decision-making processes, highlighting the use of guidelines, peer support, and personal experience. Quotes illustrate the complexity and variability in decision-making.

"I'd look at JRCALC although I take it with a pinch of salt." (Interview Participant 1)

Quote 82

"It's that tossing up all the time. And I think good clinicians can do that. They can justify why they're doing something, but equally, it might not be the same as someone else." (Interview Participant 2)

Quote 83

6.5.3 Decision-Making Biases

Participants identified biases in their decision-making, such as ageist bias, environmental factors, and prioritisation in multi-trauma situations.

"...in my view, the best paramedics are, they're a little bit -. I'd almost say they're a little bit naughty. They have an ability to never break the rules. You never ever break the rules, but you have to be able to bend the rules. And you have to, even with PGDs, even stuff as strict as that, you have to go, right, what is the most that I can do within my protocols and boundaries and guidelines and everything else? Safely, of course. And that, for me, is the real important skill as you move from novice up to very happy practitioner." (Interview Participant 2)

Quote 84

"So, I think where we're getting information now is a far broader range of sources. But it's, some people are very safe, good clinicians, but they're very JRCALC based, and there's others that will get from multiple sources." (Interview Participant 2)

Quote 85

6.5.4 Attitudes Towards Evidence-Based Practice (EBP)

Participants expressed varying attitudes towards evidence-based practice, with some fully supporting guidelines like JRCALC and other viewing them as restrictive or outdated.

“I am not 100% confident on all of the trusts clinical guidelines, I believe that it will take me years to get a good grip on all of them.” (Reflection Participant 1)

Quote 86

“To my detriment, whilst I was aware of the indications documented in the decision tree (Major Trauma decision tree), it was overlooked as an aid to assist in decision-making.” (Interview Participant 3)

Quote 87

“I think there’s a lot of political burden around restricting what paramedics do, especially with neurotrauma. I think that the key authors of JRCALC are pre-hospital consultants, almost certainly doctors in a lot of cases. So, they have a job where they are probably quite well-paid on a consultant pay, work for air ambulances, swoop from the sky, and save the day. And a lot of air ambulance work is around neurotrauma, and it is a great lifestyle for those who do it, and it’s a great lifestyle that you probably want to protect and maintain. Because a lot of other paramedic practice is catching up with traditional HEMs practice maybe. I do think our guidelines clip our wings almost intentionally because I don't think -. If you’re a HEMs consultant on £120,000 a year and you do conferences in Sydney and Seattle and you fly around the world and you get on the television, you probably don’t want Johnny Paramedic stealing your thunder. And I think that is a serious issue, but that doesn’t help me at 3 o’clock in the morning and an hour from a major trauma centre. Because where I work, we don’t have anybody to ring at 3 o’clock in the morning; there is nothing, which is a significant issue, I think.” (Interview Participant 3)

Quote 88

"I mean, there's no way of denying that JRCALC isn't what people regularly talk about. It is a fad!" (Interview Participant 3)

Quote 89

"It's made me realize that what I feel is a very simple job has been transformed into something I fail to recognize as emergency pre-hospital care. It was ingrained into me when I was vehicle crew staff that our job, whether it be technician or paramedic, was to prevent deterioration, promote recovery and transport to appropriate further care. All this advanced 12 lead ECG recognition, advanced paramedic practitioner, consultant paramedic etc is in my opinion pointless to vehicle-based paramedics. When I worked in A&E, when a crew 'blued' in a patient the staff weren't interested in whether you thought it was Wolf Parkinson White syndrome or torsade de pointes, whether you felt it was a metabolic imbalance, they were interested in history, immediate interventions, drugs given & their effects. I've witnessed first-hand members of the receiving team glaze over when a crew has tried to tell them what they should do because of their advanced training when they have no readings, blood gasses etc to support their claims/impressions, but likewise I have heard them hang onto to every word an experienced/known crew have to say about their patient. To me a paramedic will in quite simple terms . . . breathe for you if you can't, pump your blood if you can't, support your systems & stop them collapsing for as long as possible while trying to get you somewhere that can hopefully build on what I've done prior to your arrival at Resus, all while trying to maintain an air of calmness & control. Which is why I'm probably now irrelevant in this new super paramedic era!!" (Questionnaire Participant 18)

Quote 90

"…you know, these students that are coming out and they've BSc's, some of them going out straight and doing minor injuries modules and doing extra and extra and extra, and I don't care what the old-school dinosaur IHCD techs and paras here on station, they are smart, they are very smart. And I kind of had a bit of a realisation that I need to get my stuff together really." (Interview Participant 2)

Quote 91

6.6 Understand ‘how’ paramedics are engaging with reflective discourse and how this relates to their greater paramedic practice?

To understand **‘how’** paramedics engage with reflective discourse, it is essential to explore the sites of engagement. Understanding overlap in these sites of engagement and practices will provide insights into how reflective discourse relates to the nexus of paramedic practice.

Sites of engagement are points in space and time where mediational means and social action intersect to enable a mediated action (Scollon, 2001a). A site of engagement is not defined by one unique practice; instead, the findings of an MDA study can reveal multiple practices through differing trajectories of mediational means and actions.

Moreover, researchers in MDA construct sites of engagement in partnership with their participants, known as space-time stations, to facilitate data collection and fieldwork (de Saint-Georges, 2005).

The guided MDA analytical approach prompts the question:

- What are the practices which intersect to produce these sites of engagement?

As discussed in Chapter 2, the pre-data nexus navigation identified several sites of engagement relevant to this research. Chapter 5 further analysed these sites, revealing critical themes in paramedic reflective practices.

6.6.1 Sites of engagement within the Nexus

As listed in section 6.4, there were 12 chains of actions mentioned within the clinical practice of ‘**assessment and management of head injury patients by paramedics in the pre-hospital setting**’. These broad chains of action are arguable relevant to various patient management scenarios, including, but not limited to head injuries and may therefore be considered the foundation of a nexus of practice. A nexus of practice is subsequently recognised as linked practices enabled because of chains of actions belonging to more than one practice.

As can be seen from Figure 55 below, the chains of practice are active in this research across varying time and space locations, including peer interactions, solitary activities, patient contact, virtual spaces, and face-to-face (F2F).

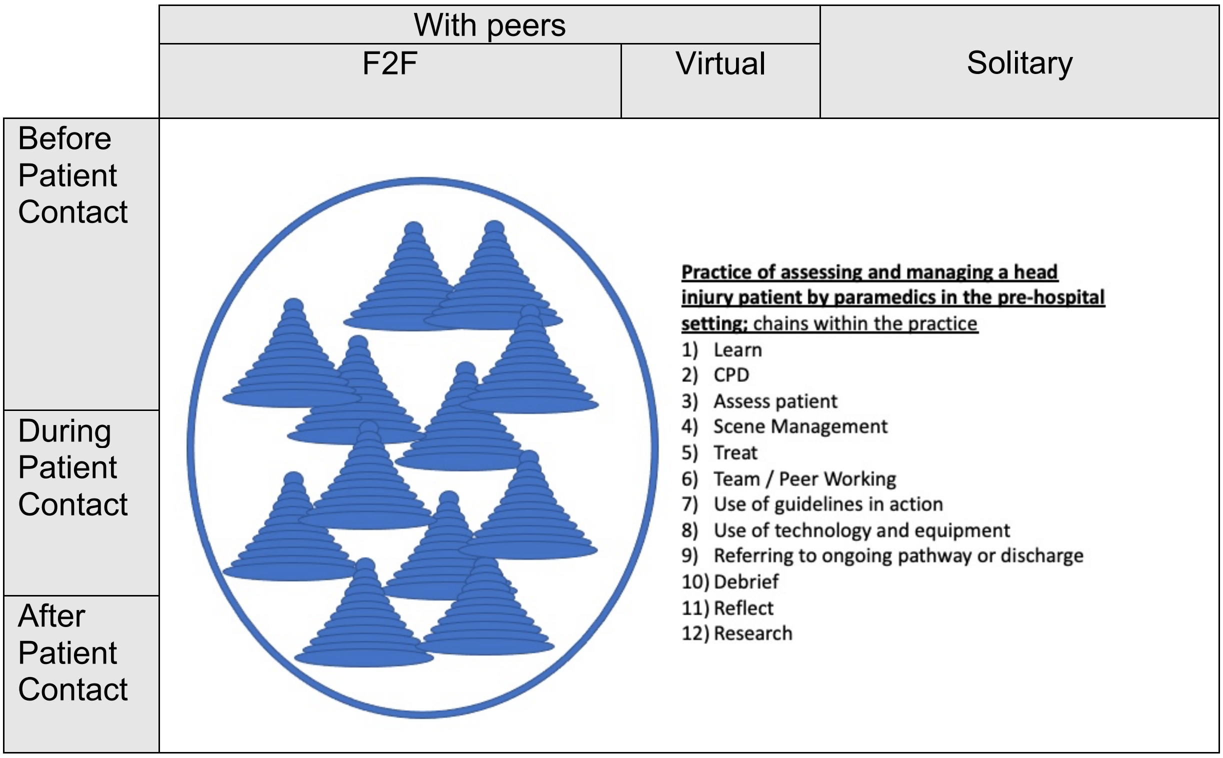

Figure 51 - Sites of engagement chains of practice.

Chains of mediated actions within the clinical practice of '*assessment and management of head injury patients in paramedic practice'* also overlap into other practices, as can be seen in Figure 56. These practices are **Clinical Practice** (not just head injury practice), **Reflective Practice**, **Evidence Based Practice**, **Quality Improvement Practice, Educational Practice and Clinical decision-making practice**.

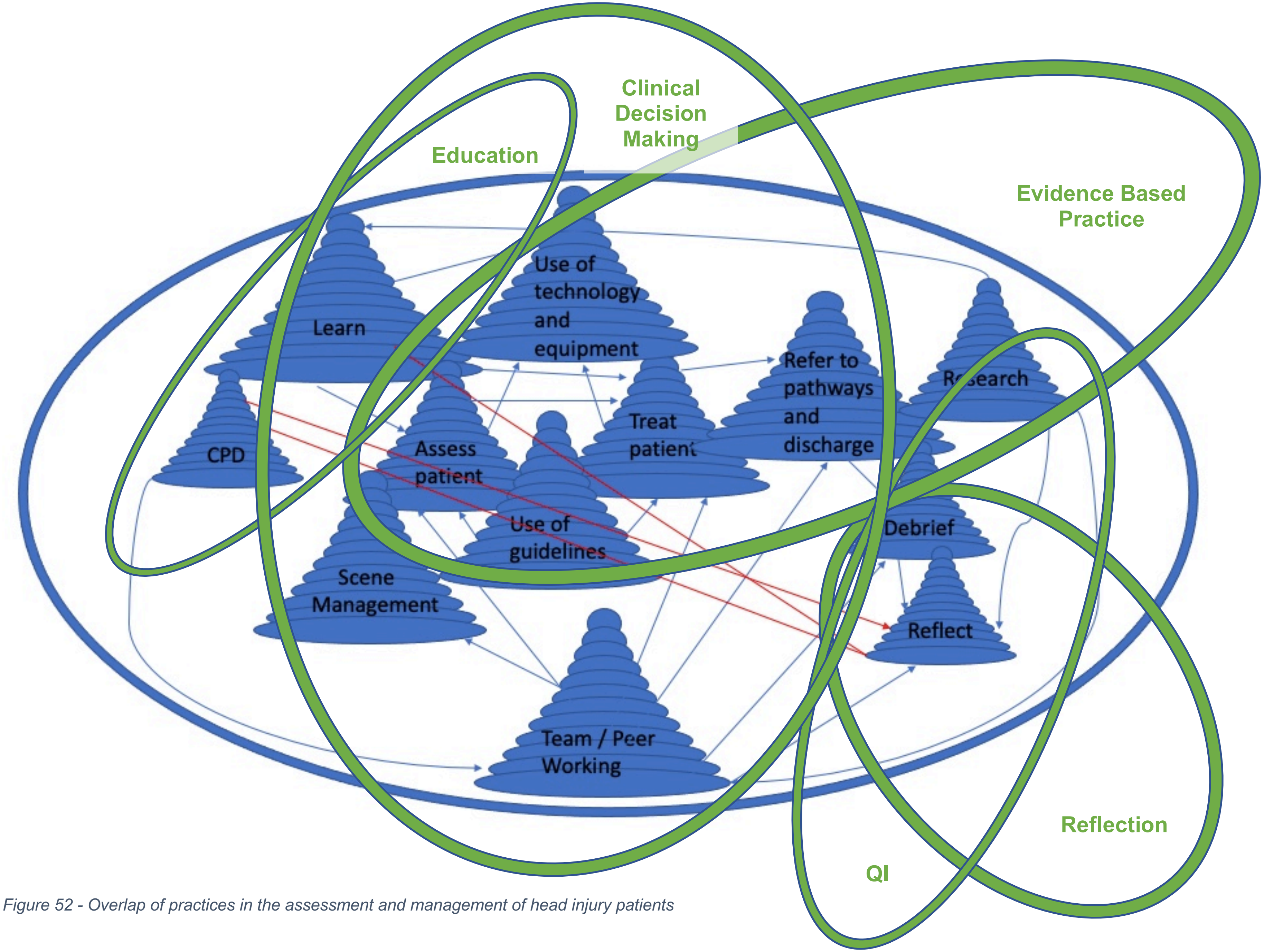

Figure 52 - Overlap of practices in the assessment and management of head injury patients

A nexus can be thought of as the coming together of these multiple overlapping practices, because of shared chains of mediated actions, thus resulting in a combination of multiple sites of engagement where various historical social actions intersect and create mediated action through various mediated means. The greater nexus of practice thus enables a potential change in the historical trajectories of these social actions, enabling future sites of engagements and mediated actions to be formed (Scollon and Scollon, 2004b; Scollon, 2001c; Scollon, 2001a)

In relation to this PhD research the Nexus can be seen as ***'Paramedic Practice'.*** As seen in Figure 57 below, this nexus is a combination of the previously identified six practices, within the research findings 'Clinical Practice', Reflective Practice', Evidence Based Practice', 'QI Practice', 'Educational Practice' and 'clinical decision-making practice'.

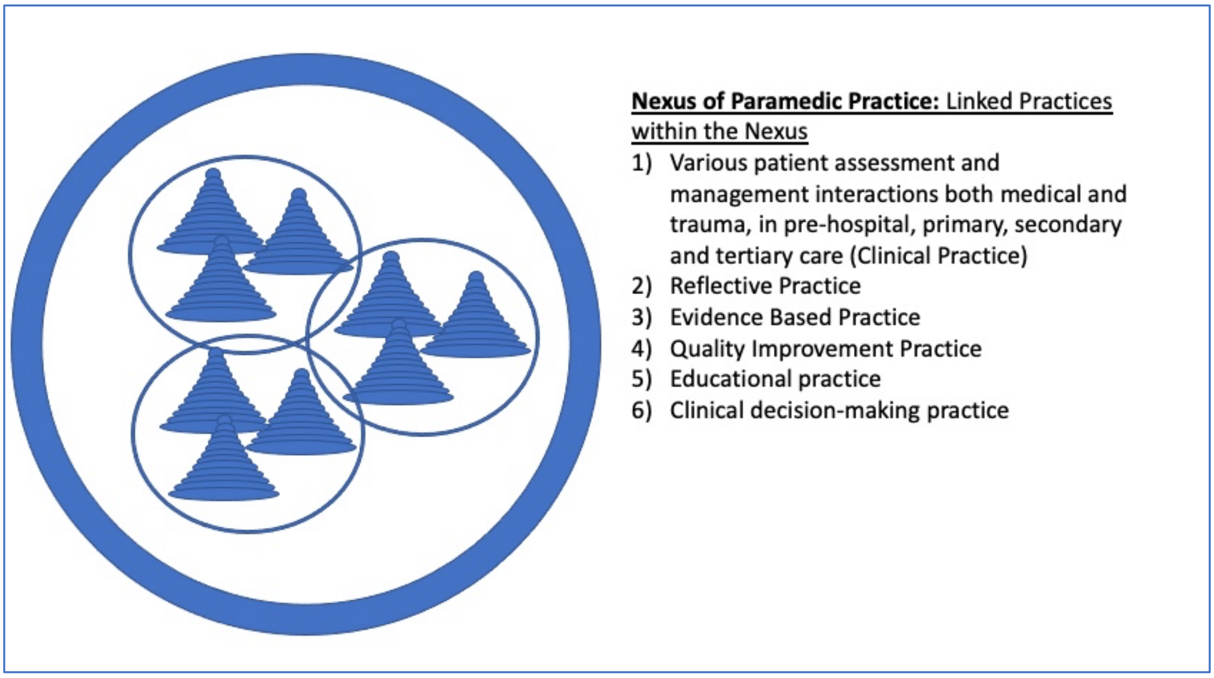

Figure 53 - Nexus of Paramedic Practice

Chapter 2 of this thesis has already explored the histories in habitus of the six practices highlighted in the PhD findings and seen in Figure 57 above. However, three golden threads were also found within the PhD findings which link these practices across the sites of engagement. These were 'collaboration with peers and seniors', 'The Virtual Space' and 'patient-pathways'.

6.6.1.1 Collaboration with Peers and Seniors

Participants highlighted the importance of collaboration with peers and seniors in their practice. The following quotes illustrate the dynamics and challenges of such collaborations.

"And they don't get in the scanner for an hour and a half because every junior doc is getting all excited, and its maybe August and they've got all the houseplants in, and it's just a sea of, 'Let's go play'. 'Let's go play'." (Interview Participant 2)

Quote 92

*"Ha! Sorry - I get a bit of a bee in my bonnet about this. I think we do our students a disservice by not challenging things like this [*incorrect decision making*], service culture tends to be very 'but I wasn't there, so you had to do what you thought was right'. I think we need to be more robust in challenging these things for patient benefit and for student learning." (Case study Participant 2 - Case Study 1)*

Quote 93

"…we have a couple of hospitals that you turn up with a collar or a minor RTA and you turn up to a nurse and they go, "Why haven't they got a collar on?" I think I'm quite lucky because I've got this biking gear on and I'm a bit – I've got a bald head and I'm big, so they don't 'gob' off to me." (Interview Participant 11)

Quote 94

"So, I've been qualified, what, nearly seven years now, and I've got my enhanced paramedic status …. It doesn't really mean much, but it just gives us Band 6, effectively. So, in our Trust, we can do the preceptorships and mentoring, but we don't have to do all the kind of running around with the Land-rover and pips on my shoulders and stuff, so it's all a bit easier." (Interview Participant 2)

Quote 95

"So, they have a job where they are probably quite well-paid on a consultant pay, work for air ambulances, swoop from the sky and save the day. I do think our guidelines clip our wings almost intentionally because I don't think -. ….. If you're a HEMs consultant on £120,000 a year and you do conferences in Sydney and Seattle and you fly around the world and you get on the television, you probably don't want Johnny Paramedic stealing your thunder." (Interview Participant 3)

Quote 96

"This meant due to a lack of HEMS and Basics availability, we were unable to suitably calm/control our patient, and this meant we both felt unable to give the best possible care to our patient, something we both disliked." (Reflection Participant 2)

Quote 97

"HEMS arrived, a double critical care paramedic crew. They were unable to RSI the patient and therefore refused to take the patient." (Reflection Participant 8)

Quote 98

"In the current format, the NHS is too dependent on the charity and volunteer sector to assist and manage these sorts of patients, and that just isn't how things are now. I've been on scene with a volunteer doctor who's very heavily pressurised me to go to a trauma unit with a patient who clearly, clearly should go to a major trauma centre, just because they couldn't be bothered – they didn't have four hours in their day to go chasing up to (city named), which is fair enough, but as the NHS ambulance service, we shouldn't be relying on them. We either have the facilities or we don't have the facilities." (Interview Participant 3)

Quote 99

6.6.1.2 The Virtual Space

Participants frequently used virtual spaces for CPD and peer learning. The following quotes illustrate the role of virtual spaces in their practice and how they have adapted to using platforms for professional development.

"The days of going, oh, I'll look up what the JRCALC says; that's really, really changed for me. So, in my practice now I do a lot of going on Twitter, podcasts, stuff that I can get really accessibly." (Interview Participant 2)

Quote 100

"My CPD is very heavily probably Twitter-focused. I do a lot of CPD through Twitter." (Interview Participant 3)

Quote 101

"…the internet and smartphones have made the whole situation so much fairer, and like the FOAMed stuff. Because stuff like head injury – I'm now in a situation, if I think, oh, I'm not sure about that, I can really look it up. And I don't have to go to a library; I don't have to go even back on base and try and find a computer; it's that speed now. And I think also, it's a great leveller across all the disciplines because, you know, just because you're an A&E consultant or an F1, F2 or I'm a paramedic or a nurse, that's now all available for everybody". (Interview Participant 2)

Quote 102

"I've done a few trauma podcasts, a few webinars. I quite enjoy that because, for me, it's a very easy way of learning." (Interview Participant 2)

Quote 103

"Appreciated that social media can be a useful platform to learn clinically and develop – it isn't just for socialising." (Questionnaire Participant 8)

Quote 104

6.6.1.3 Patient Pathway

Pathways also featured as a regular theme across the data analysis and phases of this PhD. Ensuring pathways were created with staff and fit for purpose was important to staff. The MTC divert policy, national protocols and protocols across trusts also featured greatly. There were discussions around decision-making to divert, time to divert, and skills needed to hold the perceived ‘risky’ decision to divert, as well as the debate regarding when to stay on scene and when to leave, as seen in Quote 105, Quote 106 and Quote 107. This decision is sometimes referred to as ‘*stay and play*’ or ‘*load and go’*. These conversations then extended to the future potential of shortening some of these pathways by allowing direct access to neuro specialists or scanners and even extending this technology to out of hospital settings.

> *“The view that I take with a lot of these things is that we forget that the important fluid on an ambulance is diesel at our peril, because actually, a full multi-system scan and start addressing these issues is so important. I’m not a load and go person; I’m a load and go and do. And I think that’s -. If it’s a position where you could do something quite easily, quickly, on the move particularly, then I think that would be extremely useful.” (Interview Participant 2)*

Quote 105

> *“It’s a fine line, staying and playing, or load and go. When it comes to raised pressure from subdural bleed, at the end of the day, they need a neurosurgeon. So, we need to get those patients to a neurosurgeon. Although, we need to do it safely and I think it needs to be done in a way where we support their vital signs on-route, as well.” (Interview Participant 8)*

Quote 106

> *“…. if we do a little bit more on-scene, potentially, haemodynamically stable, to get these patients straight to scanner and potentially straight to theatre from there, possibly.” (Interview Participant 8)*

Quote 107

6.6.2 A Meta-discursive Structure

Within this PhD the researcher created ‘space-time stations’ utilising recognised discourses in place, such as written reflections, peer conversations, and problem-based learning among peers. This allowed for reflective practice either ‘in’ or ‘on’ action, which was either an individual or peer activity, and either virtual or ‘face to face’, as can be seen in Figure 58.

In this section, the meta-discursive structure of the reflective discourse engaged in by paramedics is explored. Meat-discourse refers to the ways in which language is used to organise, engage, and relate to the audience within a text. Understanding the meta-discursive structure helps to reveal how paramedics communicate their experiences, decisions, and reflections, and how these communications contribute to their professional practice. The following subsections will discuss the emerging secondary focus within meta-discourse, the impact of structure and models, and the familiarity in meta-discourse language.

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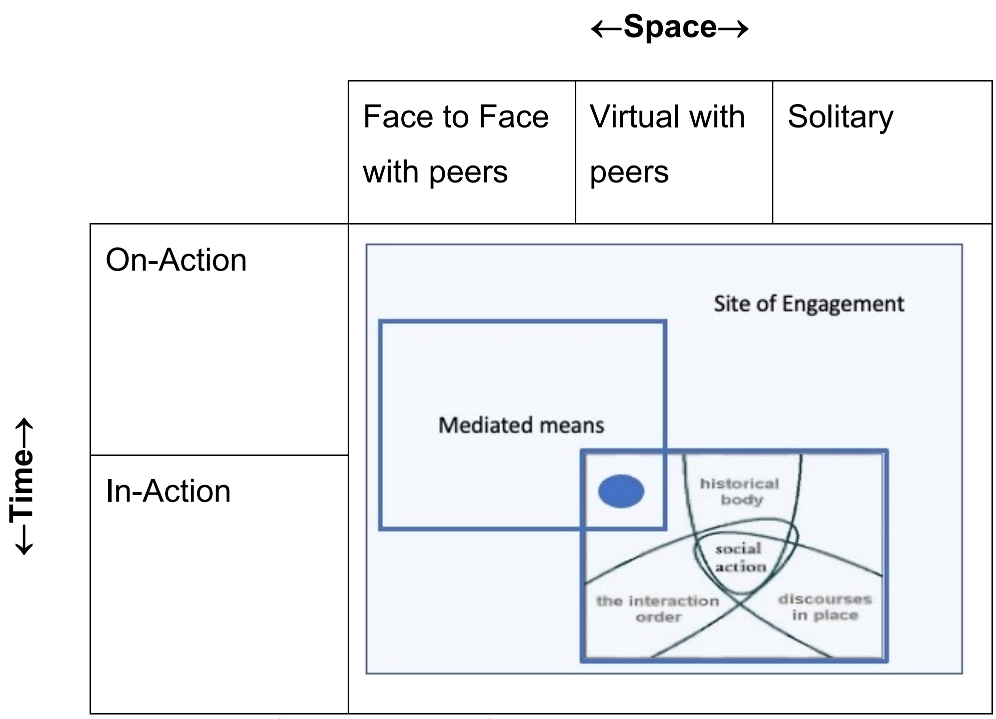


Figure 54 - Research sites of engagement identified prior to data collection.

When analysing these space-time stations, the guided MDA analytical approach prompts the following question:

- What are anticipated and retrospective discourses that could provide a meta-discursive structure?

Meta discourse is used to create a relationship between text, reader, and writer (Hyland, 2017). In essence, meta-discourse is the ‘talk’ about the ‘talk’, it is how the subject matter is discussed. For example, the subject matter may be the same in a blog, research paper, book chapter, and conference presentation, but the way in which that subject matter is discussed and the relationship the author then creates with the reader by use of that meta-discourse will no doubt vary between each of those differing discourses (Hyland, 2017; Craig, 2008).

In the case of this research, MDA guided analysis asks the researcher to consider what anticipated and retrospective discourses could provide this meta-discursive structure. When considering how clinicians (as authors) are producing discourse relating to head injury assessment and management, the researcher anticipated that transcripts from peer-to-peer discussion of past events through semi-structured interviews, written reflections, and transcripts from case studies online would provide this text, reader, and writer (or author) relationship in varying forms.

While all three forms of discourse within the research allowed for a relationship with the researcher in relation to the topic of head injury assessment and management, they all engaged the researcher as a reader or listener in slightly different ways. This may be because the intended audience for the discourse and therefore chosen meta discourse was different. The semi-structured interviews and post case study questionnaires were purposely designed for this research activity and on a one – to – one basis between participant and researcher, whereas the written reflective pieces were written before their submission for research analysis and therefore the intended audience may have been academically centred, for senior colleague review or perhaps only for personal reflection with no expectation for an audience outside of the author. Moreover, the case studies were designed for research purposes but based on a pre-existing platform and model which was successful in shared peer discussion and the meta-discourse may have been purposely selected by the participants with both of those factors in mind.

On analysis of those discourses there were clear differences in the meta-discourse which became apparent because of both structural, content, and computer mediated analysis. These differences could be categorised into themes of ‘focus’, ‘structure’ and ‘language’ which will form the basis of discussion within this sub section.

6.6.2.1 Emerging secondary focus within meta discourse

The three phases within this PhD research had a ‘primary’ focus which the researcher communicated within the participant information sheets. The primary focus was specific to the assessment and management of head injury patients, either in terms of case study information, semi-structured interview questions, or inclusion and exclusion criteria for written reflections. Participants also stated the intended focus of their written reflections, which included patient condition, and in some cases their reason for reflection. These ‘primary foci’ were easily identified; however, through analysis of data, more subtle and secondary foci have been established.

A difference in reflective focus was noted across the phases of this PhD data collection. There was a focus on ‘thinking’ in the interviews and case studies, in contrast to ‘feeling’ in the written reflections. However, the focus within transcripts from interviews and post-case study questionnaires was on the participant, in contrast to a focus on the patient in the written reflections and case studies.

6.6.2.2 Impact of structure and models within meta discourse

The analysis of data from this PhD research, seen within Chapter 5, can contribute to a better understanding of structure within reflective activities. The analysis of written reflections has suggested that more complex reflective accounts are aligned with greater word count and that those written reflections with a declared model or identified structure had a greater percentage of critical reflective writing versus descriptive content. A relationship between reflective models and references was also noted in the findings. All reflections utilising a reflective model have included references, whereas only 50% of the reflections with no evident model have references cited. There also seems to be a relationship between the presence of a reflective model and the presence of ‘EBP Implementation decision making’ discussion within the reflections.

As with the written reflection findings in this PhD, a similarity between length of activity and complexity or criticality was also found in the semi-structured interviews of this PhD. A greater breadth of vocabulary was evident in lengthier interviews, and the potential for QI discussion to emerge was also noted to need greater time for idea generation.

The online case studies within this PhD appeared to follow a pattern of development over four quarters. These phases would appear to start with neutral questioning of the moderator and appropriate replies focused on assessment and treatment conversation. The conversations then seemed to move more towards a peer-to-peer conversation and a change in language to include both opposing/defensive and supportive language. The conversations then move into implementation with occasional QI comments and a presence of stand-alone comments from participants.

6.6.2.3 Familiarity in meta discourse language

The analysis of vocabulary across the phases has also highlighted a focus on 'familiarity' within the language used by participants. This familiarity can be found in the use of colloquial terms or 'sayings', humour, abbreviations, and emojis. Most of the time, this use of abbreviations, acronyms, or 'sayings' did not cause any issues with conversation flow as many of these were recognised by participants, or the paramedic researcher, as regularly used abbreviations in clinical practice. However, at times, abbreviations caused either confusion, needed clarification, or caused a debate regarding the appropriateness of their use.

6.7 Establish if reflective practice can contribute to healthcare quality improvement and implementation science (QI)?

Reflective practice can contribute to QI by engaging participants in reflective activities that pertain to assessment and treatment decision-making options. This PhD research, utilising reflective practice and mediated discourse analysis, has provided insights into how reflective practice can be integrated into QI and implementation science. The following sub-sections explore the themes, challenges, and suggestions for improvement identified through the research.

6.7.1 Quality Improvement Themes

Quality improvement themes emerged from the content analysis, suggesting that case study activity may be more productive for engaging participants in reflective activities related to assessment and treatment decision-making options. However, interviews and written reflections were better suited for QI and EBP discussion and idea generation. The breakdown of QI and implementation within the three phases of data collection is illustrated in Table 77.

Table 77 - Breakdown of QI and Implementation within the 3 phases of data

	Assessment and Treatment		EBP Implementation Decision Making		Quality Improvement		Total themes coded	Ave code per word count
	(n)	(%)	(n)	(%)	(n)	(%)		
Interviews	149	41	155	42	62	17	**366**	**1/87**
Written Reflections	60	36	80	48	26	16	**166**	**1/99**
Case Studies	515	82	100	16	14	2	**952**	**1/15**
	724		335		102			

This table provides a detailed breakdown of the themes coded during the three phases of data collection. It highlights the number and percentage of themes related to assessment and treatment, EBP implementation decision-making, and quality improvement. The table also shows the average code per word count, indicating the density of themes in each phase.

6.7.2 Implementation Challenges

Challenges in implementing quality improvement practices were identified, including barriers relating to people, process, equipment, materials, environment, and management. An Ishikawa diagram (fishbone diagram) was created to capture these barriers (Best and Neuhauser, 2008), as seen in Figure 59.

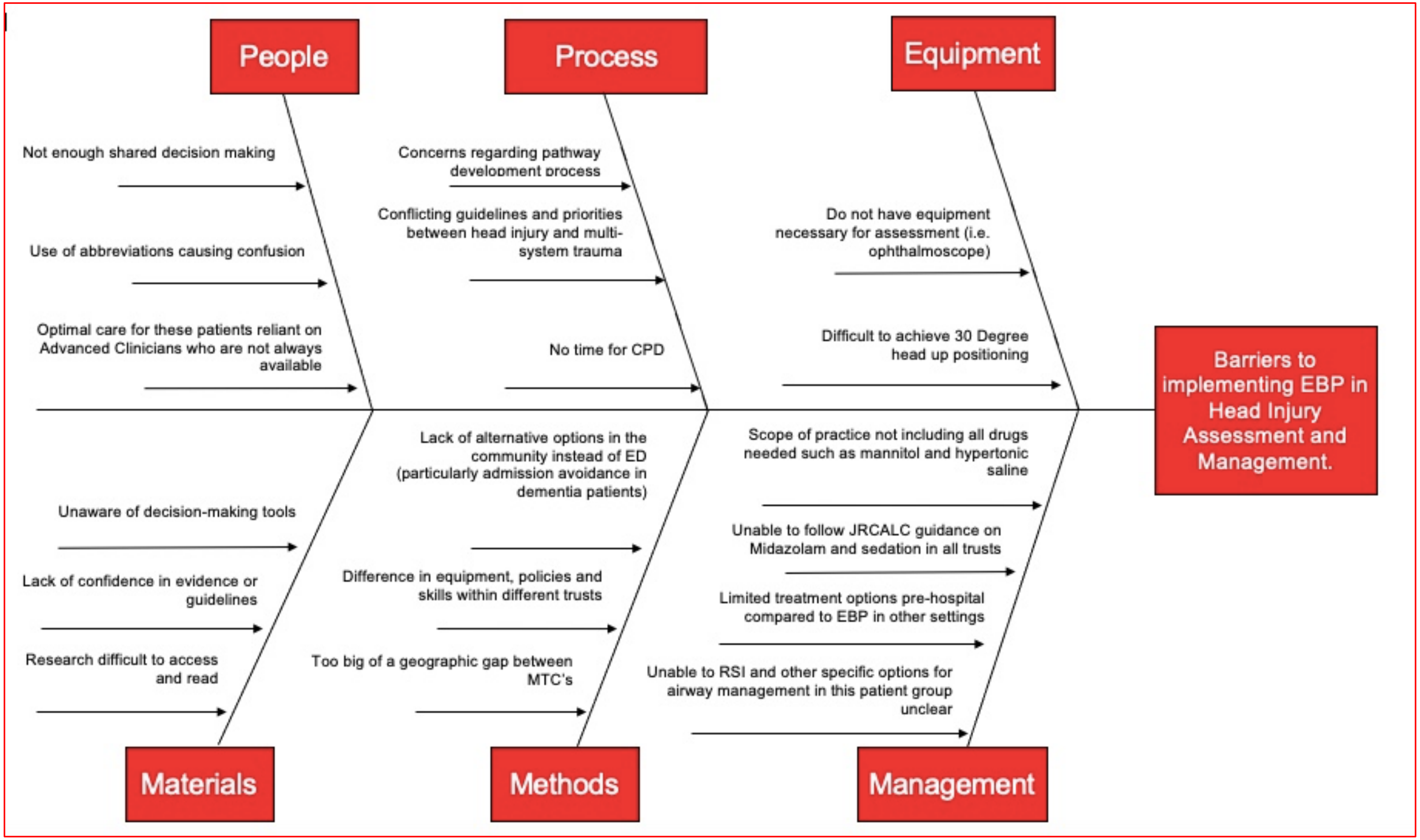


Figure 55 - Ishikawa diagram of barriers to implementing EBP in head injury assessment and management by paramedics in the pre-hospital setting

This figure illustrates the main barriers to implementing EBP in head injury assessment and management by paramedics in the pre-hospital setting. The barriers are categorised into six main themes: people, process, equipment, materials, environment, and management. Each category includes specific challenges identified through the research, such as insufficient education and training, inadequate management support, and poor communication.
Additional considerations for successful implementation of change in clinical practice are depicted in Figure 60.

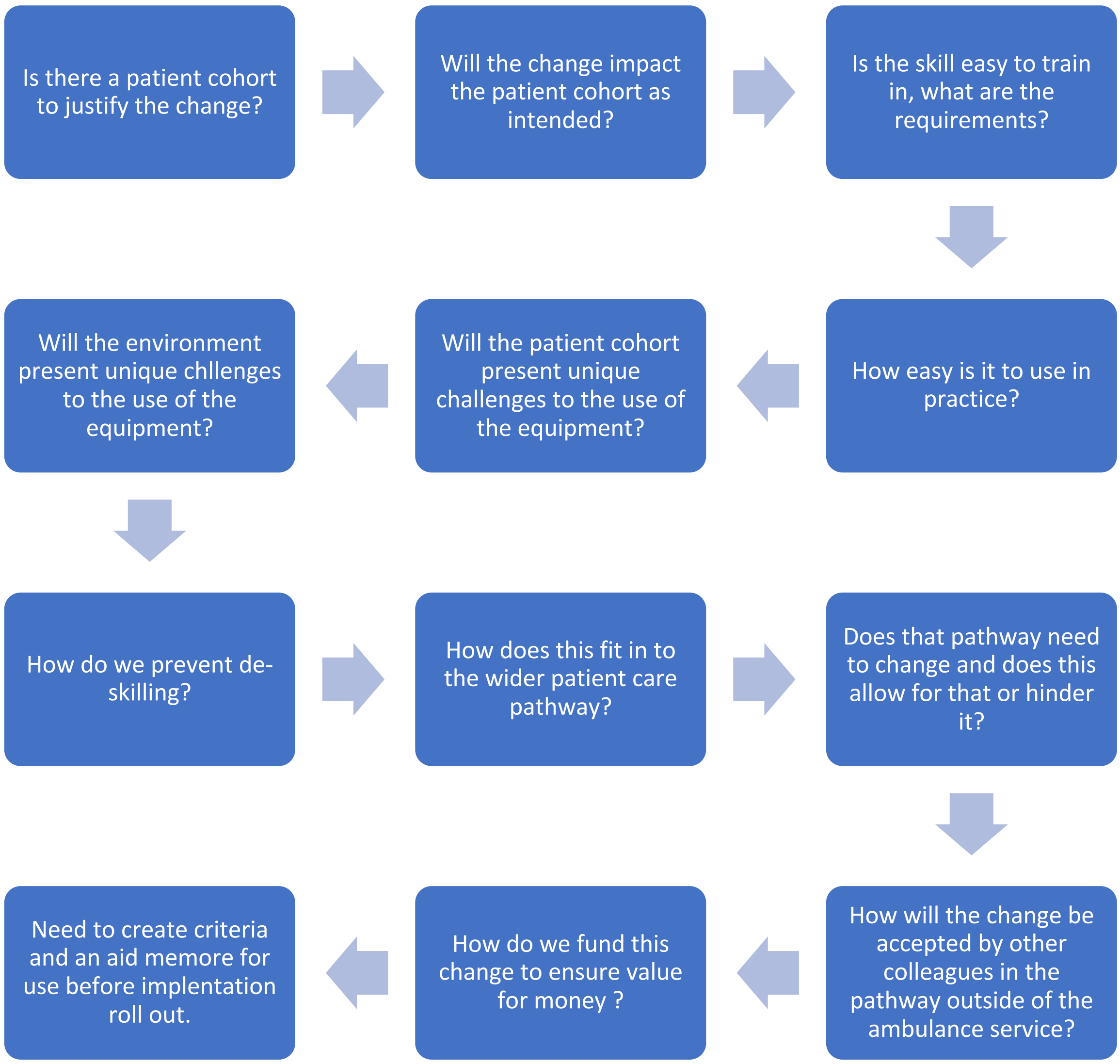


Figure 56 - Consideration for successful implementation of change in clinical practice.

This figure outlines key considerations for successfully implementing changes in clinical practice. It includes questions and criteria that need to be addressed to ensure the change is justified, easy to train, easy to use, and fits into the wider patient care pathway. The figure also highlights the importance of preventing de-skilling and ensuring value for money

6.7.3 Suggestions for Improvement

Participants identified ideas for change in clinical practice or quality improvement projects, which were categorized into pathways, CPD, education, guidelines, process, and equipment. These suggestions are summarized in an Ishikawa diagram, as shown in Figure 61.

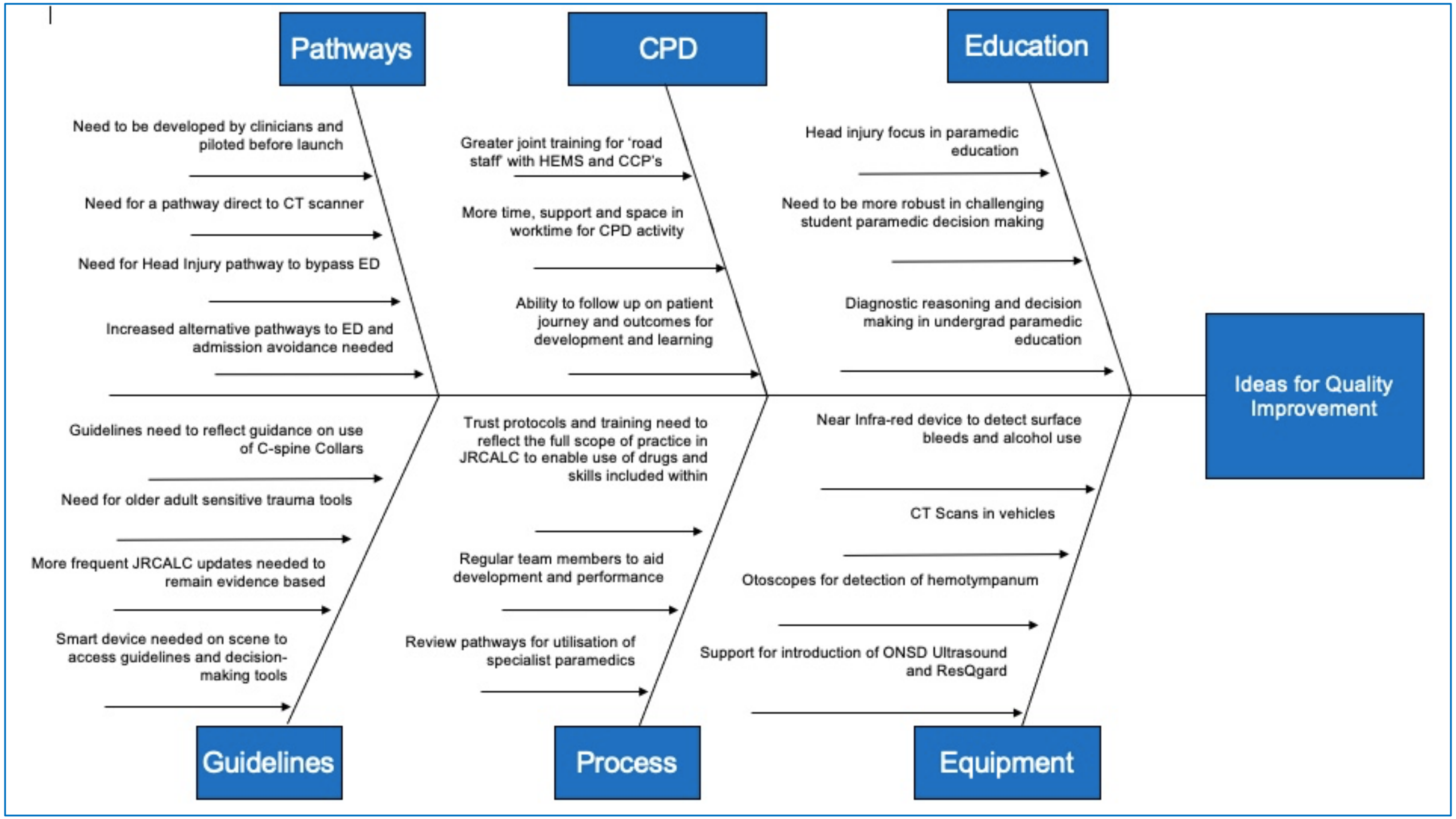


Figure 57 - Ishikawa diagram of generation of ideas for Quality Improvement

This figure presents the ideas for quality improvement generated by participants. The suggestions are categorized into six main themes: pathways, CPD, education, guidelines, process, and equipment. Each category includes specific ideas and recommendations for improving clinical practice and patient care, such as developing clear patient pathways, enhancing CPD opportunities, and updating clinical guidelines.

6.7.4 Understanding the community of practice.

"While all changes do not lead to improvement, all improvement requires change" (Institue for Health Improvement, 2019).

The statement above suggests that Improvement science requires change. However, implementation science, described as 'the study of methods in the practice of integrating research and evidence into healthcare practice and policy', suggests that improvement science does not lead to change until implementation is achieved (Eccles and Mittman, 2006).

Implementation is by its very nature a social process, therefore in order to ensure implementation science and change methodology is applied effectively, the context within which the implementation is to take place, needs to be fully appreciated and understood (Dopson and Fitzgerald, 2006).

Understanding the community of practice allows for an understanding of the context in which implementation is to take place. The community of practice, listed as the 6th and final MDA concept (Scollon, 2001c), has previously been defined as:

"An aggregate of people who come together around mutual engagement in an endeavour. Ways of doing things, ways of talking, beliefs, values, power relations – in short, practices – emerge during this mutual endeavour. As a social construct, a Community of Practice is different from the traditional community, primarily because it is defined simultaneously by its membership and by the practice in which that membership engages." (Eckert and McConell - Ginet, 1992, p. 464)

However, in addition to this definition, the community of practice is of relevance in MDA when considering the progression of a Nexus of Practice into an explicitly recognised group (Scollon, 2001c). The community of practice relevant to this PhD research pre data collection is '**QI and Implementation Science in Paramedicine**'.

This PhD research, utilising reflective practice and mediated discourse analysis has provided the researcher with a methodology for identifying practices making up the Nexus of Paramedic Practice, which include elements necessary for both QI and Implementation of EBP. It has also allowed for consideration of the organisational culture and environment within which mediated actions pertaining to these practices are performed and understanding of the meditational means by which these are enabled. All of which have been explored through a lens of social interaction and peer-to-peer relationships in varying sites of engagement. As a result, this methodology has allowed the researcher to 'uncover' the community of practice of '**QI and Implementation Science in Paramedicine**' as depicted in Figure 62.

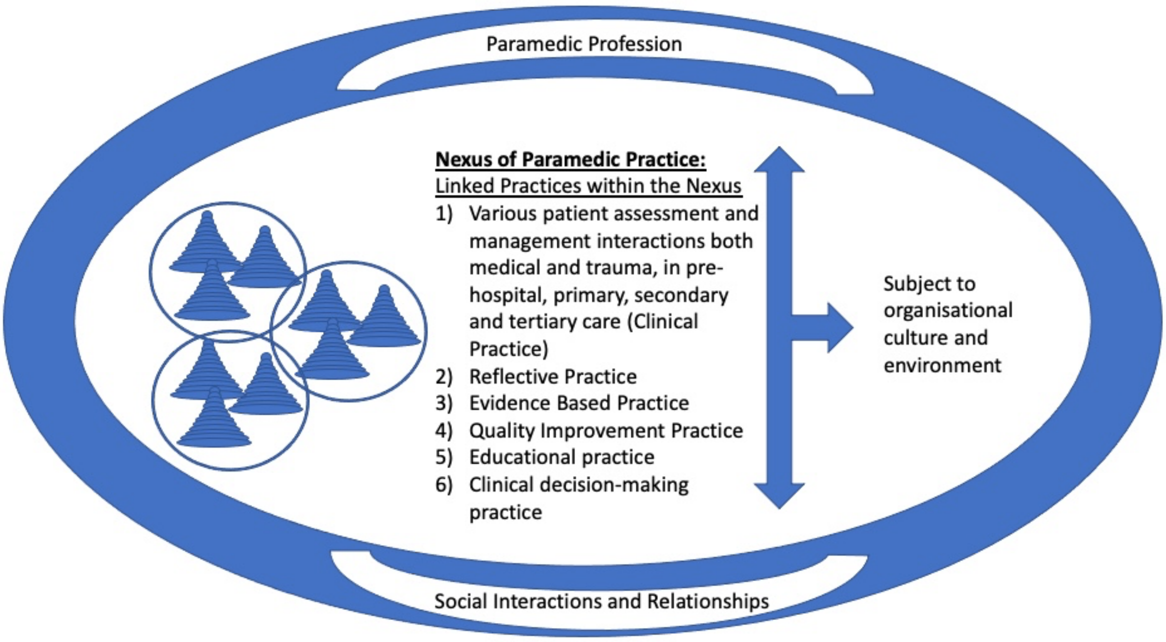


Figure 58 – QI and Implementation Science in Paramedicine: A Community of Practice

6.8 Summary of Findings

This chapter has presented the findings of the research, addressing the research question:

To improve the assessment and management of pre-hospital head injury patients is there a need to introduce a change 'into' clinical practice or change how paramedics clinically practice?

The findings are now summarised within each of the research aims.

6.8.1 Establish 'what' Treatment and Assessment Paramedics are currently providing

The research identified several key actions in the treatment and assessment of head injury patients by paramedics. These included the use of C-Spine collars, managing intoxicated patients, oxygen therapy and airway management, handling head injuries in older adults, the need for CT imaging, pharmacological interventions, and GCS scoring. Each of these actions was discussed in detail, highlighting the current practices and considerations in pre-hospital care.

6.8.2 Establish what treatment and assessment paramedics are currently providing in the management of head injury patients?

The findings revealed a hierarchy of actions within the consultation model used by paramedics. This included the use of a Review of Systems (ROS), the patient assessment triangle, and the CABCDE primary survey model. The hierarchy of actions emphasised the importance of structured assessment and management in clinical practice.
Twelve chains of actions were identified in the assessment and management of head injury patients. These chains included the process of learning, CPD, assessing the patient, scene management, treating the patient, team/peer working, use of guidelines in action, use of technology/equipment, referring to ongoing pathway or discharge, debriefing, reflecting, and research. These chains of actions are foundational to the nexus of paramedic practice.

6.8.3 Understand why Paramedics are making the decisions they are?

The research explored the mediated means used by paramedics, including guidelines like NICE and JRCALC, peer support, decision-making tools, and local guidelines. The findings highlighted the complexity and variability in decision-making processes, the presence of biases, and varying attitudes towards evidence-based practice.

6.8.4 Understand how Paramedics are engaging with Reflective Discourse

The study examined the sites of engagement within the nexus of paramedic practice, including collaboration with peers and seniors, the use of virtual spaces for CPD and peer learning, and the importance of patient pathways. The findings emphasised the role of reflective discourse in enhancing clinical practice and decision-making.
The analysis of meta-discourse revealed differences in focus, structure, and language across the three phases of data collection. The findings highlighted the importance of understanding the meta-discursive structure to create a relationship between text, reader, and writer. The themes of emerging secondary focus, the impact of structure and models, and familiarity in meta-discourse language were discussed in detail.

6.8.5 Establish if Reflective Practice can contribute to Healthcare Quality Improvement and Implementation Science (QI)

Reflective practice was found to contribute significantly to QI by engaging participants in reflective activities related to assessment and treatment decision-making. The research identified quality improvement themes, implementation challenges, and suggestions for improvement. The findings were supported by visual data, including Ishikawa diagrams and a detailed breakdown of QI and implementation within the three phases of data collection.

6.8.6 Study Limitations

This study has several limitations that should be considered when interpreting the findings. The use of virtual platforms for data collection may have limited the depth of interaction and the ability to capture non-verbal cues. The reliance on self-reported data in all 3 phases introduces the potential for social desirability bias, where participants may provide responses, they believe are expected or favourable. Additionally, the absence of direct observation, which was recognised as a valuable method for gaining real-time insights into paramedic practice, was a limitation imposed by the pandemic during the course of the PhD. Despite these challenges, the study's design allowed for the collection of rich, qualitative data, providing valuable insights into the assessment and management of head injuries by paramedics.

6.8.7 Cognitive and Social Desirability Bias

The potential for cognitive biases and social desirability bias must be considered when interpreting the findings of this study. Cognitive biases, as discussed by Nisbett and Wilson (1977), can influence participants' decision-making processes and the accuracy of their self-reported data. Social desirability bias, where participants provide responses, they believe are expected or favourable, can also affect the validity of the data (Grimm, 2010). These biases highlight the importance of employing strategies such as triangulation and reflexivity to enhance the credibility and trustworthiness of the study (Patton, 2015). By acknowledging and addressing these biases, the study provides a more nuanced understanding of the assessment and management of head injuries by paramedics.

6.9 Conclusion

Overall, the findings of this research provide a comprehensive understanding of the assessment and management of head injury patients by paramedics. They highlight the importance of structured assessment, reflective practice, and the integration of evidence-based practice in improving pre-hospital care

Chapter 7 – Discussion.

7.1 Introduction

This chapter will interpret and discuss the findings presented in Chapter 6, aligning them with the four research aims first introduced in Chapter 1. The discussion is structured into the following subsections.

- Establish '**What**' treatment and assessment paramedics are currently providing in the management of head injury patients.
- Understanding '**Why**' paramedics are making the decision they are, in relation to the management of head injury patients.
- Understand '**How**' paramedics are engaging with reflective discourse and how this relates to their greater paramedic practice.
- Establish if reflective practice can contribute to healthcare quality improvement and implementation science **(QI)**?

The chapter will conclude by summarizing the overall research aims and addressing the central research question:

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

By examining these areas, the researcher aims to provide a comprehensive understanding of current practices, decision-making processes, and the potential for reflective practice to enhance quality improvement in paramedic practice.

7.2 Establish 'What' treatment and assessment paramedics are currently providing in the management of head injury patients?

This section discusses the current practices of paramedics in the assessment and management of head injury patients. By examining the specific actions taken by paramedics, the relevance and importance of these actions within the sequence of patient care are highlighted. The subsections below explore various aspects of treatment and assessment, including the use of C-spine collars, management of intoxicated patients, oxygen therapy and airway management, managing head injuries in older adults, the need for CT imaging, pharmacological interventions, and the use of GCS scoring. Each subsection provides a detailed analysis of these practices supported by literature and reference to participant quotes from the research.

7.2.1 What is the relevance or importance of the action in the sequence?

The actions identified in Chapter 6 will be discussed in more depth to establish their importance in the sequence of patient care. This analysis will help to understand how each action contributes to the overall management of head injury by paramedics.

7.2.1.1 C-Spine collars, immobilisation and the wider contribution to discussions pertaining to management of ICP and positioning of patients at 30 degrees head up / semi recumbent.

Participants in this PhD research discussed the awareness of the need to reduce the use of cervical collars due to an increase in ICP and the suggested evidence that they are not as effective in c-spine immobilisation as clinicians may have previously thought, as seen in Quote 1 in Chapter 6.

The discussion within this PhD pertaining to harm caused from collars is supported in the literature, including a retrospective study of 1082 patients over five years, published in 2016 (Oosterwold *et al.*, 2017). Evidence supports concerns that collars may increase ICP (Hunt, Hallworth and Smith, 2001; Maissan *et al.*, 2018; Bazaie *et al.*, 2022) increase pain and agitation (Ham *et al.*, 2016; March, Ausband and Brown, 2022). In addition to the existing evidence, this PhD research also acknowledges the potential for increase in ICP or agitation while immobilised with a cervical collar, as seen in Quote 2, Quote 3 and Quote 4 within Chapter 6.

Recommendations within the PHTLS guidelines in 2018 were to remove cervical collars (National Association of Emergency Medical Technicians (U.S), 2019) and although reducing time within a cervical collar is advised (March, Ausband and Brown, 2022; Oosterwold *et al.*, 2017), literature also recognised that a safer alternative to a rigid cervical collar needed to be established (Horodyski *et al.*, 2011; Hodgett and Ward, 2020; Cowley *et al.*, 2022). Participants in the PhD research declared reverting to manual immobilisation in agitated patients where necessary as seen in Quote 5 in Chapter 6.

Evidence suggests that time in cervical and full spinal immobilisation, especially over 30 minutes, resulted in associated pain and acquired pressure sores (Worsley *et al.*, 2018; Ham *et al.*, 2016). This was also more significant in the elderly population and thus further supported the need to establish alternatives to these techniques or removal of immobilisation at the earliest opportunity and reduced 'on scene' times (March, Ausband and Brown, 2022; Ham *et al.*, 2016; Worsley *et al.*, 2018). Participants in this PhD research also recognised how uncomfortable and unpleasant the collar must be for their patients, as seen in Quote 6 in Chapter 6.

Although literature recognises that cervical collars may be beneficially in protecting the cervical spine during extraction of a trauma patient, there is no greater benefit to restricting cervical movement in a collar post extraction, versus the use of head blocks and tape (Houghton and Driscoll, 1999; Holla, 2012). The suggestion head-blocks and tape may be more effective than a collar was first published in 1983, however the more recent study in 2012 has further supported a change in guidelines as a result of this research (Holla, 2012; Podolsky *et al.*, 1983). Furthermore, various studies have suggested that the reduction in range of movement when using a collar is minimal or ineffective, with a remaining 30 degree range of motion in a correctly fitted collar but even more again in a poorly sized or fitted collar (Bell *et al.*, 2009; Horodyski *et al.*, 2011) or an increase in purposeful movement to relieve pain associated with immobilisation (Ham *et al.*, 2016). Findings within this PhD research suggest that staff are feeling conflicted in the use of collars given their awareness of the potential to increase ICP and as a result are not fitting them correctly, as seen in Quote 7 in Chapter 6.

However, participants found that receiving clinicians in ED were sometimes surprised at the lack of collar use and they were questioned and occasionally criticised for this approach, which made the participants question if their decision making was correct. They felt these experiences made implementation of this new guidance difficult in their practice, as seen in Quote 8 and Quote 9 in Chapter 6.

Participants also mentioned an awareness of the concept of keeping head injury patients 30 degrees head up to reduce any further increase in ICP, this action features in the JRCALC guidance, but was not mentioned often in the data collected (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016). Moreover, when 30 degrees head up was discussed, participants said that although they were aware of this guidance it was extremely difficult to achieve given the conflicting targets of spinal immobilisation and achieving this targeted degree of elevation. There appeared to be some improvised approaches to overcome this, but techniques could be considered to compromise safety in the absence of any equipment designed to achieve both priorities, as seen in Quote 10 and Quote 11 within Chapter 6.

Overall, spinal immobilisation was the chosen priority considering this conflicting clinical decision, as seen in Quote 12 in Chapter 6. At the time of data collection, the advice on cervical collars was changing, at that time the most recent 2016 edition of JRCALC advised clinicians to omit collars only if counterproductive or contra-indicated (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016), however many of the sources discussed in this sub section were already published. Despite the evidence discussed in this sub section, which was published between 2011 and 2019, identifying the lack of benefit from the use of collars and even a possible cause of harm, a paper in the paramedic journal of practice in 2020 still needed to make suggestions for the UK Ambulance Service guidelines to be reviewed and consider removing cervical collars from pre-hospital practice (Hodgett and Ward, 2020). The findings of this PhD suggest clinicians would welcome the removal of collars as suggested by Hodgett and Ward in 2020, especially in light of potential confusion being caused by a lack of a clear message being replicated by all sources, as seen in Quote 13 and Quote 14 within Chapter 6.

Furthermore a paper was published in the British Paramedic Journal in 2022, with the findings of a specialist commissioned group to review pre-hospital immobilisation and explore the possibility for improvement in evidence-based practice (Cowley *et al.*, 2022). The paper made the following seven recommendations:

1. Introduction of a new cervical clearance tool that discriminates between low- and high-risk patients.
2. Increased emphasis on risk of spinal injury in high-risk patient populations
3. Removal of semi-rigid collars from use
4. Increased emphasis on ‘spinal motion restriction’ and creation of a two-tier system for immobilisation
5. Use of scoop in low-risk patients and increase maximum time to 1 hour.
6. Use of a ‘marker’ for emergency departments
7. Increased emphasis on self-extrication and removal of spinal pain as a contra-indication to self-extrication (Cowley *et al.*, 2022).

Despite many of these recommendations allowing for patients to be managed in a 30 degree head up position and thus better managing head injuries, there was no mention of this within the paper (Cowley *et al.*, 2022). There would appear to be paucity in literature and evidence pertaining to the conflict between the need for immobilisation and the ability to utilise the 30-degree head up advice, and the resulting dilemma facing pre-hospital clinicians in patients presenting with the potential for both injuries, as seen Quote 15 in Chapter 6.

The group review was led by Southeast Coast Ambulance Service NHS Foundation Trust (SECAmb) and commissioned by JRCALC (Cowley *et al.*, 2022). The group featured advanced critical care paramedics, emergency consultants and senior managers from the ambulance service including the education department. The latter part of the paper, post recommendations, briefly mentioned the intention to implement these recommendations within SECAmb using teaching sessions or online tools and that a following paper on the implementation process and success would be published in the future (Cowley *et al.*, 2022). There was no mention in this paper of perceived barriers to implementation, frameworks for implementation or approach to review of success (Cowley *et al.*, 2022). It is interesting to note that the working group, while having practicing paramedic representation, only had senior specialist paramedics within the group and therefore an absence of other grades and non-specialist paramedics (Cowley *et al.*, 2022) who were however represented in this PhD research and expressed their issues when trying to practice a de-emphasised use of collars or early removal, as seen in Quote 16 in Chapter 6.

7.2.1.2 Intoxicated patients and the difficulties pertaining to this.

The participants in this PhD study made references to the intoxication of their patient as a prescriptive decision to convey to hospital but also in less defined cases of intoxication or even in patients who 'may' drink alcohol after discharge, they were inclined to act with caution and convey for monitoring as a pre-caution, as seen in Quote 17, Quote 18, Quote 19 and Quote 20 within Chapter 6.

Intoxicated patients can create a burden of activity on the NHS Emergency Departments, especially on Friday and Saturday nights where estimates are suggestive that 70% of attendances are alcohol related (Parkinson *et al.*, 2016; Verelst *et al.*, 2012). Across the country there have been various Alcohol Intoxication Management Services (AIMS) also known in some areas as 'Drunk' Tanks' or 'Sobering Stations' offering an alternative for ambulance crews to the ED, or patients to self-present (Moore *et al.*, 2021b). A study in 2019, published in 2021, estimated that the number of attendees needed in an AIM to be cost effective as an ED alternative would be 11.02, however despite the high level of alcohol related ED attendees, the average AIM attendance was only 7.57 (Moore *et al.*, 2021b). There was a great variation however, in the success rate of the AIM schemes, with the most successful scheme having a close link with the ED department and being staffed with Nurse Practitioners (Moore *et al.*, 2021b).

The study recognised the variation in these schemes and the need to further establish the reasons for success in some areas to fully realise the benefit of these fledgling services (Moore *et al.*, 2021b). This was a quantitative study to establish comparison in attendances and outcomes related to ambulance response time and ED discharge times (Moore *et al.*, 2021b). Authors of this quantitative study also conducted a qualitative study utilising semi-structured interviews to understand the experiences of 19 'end user' of the AIM schemes (Irving *et al.*, 2019b). Within that study, participants rated their experiences positively with 24% saying they would have attended ED if AIM was not available (Irving *et al.*, 2019b). The study concluded that AIMS are acceptable to the user (Irving *et al.*, 2019b). Moreover, in

2019, the authors also conducted a parallel ethnographic mixed method study comprising of semi-structured interviews of ‘end users’ and ambulance service referring clinicians (Irving *et al.*, 2019a). The results from both the end users and ambulance clinicians were favorable, with the ambulance staff stating that where AIM was available it released capacity and where unavailable the attempt to avoid admission was felt to extend on-scene time due to difficult decision making (Irving *et al.*, 2019a). In support of the comments found within this PhD research, the ethnographic study also found ambulance staff feel under pressure to convey and not discharge on scene, as this quote from that study shows:

“I think it is a good idea. It’s embarrassing taking people in who essentially just need babysitting. Because the problem is we can’t leave them either” [Paramedic, Control site] (Irving et al., 2019a, p. 45)

As we can see from this PhD study, caution with intoxicated patients who have a potential head injury may be the driving or only factor in an ED conveyance so a better understanding of the various AIM patient inclusion criteria and the clinician engagement in these schemes would help to shape any future iterations of such initiatives to avoid unnecessary conveyance.

This sense of caution and a growing novice understanding of the risks associated with alcohol in head injury patients, has also led to greater consideration for other support, such as Senior Pre-hospital clinicians as seen in Quote 21 in chapter 6.

This sense of precaution seen in the participants of this PhD study may partly be due to the difficulties experienced in assessing or managing the intoxicated patient, as seen in Quote 22 in Chapter 6.

A multi-center cohort study in the Netherlands in 2022, after the completion of data collection within this PhD, recognised that severe head injury can be difficult to recognise in the pre-hospital setting, especially in patients with a GCS above 13 (Lokerman *et al.*, 2022). However, they note that the presence of intoxication in the head injury patient did not alter the ability to recognise a severe head injury and this was thought to be due to the higher index of suspicion within this patient group and therefore the more likely decision to transmit to hospital (Lokerman *et al.*, 2022).

The study recommended further research into the benefit of including intoxication in pre-hospital guidelines as an aid to on-scene decision making (Lokerman *et al.*, 2022). In contrast to the reference by a participant in this PhD study, suggesting that JRCALC state intoxicated patients with head injuries should be transported to hospital, the current version of JRCALC at the time of data collection does not make such a recommendation (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016). The 2016 version of JRCALC does however make clear reference to the higher incidence of head injuries in intoxicated patients and warns clinicians to not make assumptions that a reduced level of consciousness is solely due to intoxications rather than a head injury, thus attempting to raise the index of suspicion (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016).

However the latest NICE Head Injury Guidelines at the time of this PhD data collection, did list ‘Current drug or alcohol intoxication’ as a reason for head injury patients to attend the Emergency Department (NICE, 2014a). Updates in the head injury chapter in the 2019 version of JRCALC (post PhD data collection) are regarding the use of TXA post the CRASH 3 trial and a change in wording regarding the use of fluids but no change in guidance relating to alcohol and decision making in the head injury patient (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019).

Moreover, data from this PhD may suggest that deciding what constitutes ‘drunk’ or ‘intoxicated’ when using guidelines to aid decision making is not prescriptive but rather a subjective concept when it comes to how important the level of intoxication of a patient is, as seen in Quote 23 and Quote 24 of Chapter 6.

Literature would support the findings of this PhD, suggesting that ability of clinicians to access levels of intoxication without the use of a structured assessment or the use of specialised tests is inconsistent (Rubenzer, 2011), partly due to the fact that many recognised signs of intoxications may have multiple other causes aside from alcohol consumption (Pennay, 2014). Despite these challenges a recent study of paramedics in Finland found that Paramedics were able to accurately diagnose intoxication in 86% of patients when compared to a later ED diagnosis (Koivulahti, Tommila and Haavisto, 2020). Finland has a comparable structure to paramedic pre-hospital provision with the more advanced paramedics obtaining a BSc and holding a professional registration, the results of this study also found a correlation between BSc level education and the ability to accurately diagnose (Koivulahti, Tommila and Haavisto, 2020).

While there are multiple tools for healthcare practitioners to use in establishing a patients level of risk to alcohol harm, such as the AUDIT and FAST tests, or their risk of withdraw from alcohol, such as the CIWA Score, there are less available tools for assessing levels of intoxication and the impact of this on clinical decision making (Office for Health Improvement and Disparities, 2020; Sullivan *et al.*, 1989). However, in 2017, Dr Hack designed the HII tool for clinicians to use with intoxicated patients at the bedside taking approximately 2-4 minutes to complete and no equipment required. The outcome, as well as a score out of 20, gives a suggested time in hours for the patient to recover from their level of intoxication, thus enabling the clinician to factor this into their assessment (Hack *et al.*, 2017; Hack, Ferrante and Baird, 2021). However, this tool was not mentioned by participants in this PhD study or any alternative tool and so there may be a lack of awareness of such resources or perhaps challenges with implementing these in practice which would need to be explored in future research.

7.2.1.3 Oxygen therapy and Airway management discussion, including the use of sedation and RSI.

Oxygen as a form of treatment, or the use of SPO2 monitoring was mentioned regularly across all three phases of this PhD study. However, there was no consistent discussion of when to administer oxygen, i.e., all head injury patients or related to SPO2, or a consensus on what was an acceptable or target SPO2 or how quickly this is to be achieved, as seen in Quote 25, Quote 26, Quote 27 and Quote 28 within Chapter 6.

There is however a reference to the use of Oxygen in head injury patients within the JRCALC 2016, 2019 and 2020 guidelines (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019). This PhD research spanned the 2016 and 2019 version of JRCALC but there were no changes in the algorithm within that time (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019). The algorithm, within the 2020 addition of TXA, can be seen in Figure 59, which clearly states that oxygen should be used as required in order to maintain saturations at the target rate, which in adults in 94% (Joint Royal Colleges Ambulance Liaison Committee, 2020).

The guidelines are also clear to avoid hyperventilation of the patient, which may be considered in contrary to the comment regarding the use of a BVM to bring oxygen levels up relatively quickly (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; Joint Royal Colleges Ambulance Liaison Committee, 2020). The comment suggesting oxygen is given irrespective of SP02 levels may be explained by a historical approach of supplementary oxygen being considered a benefit to most patients and therefore administered liberally by most healthcare providers without a recognition of the possible harm this may cause and therefore any need for clear guidance for administration (Kelly, 2014). Moreover, the most up to date British Thoracic Society (BTS) guidelines at the time of this PhD data collection, dated 2014, were advocating a target spo2 range in head injury patients of 94-98% pending the availability of blood gases (O'Driscoll *et al.*, 2017).

Alongside SPo2 monitoring there were also conversations regarding the use of EtC02 monitoring, however once again there was no consistency in any target readings or how to achieve this in terms of assistance in ventilations, as seen in Quote 29, Quote 30, Quote 31 and Quote 32 within Chapter 6.

JRCALC suggests starting capnography monitoring where available and aiming for a target ETC02 range of 35-40mmHg, as seen in Figure 59 (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; Joint Royal Colleges Ambulance Liaison Committee, 2020).

NICE head injury guidance does not make reference to SPO2 levels as previously discussed within JRCALC and BTS guidelines however it does refer to target PaC02 levels and hypercarbia or hypoxaemia as guidance in treatment decision making, such as intubation and hyperventilation (NICE, 2023; Joint Royal Colleges Ambulance Liaison Committee, 2020; O'Driscoll *et al.*, 2017). Hypoxia or hypoxemia and hyperoxia or hyperoxemia is widely referred to in head injury research regarding it's negative effect, however research focuses on PaC02 or Sa02 measurements as opposed to SP02 (Khan *et al.*, 2021; Yan *et al.*, 2014).

Arterial blood gases as an option in the pre-hospital setting, specifically used by HEMS, has been researched but findings are deemed inconclusive regards the benefits, however more research is suggested in specific patients groups (Morton *et al.*, 2022). In the absence of the ability to routinely take blood gases in most pre-hospital ambulance settings, a decision based on PaC02 or Sa02 is not possible, although the use of ETC02 is available. Moreover, a paper in the Journal of Paramedic Practice in 2015, explaining the benefits of ETC02 in the prehospital setting, listed one such benefit as assisting in the purposeful hyperventilation of head injury patients in order to maintain normal intracranial pressure (Sinclair, 2015).

The participants of this PhD study refer to the use of ETC02 regularly however there is once again disparity in their narrative, with reference to hypoxia being a priority, or aiming for the lower side of normocapnia while others refer to hyperventilation and for the target of a 'near normal' ETC02 or box waveform. JRCALC refers to the target range of ETC02 as 35-40mmHg although actual target figures are not mentioned by any participant throughout the three phases of the PhD study (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and

Association of Ambulance Chief Executives, 2019; Joint Royal Colleges Ambulance Liaison Committee, 2020), however the term ‘box waveform’ is synonymous with ‘normal’ ETC02 in capnography waveforms (Brandt, 2010).

Moreover, JRCALC do not suggest either hyperventilation of hypocapnia as part of the management of head injury patients, as referred to by some of the PhD participants (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; Joint Royal Colleges Ambulance Liaison Committee, 2020). The reference to this approach by participants in this research may be as a result of this treatment being used in other fields of medicine and healthcare and therefore featuring in literature available to the clinicians, however this approach remains controversial, and any supportive evidence is specific to patients with increased ICP, of which it is not possible to confirm in the pre-hospital setting (Zhang, Guo and Wang, 2019; Bogossian *et al.*, 2021; Brandi *et al.*, 2019; Wettervik *et al.*, 2020; Ensnault *et al.*, 2018).

Moreover, despite the understanding of how hyperventilation may effect ICP through vasoconstriction causing reduced cerebral blood and subsequent reduction in ICP, it is noted that more evidence is needed regarding patient outcomes post their initial injury (Zhang, Guo and Wang, 2019). It is also known that physiologically hyperventilation will cause hypocapnia which may explain the reference by a participant in this PhD study to aim to achieve this measurable outcome (Sharma and Hashmi, 2023).

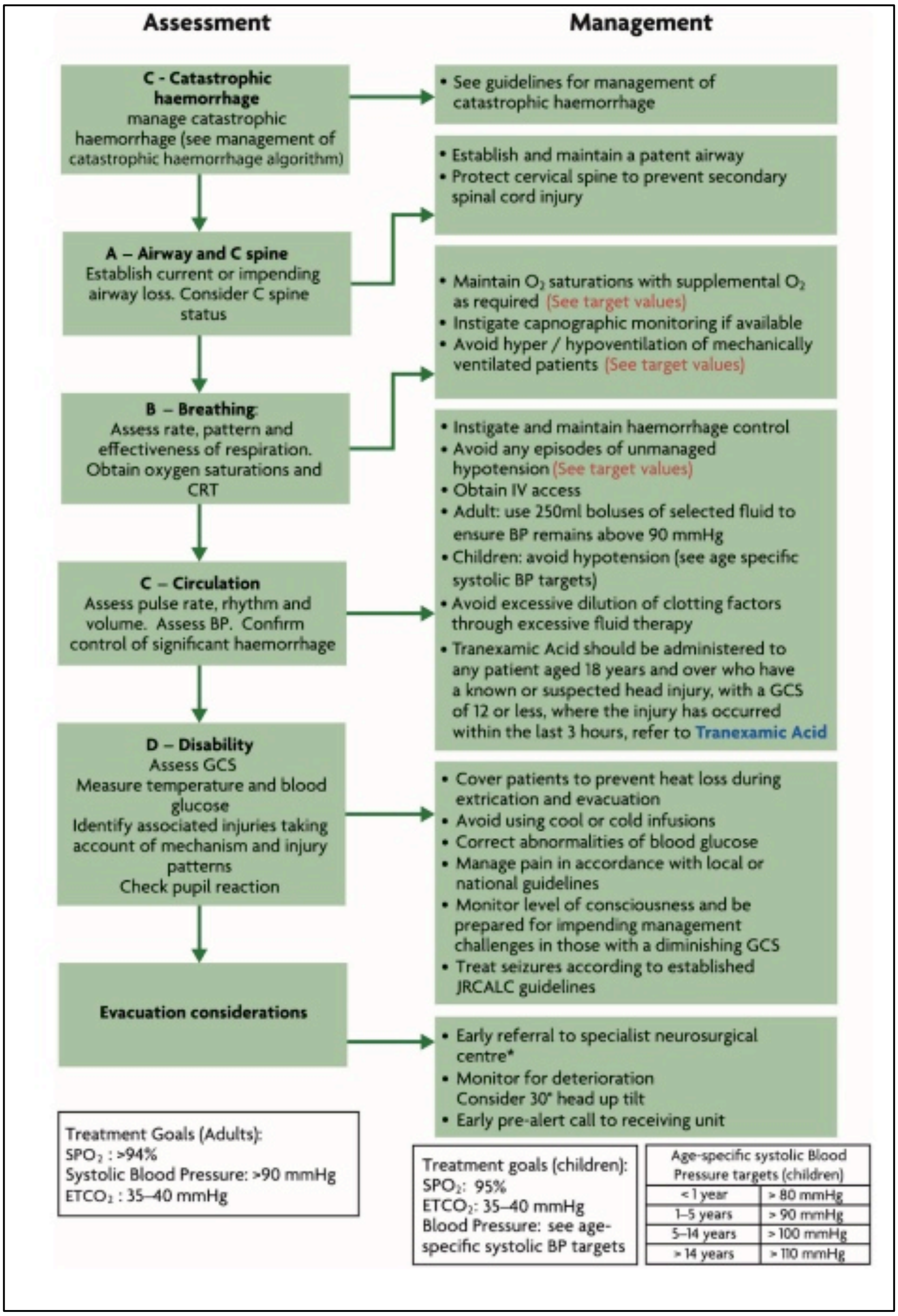


Figure 59 - JRCALC 2019 Head Injury Algorithm (with 2020 Crash Trial TXA Addition) (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives 2019).

Participants in this PhD research identified additional pharmacological skills required to consciously sedate and assist with airway management, up to and including RSI. Moreover, there was a wider conversation around the perceived need for paramedics to be able to RSI as a separate advanced skill. However, some participants were frustrated as they felt their employing trust / organisation did not support the implementation of some of these advanced airway skills despite their understanding that these were supported within JRACLC. Several years before the data collection within this PhD, in 2008, the college of paramedic recommended that tracheal intubation should not be included in mandatory training for UK paramedics (Deakin *et al.*, 2010). Therefore, resulting in an initial de-emphasis within paramedic practice guidelines in favour of a step-wise approach and a recognition of a comparable benefit with Supraglottic airway devices (Deakin *et al.*, 2010). Furthermore in light of this recommendation, a structured questionnaire was sent to the medical directors of each of the 14 UK ambulance trusts to establish if they were still teaching tracheal intubation, the results of which confirmed that intubation was still practiced in all UK ambulance trusts despite the JRCALC recommendations (George, Smith and Moore, 2012; Deakin *et al.*, 2010). Despite the college of paramedics statement on tracheal intubation supporting the skill as long as appropriate training and maintenance of competence was in place (College of Paramedics, 2018a), many ambulance trusts have since removed intubation from paramedic practice unless provided by advanced paramedics; this has taken place post the data collection in this PhD (Unison EEAS Branch, 2020; Younger, Pilbery and Lethbridge, 2016; Unison SWAAHB, 2020).

Moreover, the benefit of tracheal intubation without pharmacological drugs has been debated for over 20 years, with findings suggesting that patients who are intubated without drugs were unlikely to have a successful outcome as a result of their presenting condition allowing for such an intervention (Lockey, Davies and Coats, 2001; Christensen, 2003; Davis *et al.*, 2003; Murray *et al.*, 2000; Gausche *et al.*, 2000). This was recognised by participants in this PhD as seen in Quote 33 and Quote 34 within Chapter 6.

Although participants in this research were discussing the need for RSI as a skill in trauma patients, they were also accepting that in the absence of this skill they would benefit from the addition of various prescribed medication in order to consciously sedate patients to better manage their airway, as seen Quote 35, Quote 36 and Quote 37 within chapter 6.

In 2012, pre the data collection within this PhD study, The Royal College of Surgeons of Edinburgh, Faculty of Pre-Hospital Care, published a PALM Consensus Outcome Paper (Faculty of Pre-Hospital Care, 2012). Multiple stakeholders from across pre-hospital care contributed to the process and final paper, including several NHS Ambulance services, Air Ambulances, The College of Paramedics and Medic led services such as BASICs. As part of the consensus process the stakeholders conducted a review of evidence and acknowledged that although there is strong evidence to support the use of Supraglottic Airway Devices (SAD) such as a Laryngeal Mask, in pre-hospital care, there is scant evidence to support PALM (Faculty of Pre-Hospital Care, 2012).

The use of a SAD in pre-hospital care would normally be used in a patient who already has a GCS low enough to tolerate the insertion without pharmacological intervention, such as those in cardiac arrest (Faculty of Pre-Hospital Care, 2012). PALM is a procedure which uses a SAD alongside a pharmacologically induced reduction in GCS to allow for this to happen, without neuromuscular blockade (Faculty of Pre-Hospital Care, 2012). Although the consensus recognised the limited evidence for PALM, it did however decide to recommend the use of this technique, given that the decision to use PALM would only be made in patients for which all other airways managements had been tried or were not available and therefore the risks associated with PALM outweighed the risks to the patients should the technique not be performed (Faculty of Pre-Hospital Care, 2012).

The consensus however recommended that the technique should be checklist driven, the use of end-tidal CO2 (ETC02) should be mandatory, it should only be performed by level 7 clinicians who are highly experienced in pre-hospital care, especially the management and transfer of critically ill patients and the ongoing management of sedation with the ability to perform surgical airways (Faculty of Pre-Hospital Care, 2012). This would limit the amount of Paramedics able to perform PALM to small numbers and likely to only be those who operate in Critical Care Practitioner Roles (Faculty of Pre-Hospital Care, 2012). The consensus stated that there was little evidence to inform the choice of drug for PALM, however they recommended either the use of Midazolam or Ketamine and further suggested that doses should also not be restrictive but tailored to patient response and thus allowing for titration to achieve the required response (Faculty of Pre-Hospital Care, 2012).

Participants in this PhD study also discussed the general practice of sedating patients with head injuries, as can be seen below. There was however some frustration among participants who felt that much of this is supported in the JRCALC guidelines but the implementation of such had not been enabled by local trusts and employers, as seen in Quote 38, Quote 39 and Quote 40 within Chapter 6.

There are multiple medications available which can offer sedation, reduction of ICP, management of seizures or facilitate ventilation in head injury patients, including propofol, ketamine, benzodiazepines, barbiturates, narcotics, etomidate and dexmedetomidine (Flower and Hellings, 2012). There is some evidence to suggest the use of benzodiazepines for sedation in TBI, Midazolam offers the most benefits and delayed neurotoxic effects (Flower and Hellings, 2012; Sebastiani *et al.*, 2022).

JRCALC advise to treat seizures in head injury patients as per their seizure management guidance where midazolam is mentioned (Joint Royal Colleges Ambulance Liaison Committee, 2020). However, there is no separate guidance for the use of Midazolam in head injury patients without seizure management (Joint Royal Colleges Ambulance Liaison Committee, 2020). It is however possible for Ambulance Trusts to create separate trust protocols for their enhanced and advanced paramedics, such as their critical care air ambulance practitioners which may involve patient group directives (PGDs) allowing for additional scope of practice when administering medications (NICE, 2017).

Moreover, participants in this PhD also discussed using prescribed medications in order to pre-treat before intubation, the statements immediately above and below were made within a case study conversation in phase 3 of this PhD, a conversation that one participant later went on to suggest was ‘worrying’ and ‘risky’ as can be seen in Quote 41, Quote 42 and Quote 43 of Chapter 6.
Pre-treatment with medications is step recognised in intubation as part of an RSI procedure and may be used before administering sedatives and Neuromuscular blocking agent’s (NMBA). This may involve the administration of a short acting opioid such as fentanyl as well as options such as IV fluids, anxiolytics and benzodiazepines, or a short acting beta-agonist for reactive airway disease. All of which are to optimize the patient and clinical setting where intubation is being

performed (Smith and Van Meter, 2018; Ghatehorde and Regunath, 2023). However, discussions highlighted in the comments above were outside of an RSI procedure and so there would have been no further administration of a sedative or NMBA and so the continued use of a short acting opioid would not be indicated, and as such the initial pre-treatment would also not be safe practice as this would suggest the patient required RSI and in the absence of a trained clinician an alternative stepwise airway management plan should be instigated (Ghatehorde and Regunath, 2023).

The skill of RSI can feature in the offer of a critical care team as these teams consist of medical doctors as well as critical care paramedics (CCP), however the CCP may not be permitted to perform this skill without medical supervision and depending on resourcing this may not always be available (Avery *et al.*, 2021).
Participants recognised that the skill of RSI is available to the patient via a critical care team and the support of senior colleagues was mentioned multiple times by participants, an example is seen in Quote 44 in Chapter 6. However, participants also recognised the potential for this resource not to be available as these are smaller specialist teams of which there are only a few across an ambulance trust footprint, as seen in Quote 45 in Chapter 6. This had also been recognised as a potential issue in literature published during the course of this PhD research (Cross, 2018).

In the UK pre-hospital care is based on an Anglo-American model of being paramedic led as opposed to the Franco-German approach of pre-hospital care being physician led (Dick, 2003). This Anglo-American model is complimented in the UK by medical doctors, until recently this has been with local agreements and variations as there was no pre-hospital speciality for medics. However the UK has become the first European country to standardise care via the introduction of pre-hospital medicine as a sub speciality within anaesthetic and emergency medicine (Lockey, Crewdson and Lossius, 2014). Participants in this research recognised the time needed to RSI on scene and the conflicted argument between spending that time on scene to perform a skill that may be beneficial once the patient has arrived verses prioritising making progress to hospital and for the skill to be performed after arrival, as seen in Quote 46 and Quote 47 in chapter 6. Although literature recognising that non critical care paramedics in the UK will rarely see major trauma patients and thus the need to use a skill such as RSI would be rare (Henderson *et al.*, 2019), the wider literature also suggests that those trauma patients who require RSI when arriving in the emergency department would have clearly required it on-scene (Sollid, Lossius and Soreide, 2010; Sollid *et al.*, 2010).

However a study predating the JRCALC intubation statement in 2008 (Deakin *et al.*, 2010) already recognised that RSI in head injury patients by paramedics, increased cases of hypoxia and hyperventilation resulting in increased mortality rates, however those patients who survived were shown to have better neurological outcomes (Davis *et al.*, 2004). Furthermore, the Head Injury Retrieval Trial (HIRT) also reported improved outcomes for pre-hospital patients receiving tracheal intubation however the study has transferability or reliability issues pertaining to the inability to differentiate between physician and paramedic led care and recruitment issues (Garner, Fearnside and Gebski, 2013). Participants in this PhD are supporting the discussion pertaining to the benefit of RSI or advanced airway management options in the head injury patient and thus suggestive of a better understating of the benefits to this specific cohort of patients and a greater understanding of the reality of that perceived need, as overall participants recognised the challenges in managing the airway of a head injury patient as summed up in Quote 48 in Chapter 6.

Whilst much research and discussion have taken place regards RSI in pre-hospital and paramedic practice, delayed sequence intubation (DSI) is also a variation on this practice, as mentioned in Quote 49 in chapter 6, which may warrant further research. DSI allows for patients to be given a dose of ketamine before pre-oxygenation then followed by neuromuscular block and intubation as opposed to pre-oxygenation as the first step in an RSI protocol (Taylor and Hohi, 2016). Post data collection, a recent 2023 study, found that DSI was of benefit in managing the airways of trauma and combative patients with fewer incidences of pre-intubation hypoxia and increased first attempt success at tube placement when compared with RSI (Bandyopadhyay *et al.*, 2023).

Participants in this PhD study also recognised the important place for a stepwise approach to airway management and the use of other adjuncts but identified what they felt there to be a need for further research in this area, as seen in Quote 50 and Quote 51 within Chapter 6.

7.2.1.4 Managing head injuries in the older adult.

Most ED attendances with head injuries are in the older adult population (over 65) and usually the result of low impact such as falls from standing (NICE, 2014a). The total of ED attendances for head injury to ED's in the UK is 1.4 million and with the over 65 population expected to increase from 18% to 21% by 2030, the possibility of an increase in overall head injury attendances to ED is of concern (Office for National Statistics, 2022; NICE, 2014a). This concern is related not only to demand on the system but also the unnecessary experience for the elderly patient given that most elderly patients with head injuries are non-fatal and not requiring specific or specialist intervention (NICE, 2014b).

The findings of this research show that participants were discussing older adults in terms of the prevalence, complications, ethics and ultimate 'best place of care' for this patient cohort, examples of this can be seen in Quote 52 and Quote 53 within chapter 6.

There was recognition that the elderly may have pre-existing health conditions such as dementia and that ethically it may not be appropriate to transport them for further care and intervention, or that ED may not be the best place for a patient with dementia. The recognition by participants of the potential need to avoid hospital admission for patients with dementia, as seen in Quote 54, Quote 55 and Quote 56 within Chapter 6, is in keeping with NICE advice which states that alternatives to hospital and advanced planning should be considered before admission (NICE, c2020). NICE recognise that hospital admission can lead to increased confusion, distress and delirium in patients with dementia which can result in increased hospital length of stay, deconditioning and a lower prognosis of returning home independently (NICE, c2020). NICE also state that all acute trusts in England were asked to commit to becoming 'dementia friendly' as part of the 'challenge on dementia 2020' (NICE, c2020; Department of Health, 2020). However, despite these recognitions and targets, 1 in 4 hospital beds are occupied by patients with dementia and the number of short stay admissions for people with dementia has increased year on year with an overall increase from 94,908 in 2014/15 pre-PhD data collection to 115,125 in 2017/18 post PhD data collection completion (NICE, c2020).

Participants also considered guidance regarding the need to CT scan elderly patients due to age alone or in addition to prescribed anticoagulants and the potential confusion between guidance on anticoagulants verses guidance on antiplatelet medication, when deciding on the need for a head injury patient to be transported for a CT Head Scan.
Discussions included how there was felt by some to be 'no choice' in the decision to transport these patients, however it was also felt that a CT scan in these patients may not be needed as it may not ultimately change their care plan, as can be seen in quotes Quote 57, Quote 58 and Quote 59 within Chapter 6.

Head Injury Guidance published by NICE at the time of data collection recommended conveyance to hospital for head injury patients with a GCS of under 15 (NICE, 2014a). The perception of participants in this PHD research is that they had little choice in decisions to transport some patients to ED with a head injury. This was later reflected in a paper published on 'factors in influencing conveyance of older adults with head injuries' in 2022 (Nicholson *et al.*, 2022). Moreover, additional previous and subsequent research in 'conveyance decision making' also supports the findings that paramedics can find guidelines restrictive of their autonomous practice and difficult to balance with a mismatch between their clinical opinion and guidance to convey (Voss *et al.*, 2020; Porter *et al.*, 2007).

Participants felt that guidance on the need for CT scans in a patient on antiplatelet medication was not as clear as the guidance for a CT scan in patients on anticoagulant medication as seen in Quote 60 and Quote 61 within Chapter 6.
NICE Head Injury Guidelines have been released three times pre data collection for this PhD, in 2003, 2007 and 2014 (Shanahan, 2023; NICE, 2014a). The main change in the 2007 guidelines post those of 2003, recommended specialist care for severe TBI patients, resulting in a reduction in admission mortality (Shanahan, 2023). The second pertinent change in 2014 was the guidance for all anti-coagulated patients to receive a CT Head Scan regardless of symptoms (Shanahan, 2023; NICE, 2014a). The guidelines have been updated again in May 2023, with a

change in emphasis on the decision to perform a CT Head Scan (Shanahan, 2023; NICE, 2023). The guidance now encourages clinicians to have a 'considered' approach to CT scan as opposed to a prescriptively 'do' approach (Shanahan, 2023; NICE, 2023), reflecting the findings of the AHEAD study in 2017, where patients on warfarin and a GCS of 15 with no other symptoms, were found to be at low risk of adverse outcomes post head injury (Mason *et al.*, 2017).

The confusion over anti-platelets requiring a CT Head scan, similar to anti-coagulants, found in this PhD data, was also supported within the findings of a multiple methods study published in 2022, involving a study of paramedics decision making to convey older adults with head injury patients (Nicholson *et al.*, 2022). The advice to 'consider' a CT head scan, within the 2023 update of NICE guidance, now also extends to patients on anti-platelets as opposed to a previous focus on anti-coagulants, which still also remains (Shanahan, 2023; NICE, 2023). The changes in NICE guidance may reduce the low threshold for conveyance in otherwise non-symptomatic patients as found in the findings of this PhD research.

The conversation of ethics in the elderly was continued amongst PhD participants in terms of the more general debate of whether to treat, considering more than dementia, but also how the counter argument to this may be an 'ageist' approach to decision making, examples of which are seen in Quote 62 and Quote 63 within Chapter 6. The use of the Clinical Frailty Score (CFS) can assist in these decisions and has been proven to be associated with clinical outcomes, thus supporting's its use in multiple clinical settings (Church *et al.*, 2020). Although age is not solely a prognostic factor, it is associated with levels of frailty which can be considered as a CFS of 5 of more (Darvall *et al.*, 2019; Muessig *et al.*, 2018) and recognised as having a higher associated in-hospital stay, long-term mortality and discharge to alternatives to home (Darvall *et al.*, 2018; Muscedere *et al.*, 2017; Andres *et al.*, 2022). Utilising the CFS, the clinical frailty network suggests considering patients with a CSF of 7 or more as more appropriate for palliative rather than restorative care (NHS Specialist Clinical Frailty Network, 2018).

Moreover, the dilemma of transporting for further care and the appropriateness of this decision needs to also be balanced by an awareness of what can be managed in the community, which is continuously evolving, as highlighted in Quote 64 in Chapter 6.

There is a need to reduce the number of older adults conveyed to ED with a head injury, as outlined at the start of this sub section, however, participants in this research feel they sometimes have ‘little choice’ in that decision due to guidelines which they sometimes feel conflicted with. As further explored in this chapter, some participants also felt guidelines, particularly JRCALC, are ‘gold standard’ and fear repercussions if they ‘step outside’ of these guidelines, or they fear the balance of risk associated with non-conveyance. This perception of risk regards the decision not to convey was supported by research in 2022 exploring the decisions of paramedics to convey older adults with head injuries (Nicholson *et al.*, 2022). That same study also revealed that despite the need to reduce the number of conveyances, 70.5% of the patients analysed were conveyed to ED and 81% of the patients conveyed met NICE and JRCALC guidance and criteria for conveyance (Nicholson *et al.*, 2022).

Post data collection of this PhD, NHS England have launched ‘frailty virtual wards’ across England, which provide an alternative to hospital for elderly and frail patients in the community (NHS England, 2021). An exclusion criteria to admission on a frailty ward is ‘injury requiring emergency intervention’ (NHS England, 2021), however as discussed above, with a CFS of 7 or above emergency intervention may not be advantageous (NHS Specialist Clinical Frailty Network, 2018). Moreover, using a provision such as ‘Same Day Emergency Care’ (SDEC) alongside a virtual ward may allow for greater assessment for emergency treatment while still avoiding admission (NHS England, 2023).

Health Education England also recognised that many admissions to hospital via ambulance could be avoided and as a result has piloted a new working model for specialist and advanced paramedics to rotate through varying clinical settings which alongside competency frameworks will see these roles further enhance patient care (Health Education England, 2018; Health Education England, 2020b; Skills for Health and College of Paramedics, 2019). A combination of specialist and advanced roles, alongside SDEC and virtual wards can all provide admission alternatives for the frail patient.

7.2.1.5 The need for CT imaging in head injury patients and pathways to achieve this.

The decision to convey for a head CT scan of an elderly patient has been discussed in the section above, however participants in this PhD also had several other CT related conversations regarding head injury patients, particularly the potential for future CT scans within the back of an Ambulance and the potential to change pathways to allow paramedics to take head injury patients straight to a CT scan on arrival at hospital.

Participants recognised the potential to introduce changes in pre-hospital pathways to allow for head injury patients to go direct to a CT scanner, but also the potential for CT Scanners to be available in an ambulance, as seen in Quote 65, Quote 66 and Quote 67 within Chapter 6.

As previously discussed in chapter 2, East of England ambulance service have recently introduced a CT Scan within the rear of an ambulance as part of a greater ‘stroke’ specific designed ambulance, but there are no further advancements in introducing this type of imaging provision for other patient groups at this time (Stannard, 2021; East of England Ambulance Service, 2020; Ebinger *et al.*, 2015). Moreover Paramedics have also been able to take patients direct to CT Scan, as suggested by participants in this PhD, however this has been specifically for patients within the catchment area of Kings College Hospital (Healthcare-in-europe, 2013) or for specifically for stroke patients once again, as part of the PASTA Trial ‘Paramedic Acute Stroke Treatment Assessment’ (Price *et al.*, 2019). There has been no publication of research findings from the King’s College Hospital pathway that could be found during the writing of this thesis. Findings from the PASTA trial suggested that this pathway did not increase the overall number of stroke patients receiving thrombolysis (Lally *et al.*, 2020). However, in 2023, the Welsh Ambulance Service, a participant in the PASTA trial, have recently announced plans for ‘Visionable’ teams to virtually triage stroke patients including the option to bypass direct to CT Scan, in their article announcing these plans they suggest they are hopeful the learning from this pilot could be transferred to other patient groups in the future (Lydon, 2023).

7.2.1.6 The use of pharmacological interventions in head injury patients, specifically IV fluids, IV TXA, Mannitol and Hypertonic Saline.

To advance head injury management, participants in this PhD research would seem to recognise a need for more advanced skills and decision-making pertaining to pharmacology options such as mannitol and hypertonic saline, an example of this is seen in Quote 68 in Chapter 6.
Paramedic's in the UK are permitted to administer Sodium Chloride 0.9% IV (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016), comments from participants, as seen in Quote 69 and Quote 70 within Chapter 6, show that this is taking place. However, there is evidence in this PhD that 'Keep vein open' (KVO) practice is still occurring which is no longer supported as EBP and a lack of clarity regards the target BP when administering fluids in head injury patients.
JRCALC guidelines advise using 250ml bolus's of supported fluid choice to achieve a BP of above 90mmhg systolic and avoid hypotension in head injury patients (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016; Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019). The practice of inserting a cannula and starting IV fluid as a 'precautionary procedure' is known to be common historically (Meenach, 2014; Paquet and Marchionni, 2016). However, evidence now supports removing this approach from practice as not all pre-hospital cannulas are used and the KVO approach may prove detrimental to the patient if not used between medications and done so with appropriate drip flow calculations and close monitoring of the requirements for fluids based on patient needs (Doyle *et al.*, 2021; Meenach, 2014). However, there are no specific paramedic studies relating to the practice of commencing IV fluids as part of a KVO practice, the appropriateness of this or the ability of paramedics to calculate necessary rates.

Sodium Chloride 0.9% is an isotonic solution (Anthon *et al.*, 2021); however, the participant above quoted a place for hypertonic solution in the management of head injury patients. Sodium Chloride 3% or 5% would be classed as hypertonic solution, with Sodium Chloride 0.45% as an example of a hypotonic solution (Anthon *et al.*, 2021). A hypertonic solution has a higher concentration of dissolved particles than blood (Anthon *et al.*, 2021) therefore drawing fluid into the bloodstream from the tissues and as such may reduce water volume inside and between brain cells thus having the effect of lowering ICP (Blanchard *et al.*, 2017; Chen, Song and Dennis, 2019).

The use of mannitol is also mentioned by participants in this PhD as a means of treating head injury patients. Mannitol is also known to have the effect of reducing ICP (Diringer, 2016), although recognised side effects include a rebound of cerebral oedema and acute renal injury (Boone *et al.*, 2015). Moreover, a meta-analysis of literature from 2010 to 2019, comparing the effects of 3% hypertonic saline and 20% mannitol solution for the management of intracranial hypertension found that although both can effectively reduce ICP, 3% hypertonic saline has a more sustained effect and can effectively increase cerebral perfusion pressure (Shi *et al.*, 2020). However, despite class II evidence to support the use of 3% hypertonic saline in paediatrics with head injury (Kochanek, Carney and Adelson, 2012), the Traumatic Brain Foundations 4th edition guidelines state there is insufficient evidence to support the use of any hyperosmolar medication in patients with severe TBI (Carney *et al.*, 2017).

Participants also referred to administering TXA in patients they were reflecting on, as seen in the results within chapter 5, however the majority of these mentions were in relation to using TXA in trauma patient's for reasons other than their head injury (Crash-3 trial collaborators, 2019). In the absence of a change in practice regards TXA, participants recognised the potential dilemma regards using TXA when an isolated head injury was not easy to define; an example of this is seen in Quote 71 within chapter 6,

However, in July 2020, post data collection, AACE made the following statement:

The assessment and management of head injury algorithm is amended in line with this recent JRCALC update: 'Following the results of the CRASH 3 trial, Tranexamic Acid should be administered to any patient aged 18 years and over who has a *known or suspected head injury, with a GCS of 12 or less, where the injury has occurred within the last 3 hours.'* (AACE, 2020c)

7.2.1.7 The use of GCS scoring in head injury patients.

In written and case study reflective activities within this research, the greater focus and activity is related to complex decision making in the assessment and management of head injury patients with a high GCS. Previously literature suggested that a severe brain injury can be classified as a GCS below 8 (Teasdale and Jennett, 1974), using this as a point of reference, the data from this PhD would suggest that within the case studies and written reflections, participants were choosing to focus on patients with a potentially minor head injury, suggestive that decision making in the minor head injury or higher GCS patient may be more complex for the paramedic in a pre-hospital setting. This PhD research suggests that decision making in the patient with a lower GCS is easier as that constitutes a red flag, an example of this is seen in Quote 72 within Chapter 6.

The term 'GCS' also featured frequently throughout all phases of the research and was quoted as a common observation in almost all patients interactions, as advocated by both JRCALC and NICE head injury guidelines as part of an ABCDE approach (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; NICE, 2014a). However, GCS has been noted in previous literature as not sensitive to identifying early increase in intracranial pressure and alternatives to monitor increase in ICP in the pre-hospital setting are limited or absent (Fodstad, Kelly and Buchfelder, 2006; ter Avest *et al.*, 2020). It was also noted by participants that GCS may not be a reliable indicator for decision making but more a 'guide' given the possibility of rapid changes in assessment, an example of which is seen in Quote 73 in Chapter 6.

7.2.2 What is the hierarchy of actions?

The specific areas of focus, or actions, listed in section 6.2, were discussed by participants either within their overall patient consultation model or within their patient management structure. These models or structures could therefore be viewed as a hierarchy of the actions relating the 'assessment and management of head injury patients' but also more generally as a hierarchy in clinical decision making in paramedic practice.

A consultation model such as the Calgary-Cambridge model is often used in healthcare to achieve a structure for clinical decision making or 'Hypothetico-deductive reasoning'. This type of consultation model not only allows for a structured approach to clinical assessment but also a patient focused consultation through the inclusion of 'history taking', discussion of 'perceived problem' with the patient and the formulation of differential diagnoses, with appropriate treatment planning (Kurtz, Silverman and Draper, 1998; Silverman, Kurtz and Draper, 1998). Moreover, this patient focused process should summarise with 'shared decision making' that builds on the initial 'perceived problem' and considers any potential health beliefs which may impact on compliance or concordance of the recommendations and treatment plan, including any necessary follow up to ensure the success of a plan (Main *et al.*, 2010; Kurtz *et al.*, 2003; Snowden and Marland, 2012).

7.2.2.1 Viewing the hierarchy of actions through the consultation model.

When specifically considering the assessment and treatment actions during patient contact, the research findings show that the participants within this PhD research were using a Review of Systems (ROS) also known as the systematic enquiry (Douglas, Nicol and Robertson, 2013; Collen, 2018), with the addition of the 'patient assessment triangle' (Halliwell *et al.*, 2013) blended into the medical note taking model (Douglas, Nicol and Robertson, 2013) or a CABCDE primary survey model approach to care (Halliwell *et al.*, 2013), as can be seen in Quote 75 within Chapter 6.

Historically ambulance-based care and clinician teaching has been based on the cardiopulmonary resuscitation ABC approach (Airway, Breathing, Circulation). The ABCDE primary assessment became standard (Halliwell *et al.*, 2013). In 2007 Southwestern Ambulance (SWAST) decided to go against the suggested ABCD approach and implemented the CABCDE approach which they designed based on the *'ABC to <C> ABC: refining the military trauma paradigm' paper* (Halliwell *et al.*, 2013; Joint Royal Colleges Ambulance Liaison Committee, 2006; Hodgetts *et al.*, 2006). After several reviews of teaching processing and reflections by educators within SWAST they realised it was difficult to teach clinicians the skill of recognising ‘gut intuition’ to make immediate decisions on patients severity (Halliwell *et al.*, 2013). However, after attending a paediatric specific educational course, educators within SWAST reflected and subsequently update their approach to incorporate an adaption of the paediatric triangle for adult use (Halliwell *et al.*, 2013) as seen in Figure 64.

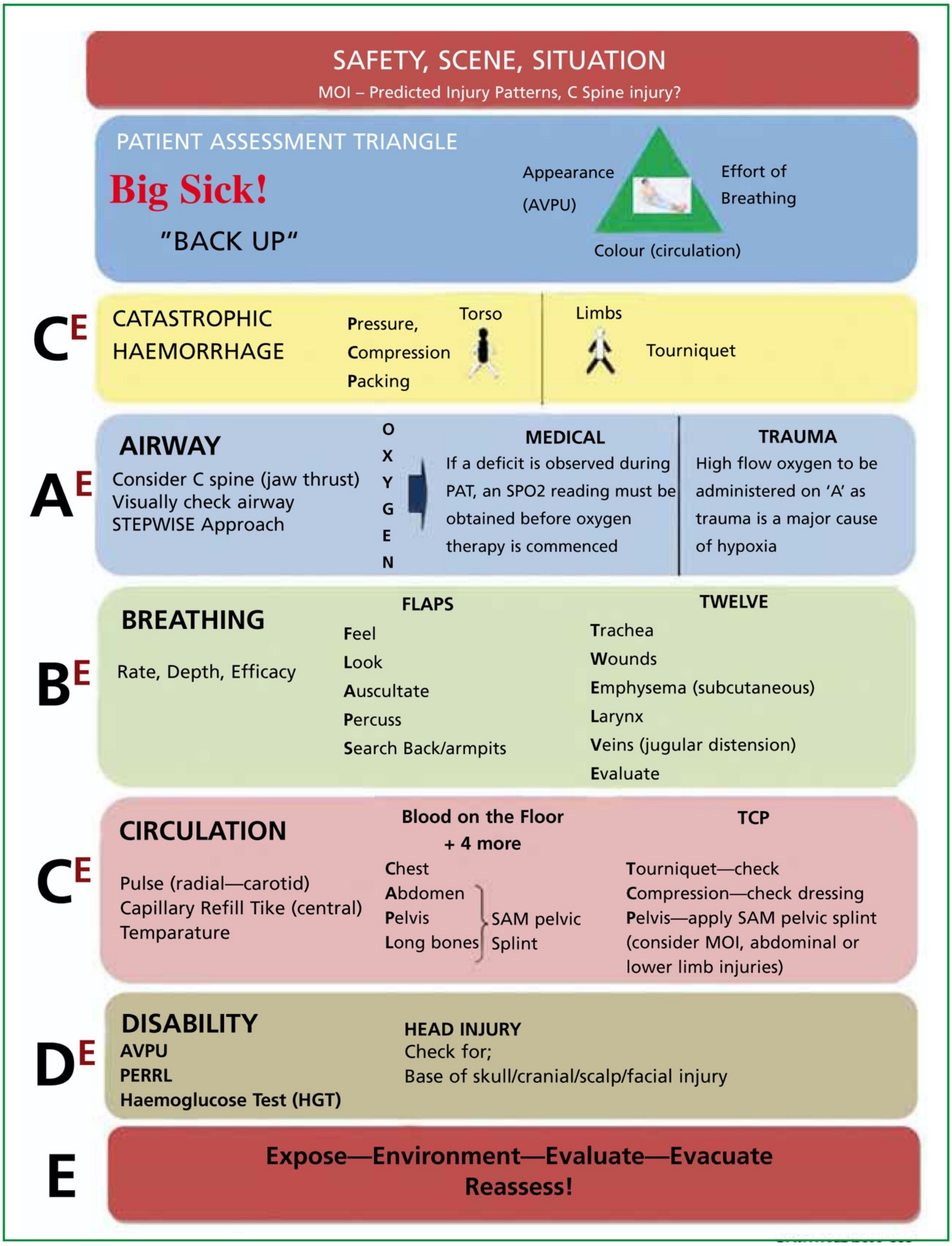


Figure 60 - Revision of the Primary Survey (including the patient assessment triangle). Halliwell et al 2013

A Netherlands study in 2017 recognised the importance of competency in the ABCDE approach for management of patients in the emergency department, and explored the frequency of use of this approach and reasons for using or not using this assessment structure (Olgers *et al.*, 2017). Part of the justification for that study was a lack of previous research and knowledge regarding how often this approach was used and with what level of completeness in medical patients (Olgers *et al.*, 2017). The study observed 270 patients for which 206 were identified as potentially unstable and therefore suitable for an ABCDE approach. Clinicians used the ABCDE approach in 31% of the 206 patients identified. During the use of the ABCDE approach, it was noted that the structure was used with 80% or greater completeness and implemented rapidly (generally within 10 minutes). Moreover, reasons for implementing, or opting to not use this approach, were based on initial vital signs and subsequent triage coding (the higher coded patients were managed with an ABCDE approach (Olgers *et al.*, 2017). The trauma code utilised in that study was the American Emergency Severity Index (ESI) (Olgers *et al.*, 2017; Gilboy *et al.*, 2020).

Research by (Halliwell *et al.*, 2013) and (Olgers *et al.*, 2017) recognise and promote the use the ABCDE approach and the patient triangle as 'clinician decision making' tools relating to initial patient severity. Moreover, further research is needed to review the clinical decision methods used by clinicians in the UK (Halliwell *et al.*, 2013), a recommendation the findings of this PhD may contribute to.

However, the JRCALC head injury algorithm and NICE head injury guidelines, as discussed in chapter 1 (section 1.4.3), both encourage the ABCDE approach to achieve clinical observations and structure assessment (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2019; NICE, 2014a).

Although it is noted that this approach can limit the focus on clinical observations to a specific list of assessment options, such as GCS, Pupil assessment and the Cushing Triad which are not sensitive to identifying early increase in intracranial pressure (Fodstad, Kelly and Buchfelder, 2006; ter Avest *et al.*, 2020), as demonstrated in Quote 76 within Chapter 6.

The Netherlands study found that up to 20% of the ABCDE approach is not always being used (Olgers *et al.*, 2017). The ’review of systems’ (ROS), however, provides an alternative consultation structure, to the use of the ‘primary survey’. JRCALC advocates an approach related to a review of systems, however this is referred to as a secondary survey approach and much like the use of the ABCDE approach for initial severity decision making, this secondary survey is advocated for similar use and includes a survey of the Head, Chest, Abdomen and Limbs (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2016). The findings from this PhD may suggest that this the incomplete use of the ABCDE approach is as the result of clinicians using a blended approach between previously advocated primary and secondary surveys in patients who may either not immediately present as time-critical or who present with a higher GCS but in an emergency first contact presentation. This is seen in quotes 2, 4 and 5 of Chapter 6.

7.3 Understand ‘Why’ paramedics are making the decision they are, in relation to the management of head injury patients?

Of the mediated means mentioned by participants, as highlighted in chapter 6, section 6.5.1, JRCALC was discussed frequently and with intense focus in some elements of data collection. This sub section will now discuss how participants are using JRCALC in mediated actions and how this relates to some of their wider discussions around mediated means at various stages of the chain of mediated actions in practice.

7.3.1 How are these mediated means used in these actions?

There would seem to be a division in staff opinion regarding the place for JRCALC in current practice, varying from in full support and revering the guidelines to seeing it as a ‘fad’ or only one of many sources for consideration. JRACLC may be considered the national standard for ambulance service practice in the UK and is used as a teaching resource in paramedic education within ambulance trusts, universities and endorsed by the college of paramedics. This would appear to be supported by some of the participants in this study, however this is accompanied by a fixed perception that JRCALC is ‘best practice’ and therefore an associated frustration when trust guidelines or protocols do not support all staff to use the skills referred to within the latest JRCALC edition, examples of which can be seen in Quote 79 and Quote 80 in Chapter 6.

Some participants were also outwardly frustrated with JRCALC to varying degrees, varying from seeing it as a ‘fad’ or a resource that is often ‘out of date’, to perceptions of purposeful attempts to restrict the growth of the profession; examples can be seen in Quote 81, Quote 88 and Quote 89 within Chapter 6.

The perception that guidelines such as JRCALC can ‘restrict’ decision making, referred to here as ‘clipping wings’ was also shared by paramedic participants in a 2022 study by South Western Ambulance Service (Nicholson *et al.*, 2022).

Paramedic specific pre-hospital guidelines in the UK are produced by The Joint Royal Colleges Ambulance Liaison Committee (JRCALC) in partnership with The Association of Ambulance Chief Executives (AACE) (Joint Royal Colleges Ambulance Liaison Committee, 2021a). JRCALC published their first version of guidelines in 2006, these were then superseded by a revised version in 2013 and subsequently updated every three years with versions in 2016, 2019 and the latest version in 2022 (Joint Royal Colleges Ambulance Liaison Committee and Association of Ambulance Chief Executives, 2022; Joint Royal Colleges Ambulance Liaison Committee, 2021a). Despite guidelines only being released every three years, there are also on-line updates available through the JRACLC or iCPG app (Joint Royal Colleges Ambulance Liaison Committee, 2021b). On their webpage JRCALC refer to these as defining sources which should be used, as seen in the quote below:

“...the JRCALC apps have become the defining source for clinical guidance for UK paramedics and should be used to inform clinical decision making.” (Joint Royal Colleges Ambulance Liaison Committee, 2021b).

There have also been pocket guide versions released in 2013, 2016, 2017, 2019 and 2021 (Joint Royal Colleges Ambulance Liaison Committee, 2021a).

Views expressed in the data collected within this PhD has subsequently been supported in a paper published in 2023, which also suggested that issues have been raised regarding the period between JRCALC updates and that three years is too long and leading to protocols being out of date by the time editions are published. The paper does note that the app is available which should overcome this delay in publications, however they also refer to issues with downloading and accessing apps on certain devices (Dowling, 2023). A previous paper in 2013, pre-PhD data collection, also recognised clinicians felt JRCALC could influence their decision making away from their intended action rather than support them in that decision, thus preventing them from being autonomous and making what they felt to be the best decision for the patient (Gregory, 2013).

Some of those who still recognise a place for JRCALC in their practice do however seem to be moving away from recognising it as the main source of their EBP and are widening their sources to include less traditional or formal forms of mediated discourse, such as twitter and podcasts, as can be seen from Quote 82, Quote 100, Quote 101 and Quote 85 within Chapter 6.

Chapter 2 of this PhD has previously discussed the use of twitter, Facebook, and other social media within both NHS Trusts and by individuals and voluntary groups of likeminded clinicians to facilitate and enable professional discussions and CPD activities. The increased use in social media as a mediated discourse in EBP and CPD has been recent in the paramedic profession but also grown rapidly in popularity as demonstrated by numbers of ‘membership’ or contributors in forums and activities (Richardson *et al.*, 2016) as well as peer guidance on engagement (Batt, 2014). However, there have also been questions raised over confidentiality and professionalism while using social media platforms for these activities (College of Paramedics, 2009; London Ambulance Service, 2015; Baron, 2017). As such professional bodies have adapted in order to also provide governed virtual alternatives (College of Paramedics, 2019a), but also guidelines on standards of professional engagement while using social media (Parameducate, 2016; AACE, 2019). Moreover, encouragement for the inclusion of these platforms in formal education is also being encouraged (Higginson, 2017; Peck, 2014; Nelmes, 2012; Jones *et al.*, 2016; Jones *et al.*, 2021).

This move away from JRCALC extended into discussions pertaining to how the mediated means were used in the mediated action of clinical decision making, with a perceived move away from prescriptive use of guidelines towards a more descriptive approach, as could be seen in Quote 83 and Quote 84 within Chapter 6.
When discussed in the wider context of formal alternatives to JRCALC, participants seemed to be overwhelmed by the multiple sources to be used ‘in action’ while with a patient. This was noted as both a conscious awareness of such, and a retrospective reflection on a missed opportunity, as captured in Quote 86 and Quote 87 within Chapter 6.

In the 10 years prior to this PhD data collection, literature also recognised a potential excess of clinical guidelines which can be difficult or impractical for clinicians to stay up to date with thus impacting on successful implementation and utilisation (Grol, 2010; Gagliardi *et al.*, 2011). Research focusing on acute physicians in 2005 found that in order to treat patients with 44 diagnoses over the course of a clinical shift, the clinician would have needed to read 3679 pages of clinical guidelines (Allen and Harkins, 2005). Although not published, the researchers state they repeated the study in 2009 finding similar results with a total of 1131 pages of clinical guidelines for 41 diagnoses (Allen, 2010). Although not paramedic specific research, these findings would have been transferable as this was completed in an acute clinical setting.

Throughout this PhD research there were mentions of the shift in the profession from non-graduate to graduate entry education, there seemed to be an awareness of this shift, and participants also had a perception of a change in paramedic ability and attitude associated with graduate entry. However, there is a spectrum of views both in favour and support of the change in the profession but also those who are cautious or against such change, as seen in Quote 90 and Quote 91 in Chapter 6, despite the first graduate paramedics entering the profession in 2004 and the first seconded or employed paramedics into NHS MIU’s taking place in 2002, 12 and 14 years before PhD data collection commenced (College of Paramedics, 2020f; Catterall, 2012). The move into higher education was deemed necessary for previous ‘vocational’ ambulance service training to evolve and meet the contemporary needs of the growing profession (College of Paramedics, 2008; Association of Chief Ambulance Officers, 2011; Department of Health, 2005).

7.4 Understand 'how' paramedics are engaging with reflective discourse and how this relates to their greater paramedic practice?

After identifying the 'Sites of Engagement', in the analytical process of chapter 5 and findings within chapter 6, the guided MDA analytical approach further prompts the question:

- What histories in habitus do these practices have?

7.4.1 Emerging habitus within the Nexus

In chapter 6, three 'nexus golden threads' were identified, these were 'collaboration with peers and seniors', 'The Virtual Space' and 'patient-pathways'. These will now be further explored to understand how they feature within practices and as a key component of the overall nexus of practice.

7.4.1.1 Collaboration with Peers and Seniors

Collaboration and support from peers and seniors feature regularly across the data analysis within the phases of this PhD. This included peer learning and support both during a patient interaction and afterwards, to learn from reflection and CPD activities. The ability to learn from reflective and CPD activities featured as an important aspect of clinicians working lives but also a recognition of some challenges to achieve this in terms of time and the ability to come together for such activities. Specific to the care of head injury patients, the use of ED consultants or senior doctors, critical care or HEMS teams, critical care paramedics or GPs featured regularly as supportive members of staff to increase or widen assessment and treatment options.

Previous literature acknowledges the importance of teamwork in healthcare and recognises 70% of medical errors can be attributed to 'poor' teamwork, particularly 'poor communication' (West and Lyubovnikova, 2013; Hassan, 2018; Jirapaet, Jirapaet and C., 2006; Barrington *et al.*, 2015; Koleva, 2020; Aghighi, Aryankhesal and Raeissi, 2022; Rabol *et al.*, 2011). However, it is noted that working in a group of people, sometimes referred to as a team, within healthcare, brings with it an assumption that teamwork is being achieved, which may be no more than an illusion (Jirapaet, Jirapaet and C., 2006). It is important to ensure such teamwork has clear coordination, role allocation, closed loop communication, supportive cultural conditions and shared responsibility for the benefits of true 'teamwork' to be realised (West and Lyubovnikova, 2013; Zajac *et al.*, 2021).

However, there were some specific negative opinions and experiences when participants in this PhD were discussing senior and peer collaboration, in particular attitudes towards junior doctors, availability of senior clinical colleagues, perceived reliance on volunteers and attitudes towards challenging students. Professional relationships between colleagues is vital in the success of multi-disciplinary team working but sub-cultures and perceptions between professions and grades can cause barriers in this way of working (West and Lyubovnikova, 2013; Zajac *et al.*, 2021). These barriers can be a negative side effect of a purposeful design. For example, historically teams in healthcare were single-disciplinary, however in order to benefit from shared decision making and an increase in skills and experience, many teams are now multidisciplinary or interdisciplinary (Jeanes and Hamilton, 2018; Ruiz, 2020; Brown, Crawford and Darongkamas, 2008).

However the expansion of a team to other disciplines may also bring with it a hierarchy, or perceived hierarchy through senior grades or discipline identities that may not have not been evident or prevalent in a single-disciplinary structure (West and Lyubovnikova, 2013; Liberati, Gorli and Scaratti, 2016). With this perceived authority structure or discipline boundaries may then come conflict leading to decision making conflict, and an undermining of quality of care (West and Lyubovnikova, 2013; Liberati, Gorli and Scaratti, 2016). Furthermore, healthcare teams may differ in the stability of their design, with some teams having permanence leading to the opportunity for effective team working to develop between familiar membership, while others are created reactively with only a temporal structure to achieve an immediate need, in which innovation is seen to be more prevalent (West and Lyubovnikova, 2013; Hollenbeck, Beersma and Schouten, 2012).

Barriers in effective team working is noted in existing literature with differences in the individuals experiences throughout their career as part of these barriers, such as differences in training, approaches to problem solving, their professional values and understanding of critical issues (Hall, 2005; Zajac *et al.*, 2021). Moreover, the individuals personal values and personal preferences regards communication styles will also impact on their participation in a shared goal (Bell *et al.*, 2018; Zajac *et al.*, 2021). Specifically in healthcare the barriers associated with professional silos, hierarchies and power balances are also recognised (Weller, Boyd and Cumin, 2014; Zajac *et al.*, 2021).
Specific examples of personal opinions which may create barriers to effective peer collaboration in this PhD research included attitudes towards doctors and students as well as a self-perceived importance relating to rank, uniform, and a sense of identity, supporting the idea that multidisciplinary teams can create issues with perceived hierarchy, power balance and profession specific silos as discussed above and seen in Quote 92, Quote 93,Quote 94,Quote 95 and Quote 96 in Chapter 6.

Participants in this research also referred to availability of senior clinicians and specifically in relation to the voluntary aspect of those supporting teams, such as British Association for Immediate Care (BASICs) (BASICS, 2020), and Helicopter Emergency Medical Services (HEMS), operated by 21 Air Ambulance charities across the UK (Air Ambulances UK, 2023), as seen in Quote 97, Quote 98 and Quote 99 within Chapter 6.

A report by the Kings Fund found that staff were concerned the NHS may be relying on ‘non clinical’ volunteers in areas of service delivery which were already under significant demand, although this report did not feature clinical voluntary or charity organisations such as those referred to by the participants of this PhD (The Kings Fund, 2018). However, similar concerns over relying on services such as BASICS was expressed in the media back in 2011, when a newspaper article suggested doctors were filling gaps in 999 services but with a ‘striking’ inequality across the country (Daily Mail Reporter, 2011).

7.4.1.2 The virtual space

Participants regularly referred to how their practice within the nexus featured in virtual spaces either as an individual or with others, as seen in Quote 100, Quote 101, Quote 102, Quote 103 and Quote 104. Much of the mediated actions within these virtual spaces were related to evidence-based practice or CPD, whether 'in-action' such as referring to guidelines while with a patient, or 'for action' such as a shift away from face-to-face education, or finally 'on-action' such as reflective CPD activities. A variety of virtual spaces were referred to, in support of facilitating these activities, many of which are purposely designed for that mediated mean, such as an application for online guidelines (Joint Royal Colleges Ambulance Liaison Committee, 2021b), however social media also featured as a mediated means for these activities.

A multicentre survey published in 2016, the year of data collection initiation for this PhD, found a significant increase in the ownership of smartphones among Doctors and Nurses and frequent use of these devices in their clinical practice (Mobasheri *et al.*, 2016). The use ranged from messaging colleagues regarding patients including the sharing of pictures and the use of varying medical applications (Mobasheri *et al.*, 2016). This multicentre survey was conducted within only one trust and did not include Allied Healthcare professionals (Mobasheri *et al.*, 2016). A mixed discipline study conducted in 2020, in Iran, found that the majority of medical and paramedical students were using social networks for educational purposes, with the educational interaction deemed to be the main priority for use of social networking (Kimiafar, Banaye and Masoumeh, 2020).
Despite the pre-existence of virtual spaces for education and clinical activities as highlighted pre-data collection in chapter 2 of this thesis (Kim *et al.*, 2020a; Kim *et al.*, 2020b; College of Paramedics, 2019a; College of Paramedics, 2009; Parameducate, 2016; Batt, 2014), during the Covid-19 pandemic, virtual spaces were utilised increasingly as an alternative to the physical environment for learning. During that time more professional groups launched their inaugural online conferences and there was an increased use of platforms such as podcasts and webinars (Mouratidis and Peters, 2022). Moreover, (Rashid *et al.*, 2022) recognised that Twitter, through the use of FOAMed, was able to transcend geographical

borders, and the participants of this PhD have complimented those findings by suggesting Twitter also has the advantage of transcending professional borders, creating an equality in access to medical education which may not otherwise be so accessible. (Lim and Anyu, 2022) respond to this research by stating that Twitter is not the only social media platform to be present in the virtual medical education space and the upcoming use of TikTok, for example, should be considered in future research. Further understanding of the use of social media and social networking among paramedics within the UK would be advantageous in order to understand how the profession can support the CPD needs of these clinicians in an ever-increasing virtual world, capitalising on the transcendence of geographical borders and professional boundaries these activities enable.

7.4.1.3 Patient Pathways

The terms ‘stay and play’ and ‘load and go’ are known to be used in ambulance crew rooms to refer to time spent on scene assessing and treating the patient, versus the decision to load the patient onto the ambulance and transport to hospital as the most important intervention and the balance in-between (Hobson, 2013; Navarro, 2020). With regards to head injury patients and the suggestion to divert direct to a neurosurgeon, a similar trial was conducted in 2016, which recruited 293 patients over a 12-month period (Lecky *et al.*, 2016). The trial allowed paramedics within two ambulance services to transport head injury patients direct to neuroscience centers (Lecky *et al.*, 2016). Results showed that the ability to divert patients to neuro-centers created a bias in decision making favoring admission with an over triage of 13:1 for neurosurgery and 4:1 for TBI (Lecky *et al.*, 2016).

One of the main challenges noted in the study was the use of GCS as a criterion for divert and the prevalence of high GCS in TBI patients, within the elderly population. It was felt that increasing the GCS for inclusion would increase sensitivity but not specificity whereas further reducing the GCS criteria may correct some of the issues with specificity and over triage but would decrease sensitivity (Lecky *et al.*, 2016). However, as noted by participants in this PhD research, there is the need to also support vital signs on-route and ‘do more’ on scene, as well as having an adjusted pathway for admission, as seen in Quote 107. The addition of specialist or more advanced assessment and treatment options on scene may make diverting to neuro centers more feasible in the future.

7.4.2 A Meta-discursive Structure

In this section, the meta-discursive structure of the reflective discourse engaged in by paramedics is explored. Meat-discourse refers to the ways in which language is used to organise, engage, and relate to the audience within a text. Understanding the meta-discursive structure helps to reveal how paramedics communicate their experiences, decisions, and reflections, and how these communications contribute to their professional practice. The following subsections will discuss the emerging secondary focus within meta-discourse, the impact of structure and models, and the familiarity in meta-discourse language.

7.4.2.1 Emerging secondary focus within meta discourse

A focus on feeling is included in some written reflective templates or structures suggested in healthcare, with Gibbs being a frequently used and recommended example (Shiau and Chen, 2008) and utilised by participants within this PhD. There were no such direct prompts to encourage feelings to be expressed through the other phases of data collection, such as interviews or case studies, although there was opportunity for this to feature if the participant has chosen to share. Psychological safety is recognised as important in creating an honest reflective experience (Bindels *et al.*, 2018), the sharing of emotion would have been 'live' and with others in the activities such as within the case studies with peers and with the researcher in the semi-structured interviews, rather than after time for consideration and as a 'solo' written exercise in the reflections. Critical thinking is an important skill within healthcare professions and the use of reflective practice can help to achieve this (Shiau and Chen, 2008). Moreover, literature suggests a correlation between critical thinking and emotional intelligence within individuals (Li *et al.*, 2021), thus further supporting the need to enhance both the metacognition of 'thinking about thinking' and recognising emotion and feelings within the reflective process. Analysis of the questionnaires within this PhD data showed that the contrast between the focus within both questions highlighted a change in the realised benefits of taking part for more senior clinicians. The reasons for taking part, in senior clinicians, was very much focused on 'benefits for others', however on reflection they declared 'personal gains' not previously given as reasons for taking part. What motivates participants to take part in research is recognised as ambiguous (Carrera *et al.*, 2018), however the greatest motivation in healthcare research is thought to be altruistic in some literature (Carrera *et al.*, 2018; Olsen, DePalma and Evans, 2020), moreover noting that multiple forms of altruism exist although all grounded in a sense of connection (Carrera *et al.*, 2018). However others argue that while altruism is a feature of motivation, some participants look for self-benefit, in particular patient participants (Hunter *et al.*, 2012).

7.4.2.2 Impact of structure and models within meta discourse

Various written reflective structures are available and suggested for use within the healthcare profession to allow for a structure to recall, inward reflection and the subsequent writing process. However, the nature of such a structure may imply that all steps need to be followed, moreover the models available to clinicians may not necessarily fit every situation for which reflection would be advantageous, or may be deemed over simplified or complex (Smart, 2011; Hobbs, 2007).

There is very little literature to suggest the length of time required for a semi-structured interview, however (DiCicco-Bloom and Crabtree, 2006) suggest 30-60 minutes. Moreover, there is a lack of literature to suggest any correlation between length of time of interviews and the creation of data.

Asynchronous online discussion during case-based learning is recognised as a potentially difficult problem-solving process as learners are trying to balance their own process of working through the problem as well as balancing their contribution to the conversation (Koehler *et al.*, 2020). If the balance is not adequately achieved, then participant learning will be negatively impacted both in terms of individual and peer learning (Koehler *et al.*, 2020).

The findings of this PhD research recognised a pattern of case study conversation development. Previous research in a similar context has found role-based discussion forums to follow distinct phases of knowledge construction (KC), starting with lower levels KC processes and moving to higher (Wise and Chiu, 2011). The pivotal point of movement towards higher KC discussion was found to be initiated mid-discussion by participants summarising conversations (Wise and Chiu, 2011). Moreover, (Ertmer and Koehler, 2018) noted a greater attention to 'problem solving' conversation in online case-based discussion, as used in this PhD, verses more focus on 'problem finding' conversation in face-to-face case-based discussion. The findings of this PhD research compliment (Ertmer and Koehler, 2018) research by further suggesting how these 'problem finding and solving' conversations feature in a repetitive pattern.

7.4.2.3 Familiarity in meta discourse language

Abbreviations in medical notes is a known practice that was increasing prior to this PhD data collection (Pakhomov, Pendersen and Chute, 2005; Pakhomov, 2002; Stetson *et al.*, 2002; Xu *et al.*, 2006; Xu, Stetson and Friedman, 2007; Collard and Royal, 2015), with a recognised potential for confusion and negative impact on patient care (Kuhn, 2007; Walsh and Gurwitz, 2008; Brunetti, Santell and Hicks, 2007). Much research in this area is published 10 or more years prior to PhD data collection and is non paramedic specific. However a more recent study evaluating Malaysian electronic clinical notes found that an overall 19% of the total word count analysed, across 1102 discharge summaries, were abbreviations (Sulaiman, Bulgiba and Kareem, 2022). Of those abbreviation, 22.6% were deemed ambiguous and 52.3% were labelled dangerous (Sulaiman, Bulgiba and Kareem, 2022). A recent study in Australia also found abbreviations occurred within clinical notes at a frequency of one in every five words (Politis *et al.*, 2015). There may be future benefit in research within the use of abbreviations in paramedic practice in the UK.

There is a paucity in research pertaining to informal paramedic language, or colloquialisms, however one pedagogic research paper published during the time of this PhD data collection, had recognised a potential challenge when interpreting paramedic specific discourse as a result of informal language (Crezee and Grant, 2016). An informal blog, published by a paramedic, had featured an entry specific to 'Ambulance Lingo' which lists various abbreviations but also colloquialisms and 'sayings' that are familiar to the researcher, given their paramedic practice, several of which were listed in a humorous context, however the list is not inclusive of some of the terms seen in this PhD data (Binder999, c2011). There may be benefit in future research within this area to understand some of the common ‘sayings’ and their intended meanings and appropriateness, within the paramedic profession.

The use of emoji’s in phase three case studies was not anticipated and thus further data analysis of similar online communication for CPD may prove advantageous, such as the presence of emoji use either between colleagues or between ‘new collaborators’, data in this PhD was insufficient for this level of analysis. Emoji use in social media is widespread and can increase the effectiveness of computer-mediated communication, however it’s use can be subtle, complicated and difficult to predict (Zhao *et al.*, 2018). A recent study in 2022 found that participants receiving an emoji in communication from someone with whom they had a distant relationship, such as a bank manager, was of little value when compared to those with whom they had a closer relationship (Cavalheiro *et al.*, 2022). Moreover, a further study in 2022, post the covid-19 pandemic increase in professional team related online activity, revealed that new collaborators used emoji’s online selectively, however progressively, in order to build interpersonal bonds (Shandilya, Fan and Tigwell, 2022).

7.5 Establish if reflective practice can contribute to healthcare quality improvement and implementation science (QI)?

Reflective practice plays a crucial role in enhancing clinical practice and decision-making. There is evidence to suggest that only two thirds of health improvement initiatives are successfully implemented and lead to the desired outcomes. As such there is a recognised need for these improvement initiatives to be co-designed and implemented with patients, stakeholders and staff in order to create a sustainable change (The Health Foundation, 2013). This section explores how reflective practice can contribute to healthcare quality improvement (QI) and implementation science. By engaging in reflective activities, paramedics can identify areas for improvement, generate ideas for change, and address challenges in implementing evidence-based practice. The following subsections will discuss the quality improvement themes that emerged from the research, the challenges in implementing improvements, and suggestions for enhancing clinical practice.

7.5.1 Quality Improvement Themes

The engagement in reflection and subsequent analysis of reflective activities within this PhD study has highlighted several specific issues with implementing EBP in head injury assessment and management, some of which can be transferable to wider paramedic practice, as summarised in sub section 7.5.2 below. The analysis of transcripts from each phase have also allowed for QI ideas to emerge, summarised in sub section 7.5.3 below. There was a noticeable difference in the amount of 'Implementation' and 'QI' codes between phases.

The findings of this research have suggested that case study activity may be more productive in engaging participants in reflective activity pertaining to assessment and treatment decision making options, although not best suited to QI or EBP implementation reflection or discussion. However, interviews and written reflection were better placed for QI and EBP discussion and generation of ideas.

7.5.2 Implementation challenges

The implementation of new practices and guidelines in paramedic practice, particularly in the management of head injury patients, faces several challenges. These challenges can be categorized into people, process, equipment, materials, environment, and management, as illustrated in the Ishikawa diagram in section 6.7.2.

7.5.2.1 People

One of the primary challenges is the resistance to change among paramedics. This resistance can stem from a lack of understanding or agreement with new guidelines, as well as a preference for familiar practices (Grol and Grimshaw, 2003). The historical body of paramedic's, shaped by their previous experiences and training, can influence their acceptance of new practices (Scollon and Scollon, 2004a; Lane, 2014). Additionally, there is a need for continuous education and training to ensure that all paramedics are up to date with the latest evidence-based practices (Grol *et al.*, 2007). The varying levels of experience and education among paramedics can also lead to inconsistencies in the implementation of new practices (Cabana *et al.*, 1999).

In chapter 6, participants expressed frustration with the perceived lack of involvement in the change process and the challenges they face in implementing new practices (Quotes 79, 80, 81, 86, 87). This aligns with the literature on the importance of involving staff in the change process to reduce resistance and improve implementation success (Grol, Baker and Moss, 2004).

‘The NHS management community is so accustomed to a programmatic approach to change ... that they have become deskilled and are dependent on tools and programmes to improve things. Within such a culture of dependence, where all change is micro-managed and centrally programmed, NHS managers are not at liberty to evaluate change, reframe experience and develop reflexive processes.’ (Hardarce, 2005)

Reflective practice could provide a solution for the lack of reflexive processes in change and therefore strengthening the link between EBP and clinical decision making as later seen in Figure 75, completing a full circle of synergy. A systematic review by (Grant, 2007) stated that:

“It could be reasoned that reflection can improve professional practice by facilitating understanding through self-discovery, and for this understanding to enable individuals to manage and bring about change more effectively” (Grant, 2007, p. 15).

However, Grant (2007) recognised within the review that the ability for reflection to influence effective change had yet to be achieved because reflective practice was not being meaningfully evaluated as effective; a statement that this research has been able to partially address.

Reflection is an important part of education and continuing professional development within healthcare and specifically Paramedic Practice, and a recognised and accepted method to understand a clinicians own learning needs, thus it is arguably a way to establish ‘what others know’ (Kumagai, 2014). In 2010, Booth recognised a link between the 5-step change model and reflective practice (Booth, 2010). As can be seen in Table 78, Booth builds on the already recognised concepts of reflection ‘on’ and ‘in’ action, as purposely used in the design of this PhD research, by suggesting the five steps of change can be mirrored in five forms of reflective practice (Booth, 2010). In doing so, Booth expands on reflection ‘in’ and ‘on’ action to include reflection ‘for action’, reflection ‘before action’ and reflection ‘regards action’ (Booth, 2010).

Table 78 - Stages of change relating to reflective practice (Booth 2010)

Stage of change	Definition of stage	Reflective questions	Type of reflection	Tools for reflection
Pre-Contemplation	Beginning stage of ‘Not thinking about it’. Typically involves our increasing awareness of problem of issue without knowing how it will be addressed	What am I going to do about X? (Background)	Reflection For Action	Overviews
Contemplation	Having started to think about the problem or issue we start to weigh up risks and benefits of courses of action	How am I going to do Y? (Foreground)		Systematic reviews; comparative studies; filed visits
Preparation	Proactive stage of acquiring knowledge and finding out how we will go about achieving preferred course of action.	What do we need to think about before we do this?	Refection Before Action	Implementation studies and process studies
Action	Commitment to course of action through identifiable steps and achievable goals	What is happening?	Reflection In Action	Diaries, reflective journals, blogs
		What happened?	Reflection On Action	After action reviews, debriefs
Maintenance	Involves extending planned change over a prolonged period.	Is this still worth doing? Is this still the best available course of action?	Re: Action	Environmental scanning, new research, user surveys

Evaluating the use of MDA and Nexus methodology through the medium of reflective discourse within this PhD thesis, the researcher has subsequently recognised a link between these 5 stages of reflection and change, and the research design. The researcher has therefore been able to create a hybrid version of Booths ‘stages of change relating to reflective practice’ (Booth, 2010) in combination with the stages of ‘Nexus Analysis’ (Scollon and Scollon, 2004a), and guided MDA analysis (Jones, Gold and Claxton, 2017), as can be seen in Table 79. The researcher highlights the link between engaging the nexus with the first three stages of change (pre-contemplation, contemplation, and preparation) and reflection ‘for’ and ‘before’ action. The researcher also recognises the link between navigating the nexus and the action stage of change, alongside reflection ‘in’ and ‘on’ action. Finally, the researcher recognises the link between changing the nexus and the maintenance stage of change, coupled with reflections regards action.

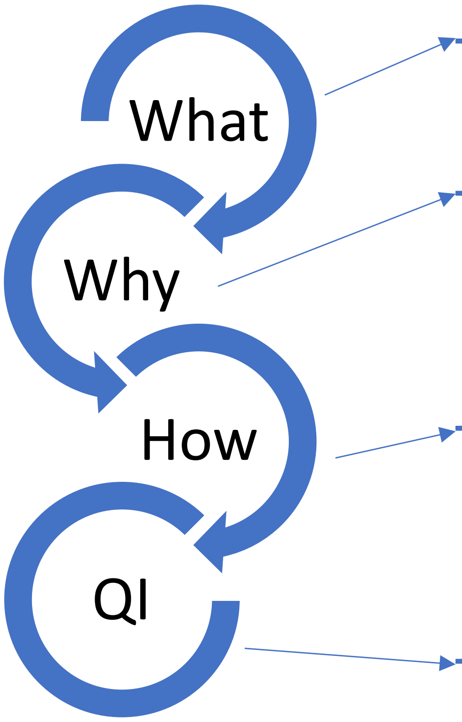
Table 79 - Hybrid of Nexus and MDA analysis with Booths stages of change and reflective practice

Nexus Analysis	**Stages of Nexus aligned Research Process**	**Stage of change**	**Definition of stage**	**Type of reflection**	**Reflective questions**	**Tools for reflection**
Engage the Nexus	Pre-contemplation of the need for change as a participant-analyst in the nexus and subsequent research design	Pre-Contemplation	Beginning stage of 'Not thinking about it'. Typically involves our increasing awareness of problem of issue without knowing how it will be addressed	Reflection For Action	What am I going to do about X? (Background)	Overviews
	Scoping of the nexus pre-data collection, using the 3 components of social action (historical body, interaction order and discourses in place)	Contemplation	Having started to think about problem or issue we start to weigh up risks and benefits of courses of action		How am I going to do Y? (Foreground)	Systematic reviews; comparative studies; filed visits
	Process of data collection using the Triad Method	Preparation	Proactive stage of acquiring knowledge and finding out how we will go about achieving preferred course of action.	Refection Before Action	What do we need to think about before we do this?	Implementation studies and process studies
Navigate the Nexus	Analysis of findings	Action	Commitment to course of action through identifiable steps and achievable goals	Reflection In Action	What is happening?	Diaries, reflective journals, blogs
	Discussion of findings aligned to the Guided Mediated Discourse Analytical Framework			Reflection On Action	What happened?	After action reviews, debriefs
Change the Nexus	Contemplating the actions the researcher can take, as a participant-analyst in the nexus of practice, that will transform discourses into actions and actions into new discourses and practices	Maintenance	Involves extending planned change over a prolonged period.	Re: Action	Is this still worth doing? Is this still the best available course of action?	Environmental scanning, new research, user surveys

Reflections have been recognised as a powerful way of capturing the narrative of a profession through story-telling (Murphy, Franz and Schlaerth, 2018; Haigh and Hardy, 2011). Sharing of stories and experiences is a key component of overall staff engagement, and literature has established a clear relationship between staff engagement and organisational improvement, resulting in improved patient experience and care. However, data has shown that Ambulance services have the lowest staff engagement figures among NHS trusts (Ham, 2014; Carter, 2019). In order to collect the data needed to establish areas for improvement in process and systems, and enhance team working in delivery of project effectiveness, a culture of 'no blame' needs to be established in order to encourage and support staff to share their stories and experiences, as discussed in chapter 2 (Koolwijk, Van Oel and Moreno, 2020; Provera, Montefusco and Canato, 2010).

The findings of this research supported the value of structure within written reflections. Considering these findings, the implication is the introduction of a new reflective model for clinicians; this reflection model is an adaption of Driscoll's 'What, So what, Now what' Model (Driscoll, 2007) and is titled the 'What, Why, How, QI' Model of reflection as depicted in Figure 65. Much like other models this is intended to give clinicians a guide to structure their reflection upon to nurture the QI element of this activity and further encourage reflective activity openly within a 'no blame' culture as previously described.

This new model is an addition to the various models available to clinicians and intended to compliment those models as additional choice for clinicians in their reflective practice, as opposed to suggesting this is always the preferred model. Clinicians should always make their own choices as to the most appropriate model for the purpose of their reflective activity. The use of this model is encouraged for activities within the TRIAD model, as previously described, if purposeful reflection is requested or facilitated specifically for the purposes of QI as opposed to collated data from previous activities.



- What did you do?
- What happened?
- What were the mediated actions?

- Why did you do this?
- What influenced your decisions?
- What were the mediated means (tools) to aid your actions?

- How did you achieve this within your wider practice (where did this happen, who with), known as site of engagement and how is this important?
- How does this effect your wider practice, what other practices and chains of actions does this effect?

- What lessons could be learnt from this, which could change practice, either for you personally or for service improvement?

Figure 61 - What, Why, How, QI, Model

Participants also mentioned difficulty in implementing change in practice when it superseded updating a previous practice, such as the de-emphasis or removal of the use of c-spine collars, as previously discussed (Quotes 1, 8, 13, 16 and 94). De-implementing inappropriate healthcare interventions is growing in research, including the use of approaches, models and frameworks as used within implementation, in order to achieve this specific form of change (Norton and Chambers, 2020; Walsh-Bailey *et al.*, 2021). However more research in de-implementation is suggested, for example, the issue of replacing an intervention with another, such as the c-spine collar guidance as highlighted in this PhD (Norton and Chambers, 2020). It is suggested that research focusing on the implementation of a new intervention should consider qualitative findings of why a clinician may return to previous practice or a variation of old and new practice (Norton and Chambers, 2020), an area in which the findings of this PhD could contribute towards.

7.5.2.3 Equipment

The availability and accessibility of necessary equipment can be a significant barrier to implementation. For example, the use of advanced airway management tools or monitoring devices may be limited by budget constraints or logistical issues (Bigham *et al.*, 2012). Ensuring that all paramedics have access to the required equipment and are trained in its use is crucial for successful implementation (Bigham *et al.*, 2012). The section on technology within paramedic practice highlights the challenges of implementing new equipment in the pre-hospital environment, such as issues with storage, power supply, and connectivity (NHS Improvement, 2019; Carter, 2019).

Participants in Chapter 6 mentioned the challenges they face with the availability and suitability of equipment, which can hinder their ability to implement best practices (Quotes 88, 89). This aligns with the literature on the importance of providing reliable and accessible equipment to support new practices (Bigham *et al.*, 2012).

7.5.2.3 Materials

The quality and availability of educational materials and resources can impact the effectiveness of training programs. Outdated or insufficient materials can lead to gaps in knowledge and understanding, making it difficult for paramedics to adopt new practices confidently (Grol *et al.*, 2007). Providing comprehensive, up-to-date, and easily accessible resources is essential for supporting paramedics in their learning and implementation efforts (Cabana *et al.*, 1999). The importance of high-quality, up-to-date educational materials are emphasised in the discussion on CPD and the transition to higher education (Collin, Van Der Heijden and Lewis, 2012; McMahon, 2017; Dymoc and Tyler, 2018)

In Chapter 6, participants expressed the need for better educational resources and training to support the implementation of new practices (Quotes 90, 91, 92). This reflects the literature on the need for comprehensive and accessible educational materials to support continuous professional development (Frenk *et al.*, 2010).

7.5.2.4 Environment

The pre-hospital environment presents unique challenges that can affect the implementation of new practices. Paramedics often work in unpredictable and high-pressure situations, which can make it difficult to adhere to new guidelines consistently (Bigham *et al.*, 2012). Environmental factors such as weather conditions, patient behavior, and scene safety can also influence the feasibility of implementing certain practices (Bigham *et al.*, 2012). The unpredictable and high-pressure nature of the pre-hospital environment is discussed in relation to the social structure and organizational culture within the paramedic profession (Sterud, Ekeberg and Hem, 2006; Turner, 2018; Okeefe and Mason, 2010).

Participants in Chapter 6 highlighted the challenges of working in the pre-hospital environment and how these factors can impact their ability to implement new practices (Quotes 93, 94, 95). This aligns with the literature on the unique challenges of the pre-hospital environment and the need for guidelines and practices that are adaptable to these conditions (Bigham *et al.*, 2012).

7.5.2.5 Management

Effective leadership and management support are critical for the successful implementation of new practices. Without strong leadership, paramedics may lack the motivation and guidance needed to adopt new guidelines (Grol, Baker and Moss, 2004). Additionally, management must ensure that there are adequate resources and support systems in place to facilitate the transition to new practices. This includes providing ongoing training, monitoring compliance, and addressing any barriers that arise during the implementation process (Grol *et al.*, 2007). The role of effective leadership and management support in fostering a positive organizational culture and facilitating the implementation of new practices is highlighted (NHS England, 2019c; NHS England, 2020).

In Chapter 6, participants discussed the importance of management support and the challenges they face when this support is lacking (Quotes 96, 97, 98). This reflects the literature on the critical role of leadership and management in supporting the implementation of new practices (Grol, Baker and Moss, 2004).

7.5.2.6 Relating the research findings on implementation challenges to the wider literature

Barriers to successful implementation of change were reviewed in a systematic review of literature and meta-analysis between 1980 and 2011, published in 2014 and within the Health Foundation Roadmap published in 2015 (Allcock *et al.*, 2015; Mosadeghrad, 2014), a visual representation of the main findings from both of these resources can be seen in Figure 66.

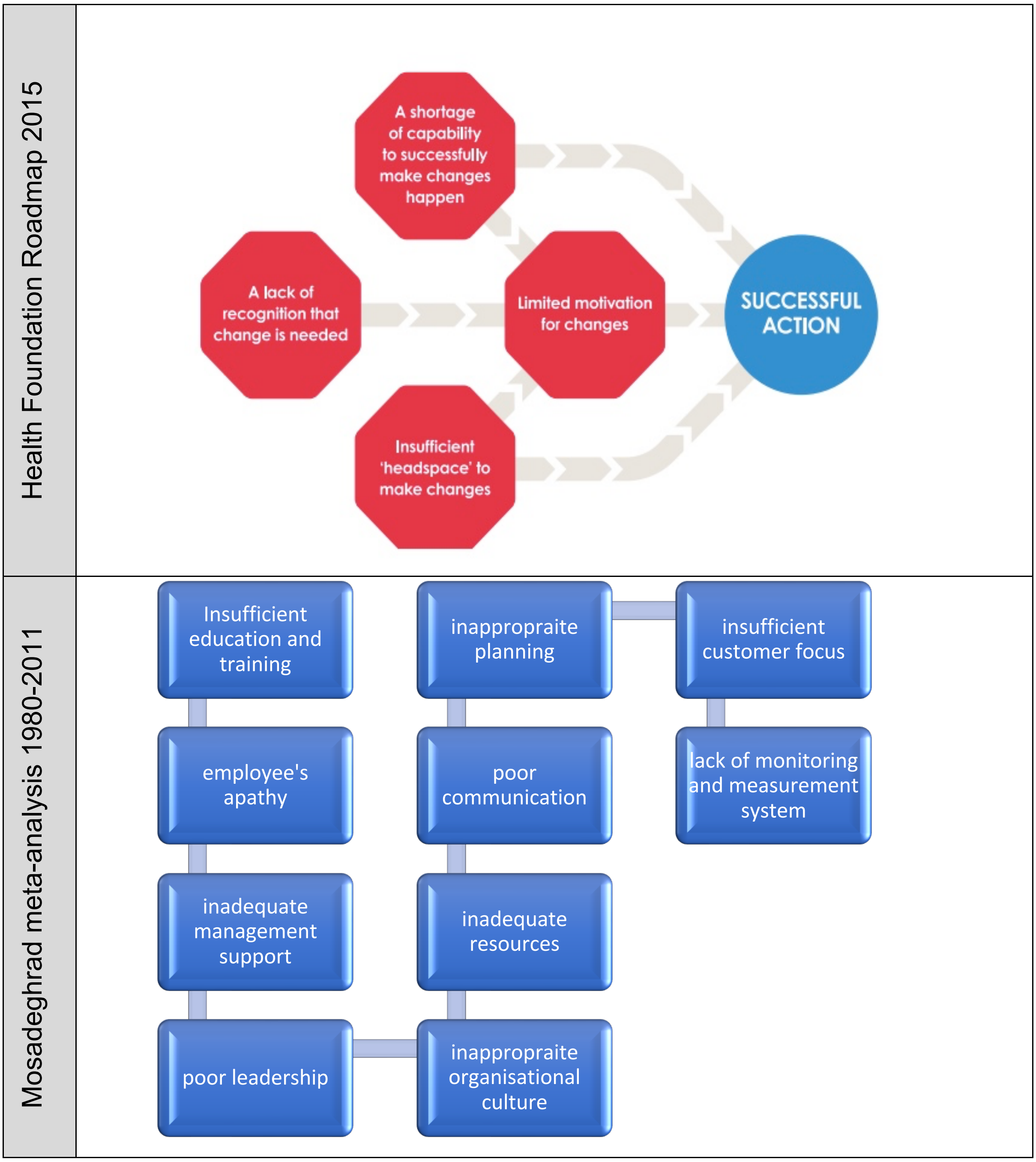


Figure 62 - Barriers to successful change (Health Foundation Roadmap 2015 and Mosadeghrad meta-analysis 1980-2011)

However, the recognition of barriers to successful change is only advantageous if used to inform change through an implementation strategy. One of the main reasons for the gap between research and evidence-based practice is the lack of an implementation strategy including known barriers and enablers (Bach-Mortensen, Lange and Montgomery, 2018; Correa *et al.*, 2020).

The findings of this PhD have then been compared to the findings of a systematic meta-review completed in 2020 by Correa et al, which compliments the findings of The Health Foundation roadmap and meta-analysis by Mosadeghrad (Allcock *et al.*, 2015; Mosadeghrad, 2014), by identifying common barriers in the implementation of clinical practice guidelines (Correa *et al.*, 2020). The comparison shows similar themes between the 2020 systematic review and this PhD; however, the results from this PhD have added some specific narrative to the paramedic and pre-hospital setting, as seen in table 81.

Table 80 - Comparison of Correa et al 2020 systematic review and PhD findings relating to barriers to implementing clinical guidelines.

Contexts	**Barriers** (Correa et al 2020)	Comparison to PhD research findings
Political and social context	• Difficulties in prioritising the health problem • Lack of access to information, lack of mechanisms and systems to support storing of information	• Difficult to access guidelines in pre-hospital setting. • Conflicting guidelines between clinical presentations which may be co-existing
Health organisational system context	• Lack of protocols and processes that clearly define the roles within the institution to implement guidelines • Additional workload • Difficulty accessing health services • Difficulties with availability of medicines • Deficiency in staff continuous education • Deficiencies in the referral of patients to services • Lack of skill and specialist knowledge within services • Insufficient support from institutions • High turnover of staff that prevents a continuous training process • Limitations of infrastructure • Lack of availability of interpreters in services • Lack of access to information, lack of mechanisms and systems to support storing of information	• Too big a gap between Major Trauma Centres • Difficulty in accessing senior colleagues who may be volunteers or part of a smaller specialist team with limited capacity. • Difficult to find time for CPD. • Difficult to follow up patients for learning. • Trust protocols perceived to restrict practice in comparison to suggestions in guidelines. • Equipment available not designed to achieve best practice as guidance changes.
Guideline's context	• Lack of awareness of the existence of guidelines and clarity of guidelines • Beliefs that the guidelines evidence is incorrect or not enough to be reported • Beliefs that CPG is too rigid, may not always be practical and cannot be applied on a day-to-day • Guidelines restrict clinical judgment and challenge professional autonomy and limits treatment options	• Conflicting local guidelines • Profession specific guidelines perceived to be out of date as not updated often enough. • Research difficult to access and read. • Too much to read in terms of research, local and national guidelines, and protocols. • Not aware of decision-making tools. • Belief that local guidelines are restricting practice.
Health professional context	• Greater confidence in clinical experience than in guidelines recommendations • Lack of effective communication, research and self-learning skills • Resistance to change caused by disagreement with the recommendations of the CPG, doubts about the efficacy of interventions and clinical outcomes • Physician's reluctance to use CPG because of patient factors, self-belief or fear of complications • Little familiarity with guideline recommendations • Negative attitudes of physicians towards the implementation of the guideline or to EBM • Lack of autonomy and authority • Belief that intervention was not part of their role	• Lack of confidence in guidelines • Belief guidelines are not aligned to specific health populations. • Belief protocols are not well tested or written with practicing clinicians' involvement.

7.5.3 Suggestions for improvement

To address the challenges identified in section 7.5.1 and enhance the implementation of new practices in paramedic practice, several strategies can be considered. These suggestions are based on the themes and ideas generated by participants in the research, as illustrated in the Ishikawa diagram in section 6.7.3.

7.5.3.1 Pathways

Developing clear and streamlined patient pathways can help paramedics make informed decisions quickly and efficiently. These pathways should be evidence-based and designed to accommodate the unique challenges of the pre-hospital environment (Grol, Baker and Moss, 2004). Additionally, involving paramedics in the development and review of these pathways can ensure that they are practical and relevant to their needs (Grol *et al.*, 2007). The need for clear patient pathways is supported by the discussion on clinical decision-making models and the importance of structured approaches to care (Kurtz, Silverman and Draper, 1998; Silverman, Kurtz and Draper, 1998).

In Chapter 6, participants suggested the need for more defined patient pathways to improve decision-making and patient outcomes (Quotes 99, 100, 101). This aligns with the literature on the importance of clear and structured pathways in clinical practice (Grol, Baker and Moss, 2004).

7.5.3.2 Continuing Professional Development (CPD)

Enhancing CPD opportunities for paramedics is essential for maintaining their skills and knowledge. This can include regular training sessions, workshops, and access to online learning platforms (Frenk *et al.*, 2010). Encouraging a culture of continuous learning and professional development can help paramedics stay up to date with the latest guidelines and best practices (Frenk *et al.*, 2010). The transition to higher education and the emphasis on CPD in Chapter 2 underscore the importance of continuous learning and professional development for paramedics (College of Paramedics, 2019b).

In Chapter 6, participants emphasized the need for ongoing CPD to support the implementation of new practices and improve clinical skills (Quotes 102, 103, 104). This reflects the literature on the importance of CPD in maintaining and enhancing clinical competence (Frenk *et al.*, 2010).

7.5.3.3 Education

Improving the quality and accessibility of educational resources is crucial for supporting paramedics in their implementation efforts. This includes providing comprehensive training materials, creating user-friendly guidelines, and offering practical, hands-on training sessions (Grol *et al.*, 2007). Additionally, incorporating reflective practice into education programs can help paramedics critically evaluate their performance and identify areas for improvement (Mann, Gordon, & MacLeod, 2009). The discussion on the evolution of paramedic education and the need for comprehensive training materials supports the suggestion to improve educational resources (Grol et al., 2007; Mann, Gordon & MacLeod, 2009).

Participants in Chapter 6 highlighted the need for better educational resources and training to support the implementation of new practices (Quotes 105, 106). This aligns with the literature on the need for high-quality educational resources to support continuous professional development (Frenk *et al.*, 2010).

The findings of the PhD research suggest that processes of reflection producing the greatest amount of QI activity have adequate time for pre-planning and participation with a flexible or simple structure, thus allowing for more intuitive cognition.

7.5.3.4 Guidelines

Ensuring that guidelines are clear, concise, and user-friendly can facilitate their adoption by paramedics. This includes providing step-by-step instructions, visual aids, and decision-making tools that can be easily referenced in the field (Grol, Baker and Moss, 2004). Regularly updating guidelines to reflect the latest evidence and feedback from paramedics can also enhance their relevance and effectiveness (Grol *et al.*, 2007). The challenges associated with clinical guidelines, such as their complexity and the need for regular updates, are discussed in Chapter 2 (Institute of Medicine, 2011; Woolf *et al.*, 1999).

In Chapter 6, participants expressed the need for more practical and regularly updated guidelines to support their clinical practice (Quotes 107, 108). This reflects the literature on the importance of clear and regularly updated guidelines in facilitating evidence-based practice (Grol, Baker and Moss, 2004).

7.5.3.5 Process

Participants suggested the need for streamlined processes and standardised procedures to improve the implementation of new practices, as seen in chapter 6 (Quotes 109, 110). Streamlining processes and reducing unnecessary complexity can help paramedics integrate new practices into their workflows more easily. This can involve simplifying documentation requirements, standardizing procedures, and providing clear protocols for common scenarios (Grol, Baker and Moss, 2004). Additionally, involving paramedics in the design and testing of new processes can ensure that they are practical and feasible (Grol *et al.*, 2007). The importance of simplifying documentation and standardising procedures is supported by the discussion on clinical decision-making and the use of structured consultation models (Grol, Baker and Moss, 2004; Kurtz *et al.*, 2003).

Historically QI and Implementation science have been separated in their usage, despite having synergy (Koczwara *et al.*, 2018; Curran *et al.*, 2012).
Moreover, historically there has been a paucity of evidence supporting the use of ethnographic data such as storytelling and cultural narratives in QI project data collection, however during this PhD study there has been a paper attempting to address this with the recommendation of a combination approach termed ‘Quadangulation’ as previously discussed and seen again in Figure 67 (Rodriguez and Hallas, 2019).

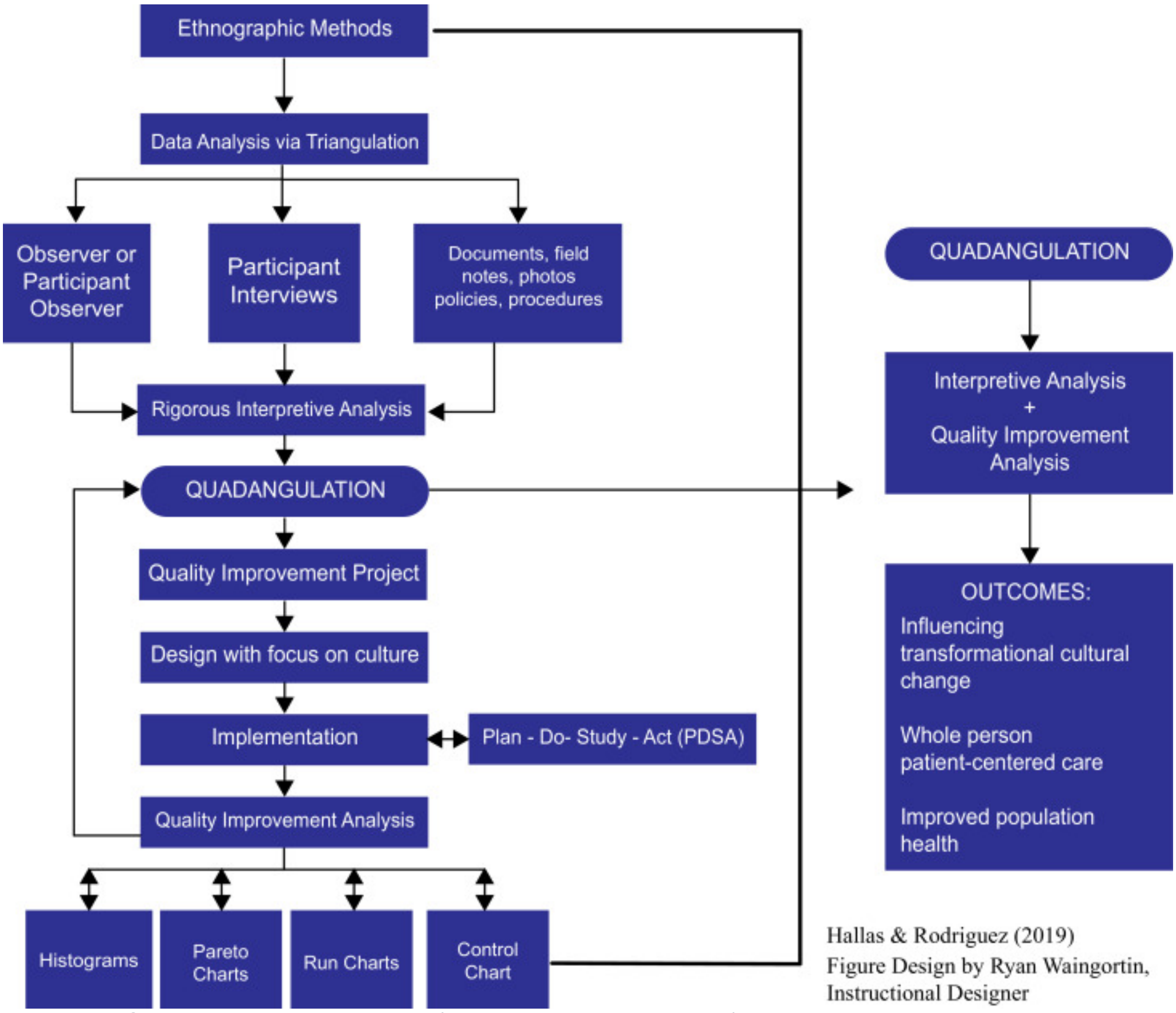


Figure 63 - Quadangulation Methodology (Rodriguez and Hallas, 2019)

As a result of the successful implementation of a blend of reflective data collection and MDA and Nexus analysis methodology within this research, the researcher would like to introduce a new model to the emerging 'improvement science' field, which compliments and expands on the recent Quadangulation Model (Rodriguez and Hallas, 2019).

This proposed model has been titled 'The TRIAD Model', an acronym for 'The Triangulation of Reflective Improvement Activities and Dissemination' and can be seen depicted in Figure 68. This model recognises the place for quantitative research and data within the concept for change; however, it aims to introduce qualitative information to compliment the improvement design phase. The model supports the use of semi-structured interviews in this PhD, alongside an active information search event, inspired by the case studies in this PhD, and the engagement in written reflections of events, to allow for a combination of reflection 'in' and 'on' actions. Thus, allowing for a triangulation of data for quality improvement activities through action research.

The findings of this PhD research suggest this is achieved through utlising reflective activities within staff / clinician communities from which this rich source of information and ideas already exists and is readily growing. There just needs to be a recognised way of channeling these activities into quality improvement projects and this model aims to capture this concept.

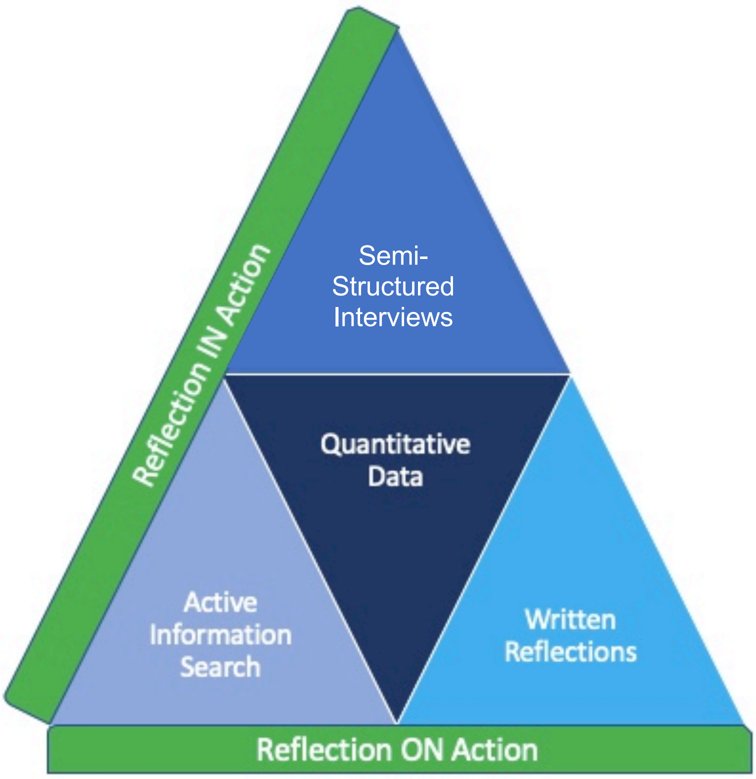


Figure 64 - Triangulation of Reflective Improvement Activities and Dissemination Model (TRIAD)

As these activities are already taking place throughout paramedic practice and potentially other healthcare professions, it should reduce the amount of new work needed in order to complement the existing quality improvement activities organisations may already be undertaking (HCPC, 2014; Academy of Medical Royal Colleges *et al.*, 2021; Mann, Gordon and MacLeod, 2007; NMC, 2019; Fragkos, 2016). The main additional activity comes in the form of collecting and collating this information. Collation of such information may be the responsibility of a Quality

Improvement lead or department, however this individual or department should ensure they utilise social networking to its maximum effect as discussed in earlier chapters and was so pivotal in the methodology used in this research to good effect.

Social media is already being utilised by clinicians to share learning and engage in settings away from their employment, at ease and in leisure time, for their own continued professional development (Batt, 2014; Richardson *et al.*, 2016; Higginson, 2017; Nelmes, 2012; Ventola, 2014; Chan and Leung, 2018; Mak, Williams and Mackness, 2010; AACE, 2019; Parameducate, 2016), the findings from this research has extended previous knowledge of this culture in learning. This research therefore suggests that this social networking pedagogy needs to feature in activities such as quality improvement if organisations are to make the most of staff engagement.

7.5.3.6 Equipment

Ensuring that paramedics have access to the necessary equipment and are trained in its use is essential for successful implementation. This includes investing in high-quality, reliable equipment and providing ongoing training and support (Bigham *et al.*, 2012). Additionally, developing protocols for the maintenance and replacement of equipment can help ensure that it remains in good working condition (Bigham *et al.*, 2012). The discussion on technological advancements and the challenges of implementing new equipment in the pre-hospital environment highlights the need for reliable and accessible equipment (NHS Improvement, 2019; Bigham et al., 2012).

In Chapter 6, participants highlighted the need for better access to equipment and training to support the implementation of new practices (Quotes 111, 112). This reflects the literature on the importance of providing reliable and accessible equipment to support new practices (Bigham *et al.*, 2012).

7.5.3.7 Process

The process of implementing new guidelines can be hindered by the complexity and perceived impracticality of the guidelines (Grol, Baker and Moss, 2004). Paramedics may find it challenging to integrate new practices into their existing workflows, especially if the guidelines are not user-friendly or if they require significant changes to established procedures. The lack of clear, step-by-step instructions can also contribute to confusion and errors in implementation (Grol *et al.*, 2007). The discussion on clinical decision-making and the use of heuristics versus hypothetico-deductive reasoning (HDR) in Chapter 2 can be linked to these challenges (Evans, 2020a; Kahneman D, 2003).

In Chapter 6, participants highlighted the difficulties they face with conflicting guidelines and the need for more practical and updated guidelines (Quotes 82, 83, 84, 85). This reflects the literature on the need for clear, concise, and regularly updated guidelines to facilitate their adoption (Institute of Medicine, 2011).

Within this research there appears to be a link between clinical decision making, reflective practice and QI activity. The findings of this PhD research suggest that processes of reflection producing the greatest amount of QI activity have adequate time for pre-planning and participation with a flexible or simple structure thus allowing for more intuitive cognition. It could be argued that like the cognitive continuum for decision making (seen again in Figure 69), there could also a QI cognitive continuum, suggestive that QI is a creative process in which the right conditions need to be created to allow for this cognitive activity to flourish. As a result of the PhD research findings, the researcher has recognised a potential QI cognitive continuum as can be seen in Figure 70.

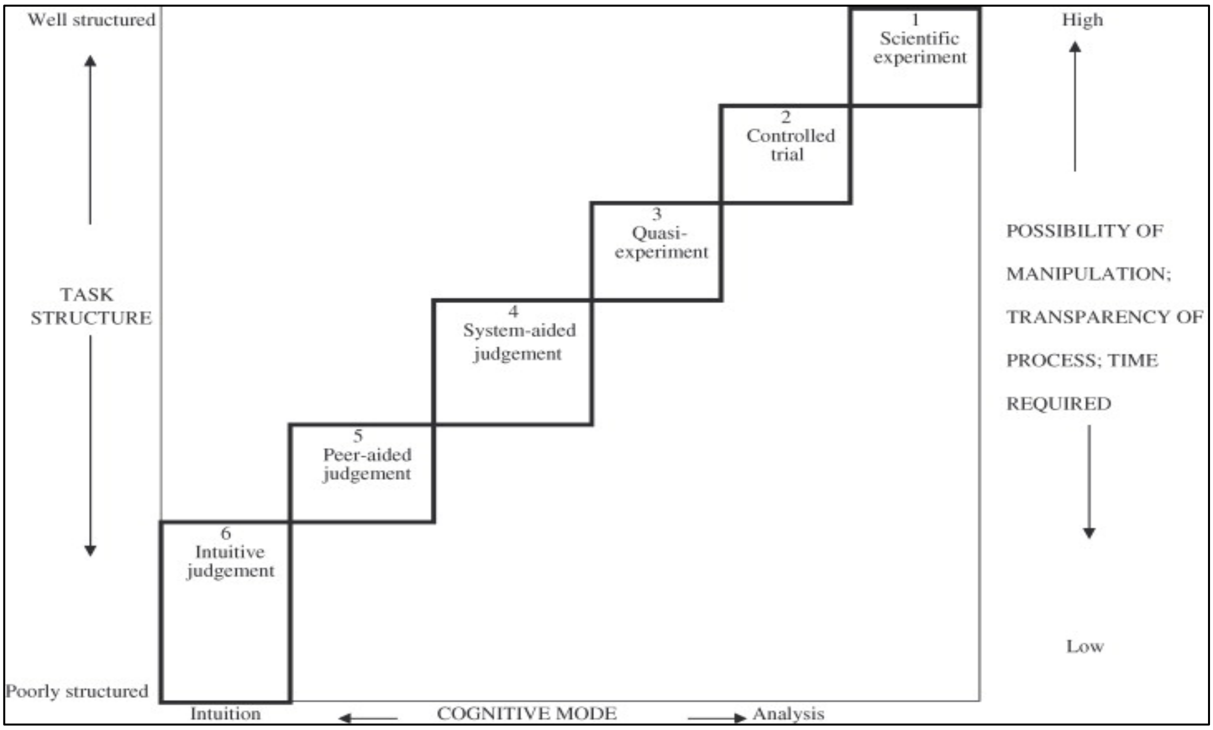


Figure 65 - Cognitive Continuum (Hamm 1988)

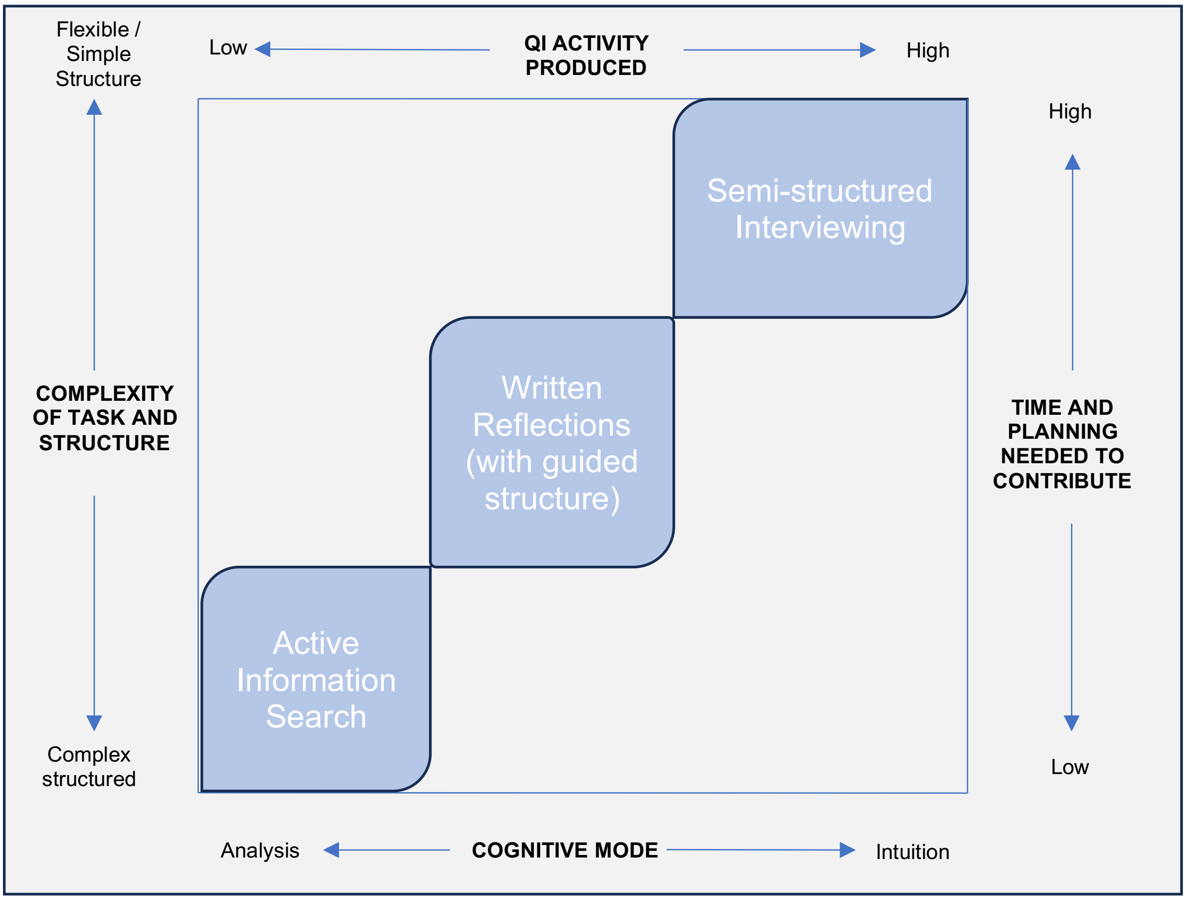


Figure 66 - QI Cognitive Continuum

This proposed QI Cognitive continuum demonstrates how activities such as semi-structured interviews require greater time for contribution but allow for flexibility or simplicity in their design with a high rate of QI activity and intuition. However, in comparison, active information search activities such as group case studies are more complex in their structure but require less time or planning by the participant with a contrasting low QI activity, but greater evidence of analytical process as opposed to intuition. Written reflections, in comparison to both active information search activities and semi-structured interviews are more balanced in all four elements of the continuum.

Nevertheless, just as we know to be the case with Hypothetico-deductive reasoning for decision making, there may be cognitive shortcutting happening with QI processes during activities occurring in short spaces of time. This is apparent from the data and themes emerging once clinicians have been given the time to pick apart events that have occurred. It is also apparent that in slower time, QI also features in the thoughts of clinical decision making, even when looking at fictional cases with no areas of improvement to identify. It could however be argued that anticipating barriers and issues is a negative outlook, however, identifying potential problems is a key part of QI even if potential ideas and solutions have yet to be found.

7.5.4 Understanding the community of practice.

The key components of a community of practice have been described by (Wenger, McDermott and Snyder, 2002) as:

1. The domain (The shared interest or subject matter)
2. Community (The culture, relationships, and social interactions between members)
3. The practice (The documents, stories, ideas, tools, language, and frameworks shared between members)

As can be seen from section 6.7.4 within the findings chapter, the domain in the ‘uncovered’ CoP is ‘QI and Implementation in Paramedicine’. This domain has been identified throughout the practices within the nexus as discussed throughout this chapter.

Exploring the second key component within McDermott and Snyder (2022) list, the community within this 'uncovered' CoP highlighted the importance of relationships and social interactions, in particular peer support, relationships with voluntary organisations and senior colleagues, and the newly emerging 'virtual' culture, as discussed within this chapter.

The quality implementation framework (QIF) attempts to inform and guide on the critical 'how to' steps involved in implementation (Meyers, Durlak and Wandersman, 2012). This is achieved through the provision of a four-phase approach which includes a lengthily list of prompts in phase one for the assessment of the host setting (Meyers, Durlak and Wandersman, 2012). However, this list does not take into consideration organisational culture or social structure alongside the more physical or 'formal' elements mentioned in the QIF, as can be seen Figure 71.

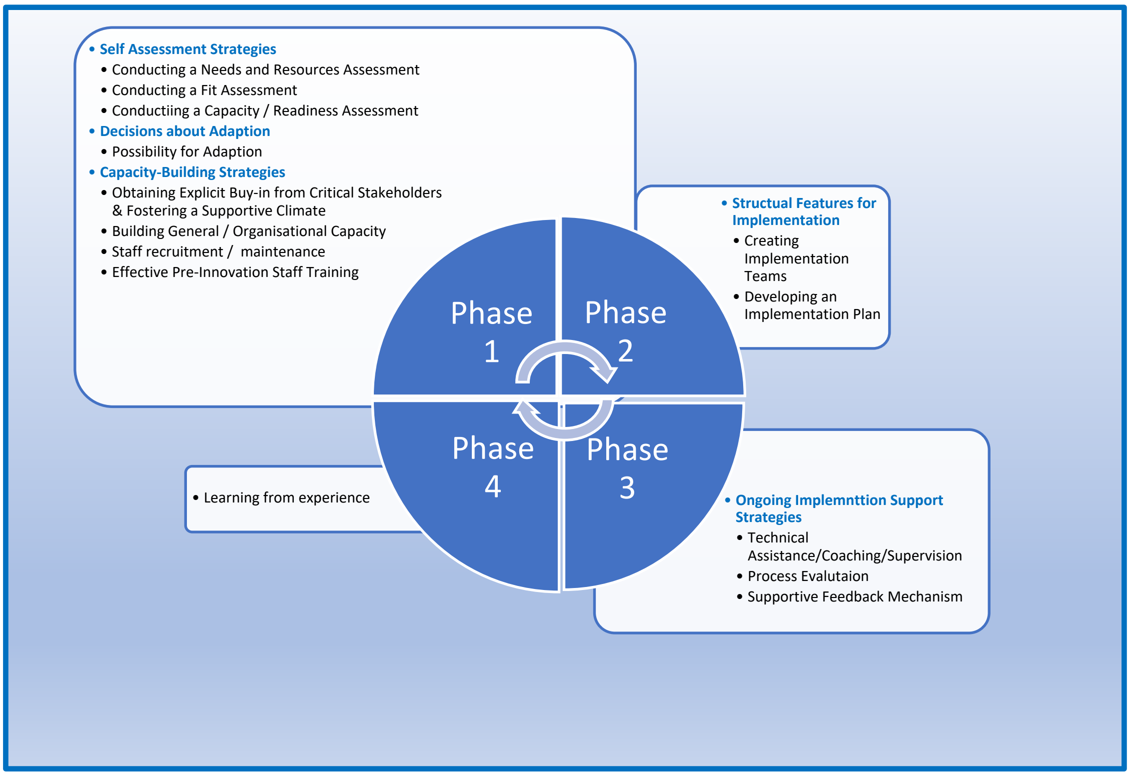


Figure 67 - Quality Implementation Framework (adapted from Meyers, Durlak and Wandersman 2012)

However, Hart et al (2015) note that 'Change management' is not only a 'science' or methodology but also an 'art form' which encompasses many other 'softer skills'. These aforementioned 'softer skills' include a knowledge of organisational culture, an understanding of organisational environment, leadership and team building (Hart *et al.*, 2015). Although culture and organisational environment are listed separately by Hart et al (2015), it is important to note that organisational culture is not a ‘stand-alone’ concept but rather one part of an interlinked six-part conceptual organisation environment framework. The remaining five parts being, social structure, physical structure, technology, and power as seen in Figure 72 (Hatch and Cunliffe, 2013). There is therefore a potential overlap between the softer skills referred to by Hart et al (2015) and the conceptual organisational framework (Hatch and Cunliffe, 2013) when highlighted through an exploration of the three essential elements of a social action (Scollon, 2001a), seen again in Figure 73 and previously discussed within the Six Central Concepts of MDA in chapter 4, sub section 4.2.1.

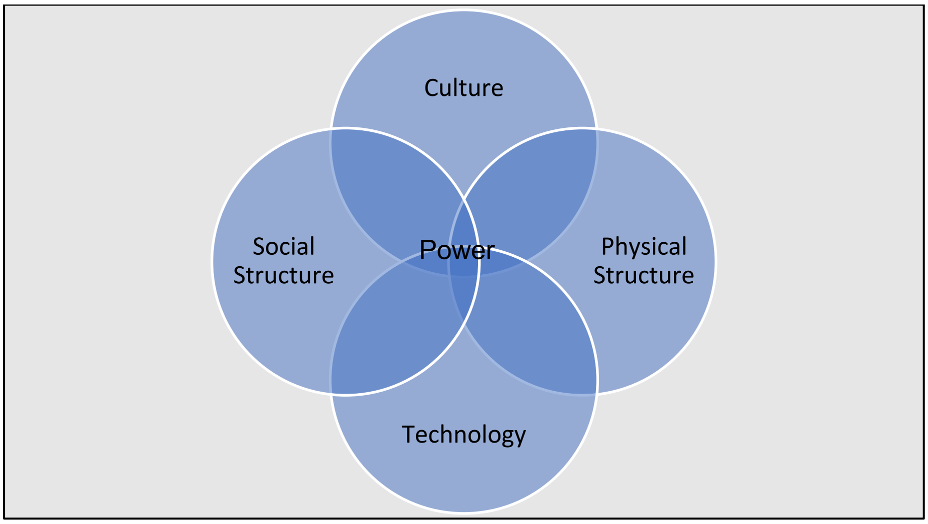


Figure 68 - Conceptual Organisation Environment Framework

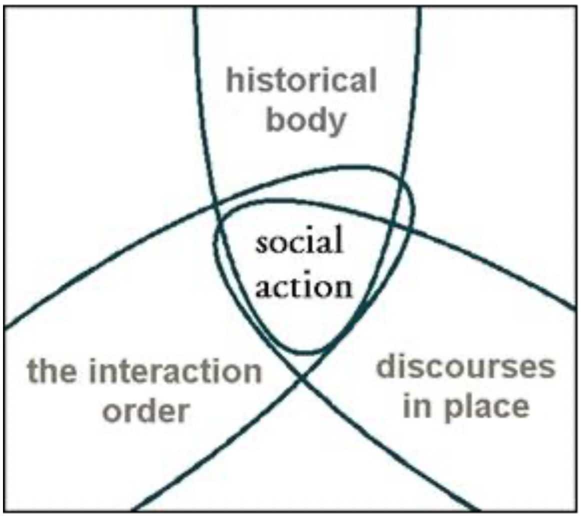


Figure 69 - 3 Essentials elements of a social action (Scollon, 2001a).

Exploring key component three within McDermott and Snyder (2022) list, the practice within this 'uncovered' CoP has also been discussed throughout this research, facilitated using MDA. The MDA approach has allowed the findings of this PhD to highlight the documents, tools, language, and frameworks shared by members of the CoP via an exploration of clinician 'stories' to identify these mediated means.

7.6 Limitations of the Study

The researcher recognises that there have been several limitations within this PhD design and subsequent findings. These limitations span across sampling comparison, sample size, structure of literature review, and self-reporting data without peer review.

7.6.1 Sampling

The sample sizes of phase 1 (semi-structured interviews) and phase 2 (review of written reflections) may arguable be considered as small, with 12 participants in phase 1 and 10 participants in phase 2. The researcher was satisfied that they had reached the point of data saturation at these numbers, the emerging 'gold standard' for sample sizing in qualitative research (Fusch and Ness, 2015; Guest, Bunce and Johnson, 2006). However there is a debate in literature as to the number of participants needed to achieve saturation in qualitative research, with recommendations varying from 12 to 50 and as such it may be beneficial to repeat these phases with greater participant numbers to validate these results (Morse, 2000; Green and Thorogood, 2017; Ritchie, Lewis and Elam, 2003; Creswell, 2007; Vasileiou et al., 2018; Morse, 1995; Guest, Bunce and Johnson, 2006).

The use of varying settings, participants and reflective methods had allowed for triangulation within the 3-phases of this study (Bekhet and Zauszniewski, 2012; Thurmond, 2001). However, the dependent variables in phase design, such as utilising a pre-existing online social media platform, within the established format for case studies, had meant that this phase was open to greater clinical grades than the previous 2-phases, thus creating a non-comparative independent variable among clinical grades across phases *(Lau and Holbrook, 2017).* To compare clinical grade throughout the phases, a similar study would need to be conducted with purposeful design to include this dependent variable throughout.

7.6.2 Bias through lone researching and self-reported data

The researcher was the sole researcher in the 3-phases of this study and thesis completion. As a result, this had led to the identification of two limitations within the proposed findings. Firstly, a systematic review, recognised as one of the more highly regarded forms of evidence, is only deemed to have a quality and robust method if undertaken by several researchers through a process of peer review, which is a time consuming process (Borah et al., 2017). Unable to do so in this PhD given constraints of time and as a sole researcher, the researcher completed a themed literature review using a semi-systematic approach (Moher, Stewart and Skekelle, 2015; Synder, 2019). Future studies in this area of research would therefore benefit from a full systematic review to allow for greater rigor of findings and recommendations.

The data collected within this PhD study came in the form of various reflective activities, all of which were self-reported accounts and opinions from participants within each phase. This self-reported data allowed the researcher to understand the lived experiences of clinicians in order to inform clinical practice (Miller, 2004), however it may mean that the findings are difficult to verify and may also be open to 'recall-bias', given the reflection on past events in some phases *(Althubati, 2016).* To negate the difficulties of verification of findings, the cumulated design of the 3-phases had allowed for triangulation of data using several virtual settings, over several years with multiple and varying participants, and utilising differing reflective method (Bekhet and Zauszniewski, 2012; Thurmond, 2001). However, the researcher suggests that the inclusion of additional methods within other similar studies, such as direct observation in practice or a review of clinical record keeping, may further aid this verification and validation, and increase methodological triangulation (Bekhet and Zauszniewski, 2012). Moreover, a sole researcher in the analysis of this data has led to the potential for further bias (Choy, 2014), however, the researcher recognised this in the analytical process and has acknowledged the impact their own experiences in the nexus may have on their interpretation of the data. Fortunately, the chosen methodology of MDA and Nexus analysis not only allows for researcher experience but also recognises the benefits of being a participant-analyst in attempts to change the nexus with research implications and recommendations (Scollon and Scollon, 2004b; Scollon and Scollon, 2004a).

Moreover, there are also counter arguments to the appropriateness of inter-rater reliability in qualitative research (Armstrong *et al.*, 1997; Belotto, 2018; McDonald, Schoenebeck and Forte, 2019). However, in similar future studies, the inclusion of additional researchers or analysts for the process of peer review, would decrease any potential for bias (Church, Dunn and Prokopy, 2019).

7.7 Concluding Summary

This chapter has provided an in-depth exploration of the factors influencing the implementation of new practices in the assessment and management of head injury patients by paramedics in the pre-hospital setting. By examining both the barriers to implementation and the strategies for improvement, this research aims to enhance the adoption of evidence-based practices and improve patient outcomes.

7.7.1 Summary of Key Findings

The chapter began by discussing the importance of understanding why paramedics make the decisions they do in relation to head injury management. It highlighted the role of guidelines such as NICE and JRCALC, and the various sources of evidence paramedics rely on, including peer support, local protocols, and online resources. The discussion revealed that while guidelines are crucial, their effectiveness is often limited by issues such as outdated information, conflicting recommendations, and the perceived impracticality of some guidelines.

The chapter then examined how paramedics engage with reflective practices and how this relates to their decision-making. It was found that reflective practice, whether through written reflections, peer discussions, or problem-based learning, plays a significant role in helping paramedics critically evaluate their actions and improve their clinical skills. The analysis identified three key themes in reflective discourse: the focus on thinking versus feeling, the impact of structured models, and the familiarity of language used in reflections.

7.7.2 Implementation Challenges

The implementation challenges identified include:

- People: Resistance to change, varying levels of experience and education, and the need for continuous professional development.
- Process: Complexity and impracticality of guidelines, lack of clear instructions, and the need for flexible and intuitive processes.
- Equipment: Availability and accessibility of necessary equipment, and the need for reliable and accessible tools.
- Materials: Quality and availability of educational resources, and the need for comprehensive and up-to-date materials.
- Environment: Unique challenges of the pre-hospital environment, including unpredictability and high-pressure situations.
- Management: Importance of effective leadership and management support, and the need for adequate resources and support systems.

7.7.3 Suggestions for Improvement

To address these challenges, several strategies were proposed:

- Pathways: Developing clear and streamlined patient pathways that are evidence-based and practical.
- CPD: Enhancing opportunities for continuous professional development through regular training sessions and online learning platforms.
- Education: Improving the quality and accessibility of educational resources and incorporating reflective practice into training programs.
- Guidelines: Ensuring guidelines are clear, concise, user-friendly, and regularly updated.
- Process: Streamlining processes, reducing unnecessary complexity, and involving paramedics in the design and testing of new procedures.
- Equipment: Providing reliable and accessible equipment and ensuring paramedics are trained in its use.

7.7.4 Contributions to Theory and Practice

As previous discussed, there is a noticeable gap in practical application between Quality improvement and successful implementation (The Health Foundation, 2013; Mosadeghrad, 2014; Correa *et al.*, 2020; Allcock *et al.*, 2015; Bach-Mortensen, Lange and Montgomery, 2018; Handley, Gorukanti and Cattamanchi, 2016). However, there is an apparent synergy between the two sciences, particularly within healthcare with a noticeable link through clinical effectiveness and evidence-based practice as explored in chapter 1, this potential synergy has yet to be harnessed as a recognised method or discipline. As a result of the overview of literature in chapter 1 and 2, the researcher been able to establish this potential synergy, within healthcare, and depict this synergy in the design of Figure 75.
As can be seen in Figure 75 the researcher has linked the pillars of clinical governance within quality improvement frameworks and therefore the wider subject of improvement science. The researcher has then identified three of those pillars (clinical effectiveness, research and development, and education and training) as mapping across to ‘clinical effectiveness implementation hybrid designs’ in implementation science. The researcher has also mapped evidence-based practice within clinical governance across to clinical decision making within implementation science. Finally, the researcher has established a link between the organisation environment pillar of Clinical governance, within improvement science, and the conceptual organisation environment framework within implementation science.

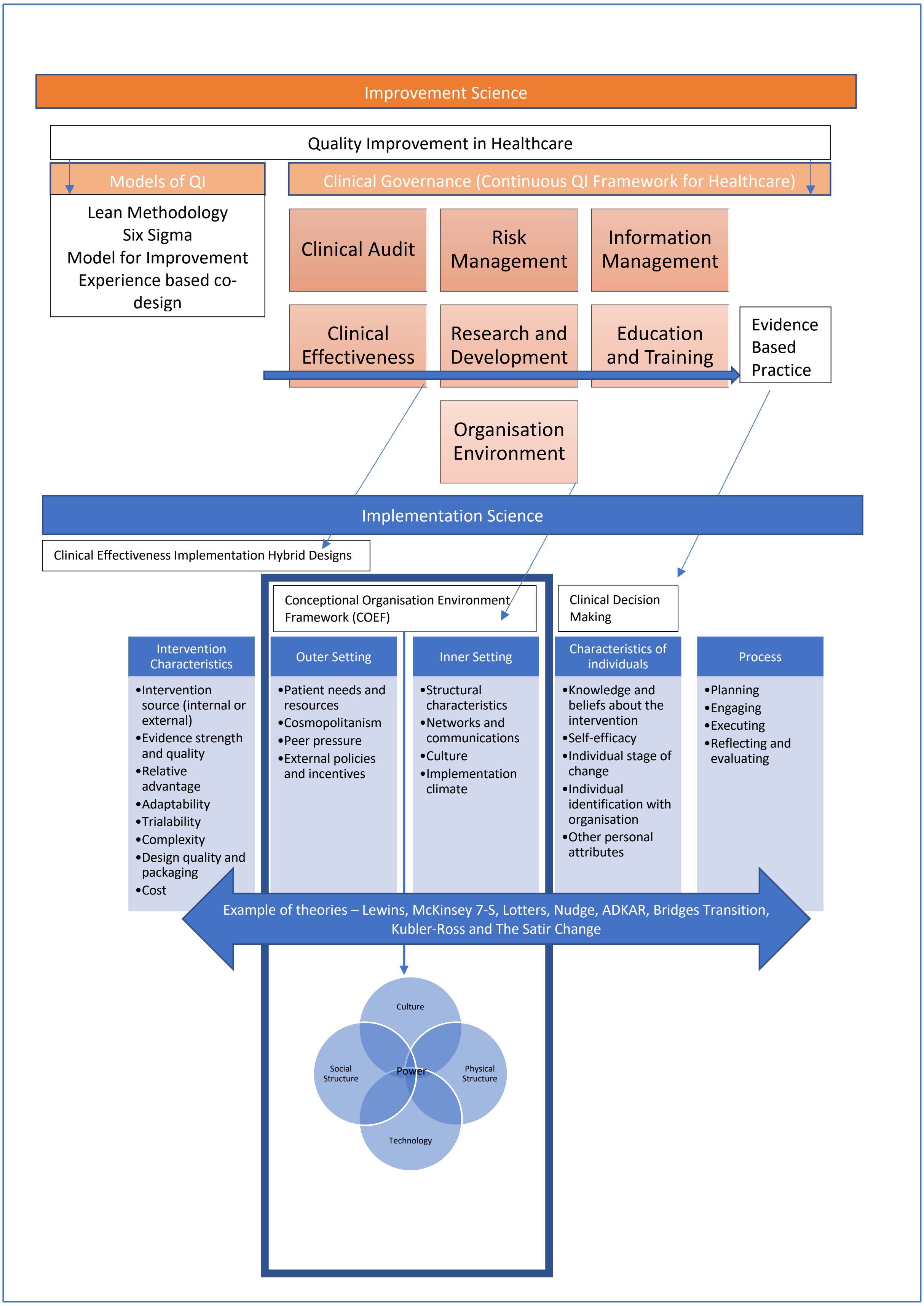


Figure 70 - Capturing the synergy of QI and Implementation Science in Healthcare

As Figure 75 shows, there is a potential link between the two sciences, through EBP within Clinical Governance as part of Quality Improvement, and the Clinical Decision Making to implement such EBP within Implementation Science.

The chapter also introduced the TRIAD Model and the QI Cognitive Continuum, developed from the findings of this research. These models offer practical frameworks for generating and implementing quality improvement ideas, emphasising the importance of diverse reflective activities such as semi-structured interviews, active information search events, and written reflections.

7.7.5 Conclusion

In conclusion, this chapter has provided a detailed analysis of the barriers to implementation and proposed actionable strategies to enhance the adoption of evidence-based practices in paramedic care. The integration of reflective practice and continuous professional development into these strategies is essential for achieving sustainable improvements in patient care. The insights and models developed from this research contribute to the broader field of quality improvement and implementation science, offering valuable tools for enhancing clinical practice and patient outcomes in the pre-hospital setting.

By addressing the identified challenges and implementing the suggested improvements, paramedic services can enhance the quality of care provided to head injury patients. Reflective practice and continuous professional development play a pivotal role in this process, enabling paramedics to critically evaluate their performance, learn from their experiences, and continuously improve their practice. This chapter has laid the groundwork for future research and practice improvements, ultimately aiming to enhance patient care through informed, reflective practice.

Chapter 8 – Conclusion

"What action can I take, as a participant-analyst in this nexus of practice, that will transform discourses into actions and actions into new discourses and practices?" (Scollon and Scollon, 2004a, p. 173).

8.1 Introduction

This chapter concludes the PhD study by summarising the key findings, highlighting the contributions to knowledge, and discussing the relevance and implications of the research. The chapter is structured as follows: summary of key findings, contributions to knowledge, relevance and implications of findings, limitations of the study, recommendations for future research, and concluding remarks.

The primary aim of this research was to improve the assessment and management of pre-hospital head injury patients by exploring whether there is a need to introduce a change 'into' clinical practice or change how paramedics clinically practice. This was achieved through the integration of reflective practice and mediated discourse analysis (MDA), providing a comprehensive understanding of paramedic practice, decision-making processes, and the role of reflective discourse in quality improvement (QI) and implementation science.

The central research question guiding this study was:

To improve the assessment and management of pre-hospital head injury patients, is there a need to introduce a change 'in to' clinical practice or change how paramedics clinically practice?

To address this question, the research was structured around four key objectives:

1. Establish **What** treatment and assessment paramedics are currently providing in the management of head injury patients.
2. Understand **Why** paramedics are making the decision they are, in relation to the assessment and management of head injury patients.

3. Understand **How** paramedics are engaging with reflective practices and how this relates to their decision making.
4. Establish if reflective practice can contribute to healthcare quality improvement and implementation science **(QI)**.

By examining these areas, the research aimed to provide a comprehensive understanding of current practices, decision-making processes, and the potential for reflective practice to enhance quality improvement in paramedic practice. The chapter will summarise the key findings, discuss their implications, and offer recommendations for future practice and research.

8.1.1 Reflecting on the thesis.

Starting with an idea for change to improve clinical practice, this PhD research has evolved from an initial proof of concept design into a study exploring the use of discourse in clinical practice. It examines how an increased understanding of what clinicians are doing and why they are doing it through reflective activities is an essential first step before any proposed change should be implemented. This approach allows for a genuine understanding of the perceived need for change and the likely success for implementation.

Initially, the research proposal considered a proof of concept for a QI proposal. The researcher realised the data would need to include qualitative methods to capture the voice of staff and perceived barriers to implementation. Through literature review, it became clear that a pre-understanding of clinicians' current practice was also important.

The research process was therefore an iterative process, as previously explained in chapter 1. The research design process in figure 1 of chapter 1 has been expanded to continue the design journey into the formulation of this thesis, as shown in Figure 71 below.

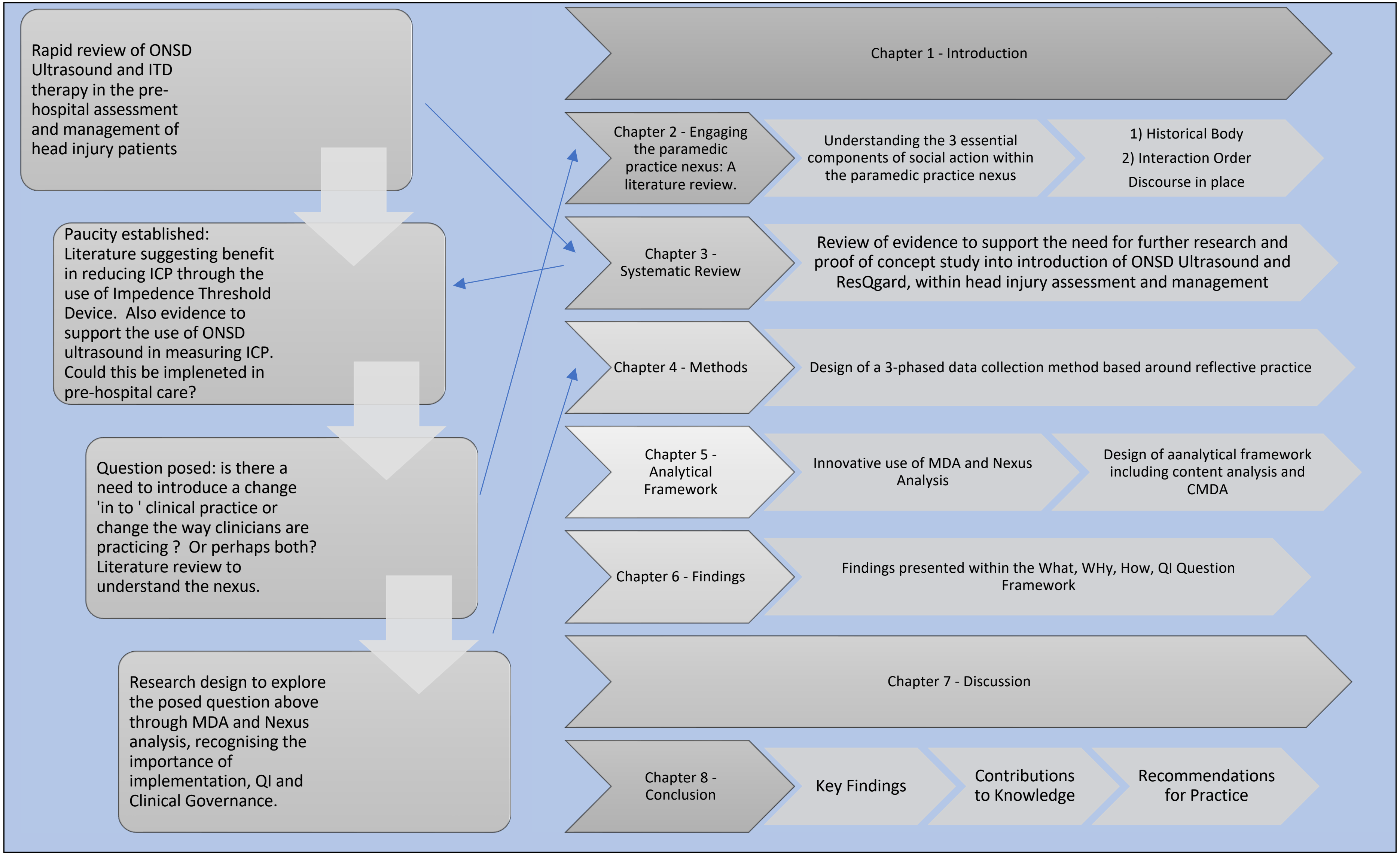


Figure 71 - Research and thesis design.

As can be seen from Figure 71 above, during the design of this research, the researcher posed the question: *Is there a need to introduce a change into clinical practice (referring to the possible implementation of ONSD ultrasound and the ResQpod, or perhaps another recommendation to come from a literature review), or is there a need to change the way clinicians are practicing?* This question arose as the researcher noted that not all evidence-based practice (EBP) was successfully implemented.

This study therefore aimed to establish and analyse factors within paramedic clinical decision asking and reflection which may influence quality improvement and subsequent implementation science in the assessment and management of head injury patients in the pre-hospital setting.

The results indicate that through the application of reflective practice, staff can contribute data useful for QI planning and understanding of implementation of change. Furthermore, the use of MDA and nexus analysis to frame discussion of this data allows for a greater understanding of the way in which staff are engaging with the social actions and mediated means in their practice to produce mediated actions, allowing for a greater understanding of the wider nexus of practice. In conclusion, the findings have demonstrated the applicability of MDA and Nexus Analysis as a method within QI and implementation science, through the utilisation of reflective practice.

8.1.2 Answering the research question.

The findings of this research support a proof-of-concept study for the introduction of ONSD ultrasound and impendence threshold device therapy, such as the ResQgard, into the assessment and management of head injury patients. The findings also highlight areas of importance to clinical staff when QI is undertaken, and implementation of change is attempted.

The results indicate that it is not always easy for staff to implement change in their practice, and they do not always feel involved in the process of change. However, they are very insightful into the need for change, sometimes attempting to change their practice in keeping with research before protocol and guidelines reflect such change. Positive relationships with peers are important in the successful implementation of EBP; however, negative relationships are detrimental to such implementation. Clinicians' relationship with the discourse they refer to in their practice is also pivotal in the successful implementation of EBP, and clinicians do not always find it easy to utilise mediated means or have trust in those means when initiating mediated actions in patient care or their own personal development.

This research has shown that there is scope to introduce change 'into' clinical practice, both in terms of the ideas the researcher proposed to participants in Phase 1 relating to the results of the systematic review, but also regarding suggestions for change from participants. Moreover, in answer to the research question, there is also a need to change the way clinicians are practising by recognising the challenges they are having in implementing 'best practice' combined with a greater understanding of how this relates to the discourses, social actions, and culture within the wider nexus of paramedic practice.

8.2 Summary of Key Findings

This section summarises the key findings of the research, organised around the four main objectives of the study.

8.2.1 Current Practices in the Management of Head Injury Patients

The research identified several key actions in the treatment and assessment of head injury patients by paramedics in the pre-hospital setting:

- **C-Spine Collars and Immobilisation**: Participants discussed the need to reduce the use of cervical collars due to their potential to increase intracranial pressure (ICP) and their limited effectiveness in immobilisation. The findings highlighted a conflict between the need for spinal immobilisation and the ability to position patients at 30 degrees head up to manage ICP.
- **Intoxicated Patients**: Managing intoxicated patients was identified as a significant challenge. Paramedics often conveyed these patients to the

hospital as a precaution, recognising the difficulties in assessing and managing intoxicated individuals.

- **Oxygen Therapy and Airway Management**: There was variability in practices related to oxygen therapy and airway management. Participants expressed the need for consistent guidelines on when to administer oxygen and the target SPO2 levels.
- **Managing Head Injuries in Older Adults**: Ethical considerations and the best place of care for older adults with head injuries were discussed. Participants recognised the need to avoid unnecessary hospital admissions for patients with dementia and other pre-existing conditions.
- **CT Imaging**: The potential for direct pathways to CT scanners and the use of CT scans in ambulances were explored. Participants suggested that changes in pre-hospital pathways could improve patient outcomes.
- **Pharmacological Interventions**: The need for advanced skills and decision-making in using pharmacological options like mannitol and hypertonic saline was highlighted. Participants also discussed the use of tranexamic acid (TXA) in head injury patients.
- **GCS Scoring**: The use of Glasgow Coma Scale (GCS) scoring was a common practice, but participants noted its limitations in identifying early increases in ICP.

8.2.2 Decision-Making Processes

The research explored why paramedics make the decisions they do in the management of head injury patients:

- **Guidelines and Protocols**: Participants frequently referenced guidelines such as JRCALC and NICE. While these guidelines are crucial, their effectiveness is often limited by issues such as outdated information, conflicting recommendations, and the perceived impracticality of some guidelines.

- **Peer Support and Personal Experience**: Decision-making was also influenced by peer support and personal experience. Participants valued the input of senior colleagues and critical care teams, especially in complex cases.
- **Biases and Attitudes**: The study identified biases in decision-making, such as ageist bias and environmental factors. Participants expressed varying attitudes towards evidence-based practice, with some fully supporting guidelines and others viewing them as restrictive or outdated.

8.2.3 Engagement with Reflective Discourse

The study examined how paramedics engage with reflective discourse and how this relates to their greater paramedic practice:

- **Reflective Practices**: Reflective practices, such as written reflections, peer discussions, and problem-based learning, played a significant role in helping paramedics critically evaluate their actions and improve their clinical skills.
- **Focus on Thinking vs. Feeling**: There was a difference in reflective focus across the phases of data collection. Interviews and case studies focused on 'thinking,' while written reflections focused on 'feeling.'
- **Impact of Structured Models**: The use of structured reflective models, such as Gibbs and Driscoll, was found to enhance the criticality of reflective writing. Longer interviews and written reflections with declared models showed greater breadth of vocabulary and potential for quality improvement (QI) discussion.
- **Familiarity in Language**: The analysis highlighted the use of colloquial terms, humour, abbreviations, and emojis in reflective discourse. While these elements often facilitated communication, they sometimes caused confusion or needed clarification.

8.2.4 Contribution to Quality Improvement (QI)

The research investigated whether reflective practice could contribute to healthcare quality improvement and implementation science:

- **Reflective Practice and QI**: Reflective practice was found to contribute significantly to QI by engaging participants in reflective activities related to assessment and treatment decision-making. Case study activities were more productive for engaging participants in reflective activities, while interviews and written reflections were better suited for QI and evidence-based practice (EBP) discussion.
- **Implementation Challenges**: Barriers to implementing QI practices included resistance to change, complexity of guidelines, availability of equipment, quality of educational materials, environmental factors, and management support.
- **Suggestions for Improvement**: Participants identified ideas for change in clinical practice or QI projects, categorised into pathways, CPD, education, guidelines, process, and equipment. The study proposed the TRIAD Model and the QI Cognitive Continuum as practical frameworks for generating and implementing quality improvement ideas.

These key findings provide a comprehensive understanding of current practices, decision-making processes, and the potential for reflective practice to enhance quality improvement in paramedic practice. The next sections will discuss the contributions to knowledge, recommendations for practice, limitations of the study, and future research directions.

8.3 Contributions to Knowledge

This section discusses the theoretical and practical contributions of the research to the existing body of knowledge in paramedic practice, reflective practice, and quality improvement.

8.3.1 Theoretical Contributions

- **Advancement of Reflective Practice in Paramedicine**: This research highlights the critical role of reflective practice in enhancing clinical decision-making and quality improvement in paramedic practice. By integrating reflective activities such as written reflections, peer discussions, and problem-based learning, the study demonstrates how reflective practice can lead to improved clinical skills and better patient outcomes. The introduction of the 'What, Why, How, QI' model of reflection provides a structured approach for paramedics to engage in reflective practice, emphasising the importance of understanding the reasons behind actions, the methods used, and the potential for quality improvement.
- **Integration of Quality Improvement and Implementation Science**: The research bridges the gap between quality improvement (QI) and implementation science by proposing the TRIAD Model (Triangulation of Reflective Improvement Activities and Dissemination). This model emphasises the importance of combining reflective practice with structured QI activities to generate actionable insights and drive sustainable improvements in clinical practice. The QI Cognitive Continuum introduced in this study offers a framework for understanding the cognitive processes involved in QI activities, highlighting the balance between structured and flexible approaches to foster creativity and critical thinking.
- **Insights into Decision-Making Processes**: The study provides a comprehensive understanding of the decision-making processes of paramedics, identifying the key factors that influence their clinical decisions. By examining the role of guidelines, peer support, personal experience, and biases, the research offers valuable insights into the complexities of clinical decision-making in the pre-hospital setting. The findings underscore the importance of evidence-based practice (EBP) and the need for clear, concise, and regularly updated guidelines to support paramedics in making informed decisions.

8.3.2 Practical Contributions

- **Improvement of Clinical Guidelines and Protocols**: The research highlights the need for improvements in clinical guidelines and protocols to enhance their relevance and practicality for paramedics. Recommendations include ensuring guidelines are clear, concise, user-friendly, and regularly updated to reflect the latest evidence and feedback from practitioners. The study emphasises the importance of involving paramedics in the development and review of guidelines to ensure they are practical and relevant to their needs.
- **Enhancement of Training and Education**: The findings underscore the importance of continuous professional development (CPD) and the need for regular training sessions, workshops, and access to online learning platforms. By enhancing CPD opportunities, paramedics can stay up to date with the latest guidelines and best practices, ultimately improving patient care. The research advocates for the integration of reflective practice into paramedic training programs, encouraging paramedics to critically evaluate their performance and identify areas for improvement.
- **Promotion of Reflective Practice**: The study demonstrates the value of reflective practice in paramedic practice and offers practical tools and models to facilitate its integration. The ‘What, Why, How, QI’ model and the TRIAD Model provide structured approaches for paramedics to engage in reflective activities, fostering a culture of continuous learning and improvement. By promoting reflective practice, the research contributes to the development of a more reflective and adaptive paramedic workforce, capable of responding to the dynamic challenges of pre-hospital care.
- **Support for Quality Improvement Initiatives**: The research provides practical insights and recommendations for implementing quality improvement initiatives in paramedic practice. By identifying the barriers to implementation and proposing strategies for overcoming these challenges, the study offers valuable guidance for enhancing the adoption of evidence-based practices. The TRIAD Model and the QI Cognitive Continuum serve as practical

frameworks for generating and implementing quality improvement ideas, emphasising the importance of diverse reflective activities and continuous professional development.

These contributions to knowledge provide a comprehensive understanding of the current practices, decision-making processes, and the potential for reflective practice to enhance quality improvement in paramedic practice. The next sections will discuss the limitations of the study, future research directions, and final thoughts.

8.3.3 Changing the Nexus – Contribution through Publication

Changing the nexus of practice through this PhD has partly been enabled through the following publications pre thesis completion (Appendix 25 and 26).

Hosznyak (2016) Does impedence threshold device therapy have a place in the treatment of increased intracranial pressure in pre-hospital patients? A literature review. *British Paramedic Journal* 1**,** 18-23.

Hosznyak (2022) 'Audit and Quality Improvement Sciences', in Hill B and Diamond-Fox S (eds.) *Advanced Clinical Practice at a glance*: Wiley.

8.4 Recommendations for Practice

Based on the findings of this research, several recommendations can be made to enhance paramedic practice, improve clinical guidelines and protocols, and integrate reflective practice more effectively. These recommendations aim to address the challenges identified in the study and support the continuous professional development of paramedics.

8.4.1 Improvement of Clinical Guidelines and Protocols

- **Clear and Concise Guidelines**: Ensure that clinical guidelines are clear, concise, and user-friendly. This includes providing step-by-step instructions, visual aids, and decision-making tools that can be easily referenced in the field.

- **Regular Updates**: Regularly update guidelines to reflect the latest evidence and feedback from paramedics. This will help ensure that guidelines remain relevant and practical.
- **Involvement of Paramedics**: Involve paramedics in the development and review of guidelines to ensure they are practical and relevant to their needs. This can be achieved through focus groups, surveys, and pilot testing of new guidelines.

8.4.2 Enhancement of Training and Education

- **Continuous Professional Development (CPD)**: Enhance CPD opportunities for paramedics through regular training sessions, workshops, and access to online learning platforms. This will help paramedics stay up to date with the latest guidelines and best practices.
- **Integration of Reflective Practice**: Integrate reflective practice into paramedic training programs. Encourage paramedics to engage in reflective activities such as written reflections, peer discussions, and problem-based learning to critically evaluate their performance and identify areas for improvement.
- **Use of Structured Reflective Models**: Promote the use of structured reflective models, such as the 'What, Why, How, QI' model, to guide paramedics in their reflective practice. This will help ensure that reflections are comprehensive and focused on quality improvement.

8.4.3 Promotion of Reflective Practice

- **Fostering a Reflective Culture**: Foster a culture of reflective practice within paramedic services. Encourage paramedics to share their reflections and learn from each other's experiences. This can be facilitated through regular debriefing sessions, reflective practice groups, and online forums.
- **Support for Reflective Activities**: Provide support for reflective activities by allocating time and resources for paramedics to engage in reflection. This includes providing access to reflective tools and models, as well as creating

opportunities for paramedics to participate in reflective practice during their shifts.

8.4.4 Support for Quality Improvement Initiatives

- **Implementation of the TRIAD Model**: Implement the TRIAD Model (Triangulation of Reflective Improvement Activities and Dissemination) to generate and implement quality improvement ideas. This model emphasises the importance of combining reflective practice with structured QI activities to drive sustainable improvements in clinical practice.
- **Addressing Barriers to Implementation**: Identify and address barriers to the implementation of quality improvement initiatives. This includes providing adequate resources, training, and support for paramedics, as well as addressing any organisational or environmental challenges.
- **Encouraging Innovation**: Encourage paramedics to innovate and contribute to quality improvement initiatives. This can be achieved by creating a supportive environment that values and rewards innovation, as well as providing opportunities for paramedics to share their ideas and collaborate on QI projects.

8.4.5 Improvement of Patient Pathways

- **Clear and Streamlined Pathways**: Develop clear and streamlined patient pathways that are evidence-based and practical. These pathways should be designed to accommodate the unique challenges of the pre-hospital environment and support paramedics in making informed decisions quickly and efficiently.
- **Direct Access to Specialists**: Explore the potential for direct access to specialists, such as neurosurgeons, for head injury patients. This could involve developing pathways that allow paramedics to bypass the emergency department and take patients directly to a specialist for assessment and treatment.

8.4.6 Enhancement of Equipment and Resources

- **Reliable and Accessible Equipment**: Ensure that paramedics have access to reliable and accessible equipment. This includes investing in high-quality, reliable equipment and providing ongoing training and support for its use.
- **Maintenance and Replacement Protocols**: Develop protocols for the maintenance and replacement of equipment to ensure that it remains in good working condition. This will help prevent equipment failures and ensure that paramedics have the tools they need to provide high-quality care.

These recommendations aim to enhance paramedic practice, improve clinical guidelines and protocols, and integrate reflective practice more effectively. By addressing the challenges identified in this research and implementing these recommendations, paramedic services can improve the quality of care provided to head injury patients and support the continuous professional development of paramedics. The next sections will discuss the limitations of the study, future research directions, and final thoughts.

8.5 Limitations of the Study

While this research provides valuable insights into the assessment and management of head injury patients by paramedics, it is important to acknowledge its limitations. These limitations span across sampling, potential biases, and the nature of the data collected. Recognising these limitations helps contextualise the findings and provides a foundation for future research to build upon.

8.5.1 Sampling

- **Sample Size**: The sample sizes for Phase 1 (semi-structured interviews) and Phase 2 (review of written reflections) were relatively small, with 12 participants in Phase 1 and 10 participants in Phase 2. While the researcher reached data saturation at these numbers, the small sample sizes may limit the generalisability of the findings. Future studies could benefit from larger sample sizes to validate these results and enhance their robustness.

- **Non-Comparative Independent Variables**: The use of varying settings, participants, and reflective methods allowed for triangulation within the three phases of this study. However, the inclusion of a pre-existing online social media platform in Phase 3, which was open to a broader range of clinical grades, created non-comparative independent variables among clinical grades across phases. To address this, future research should consider a design that includes dependent variables consistently across all phases.

8.5.2 Bias Through Lone Researching and Self-Reported Data

- **Lone Researching**: The researcher was the sole investigator in all three phases of this study, which may introduce potential bias. While the chosen methodology of Mediated Discourse Analysis (MDA) and Nexus Analysis allows for researcher experience and recognises the benefits of being a participant-analyst, the inclusion of additional researchers or analysts for peer review would help mitigate potential bias and enhance the credibility of the findings.
- **Self-Reported Data**: The data collected in this study were self-reported by participants through various reflective activities. While self-reported data provide valuable insights into the lived experiences of clinicians, they may be subject to recall bias and difficult to verify. Future studies could incorporate additional methods, such as direct observation in practice or a review of clinical record-keeping, to validate and triangulate the findings.

8.5.3 Structure of Literature Review

- **Semi-Systematic Approach**: Due to time constraints and the nature of lone researching, the literature review was conducted using a semi-systematic approach rather than a full systematic review. While this approach provided a comprehensive overview of relevant literature, a full systematic review would offer greater rigour and depth. Future research should consider conducting a full systematic review to enhance the robustness of the literature review and provide a more detailed understanding of the existing body of knowledge.

8.5.4 Generalisability

- **Context-Specific Findings**: The findings of this study are context-specific to paramedic practice in the pre-hospital setting. While the insights gained are valuable, they may not be directly applicable to other healthcare settings or professions. Future research should explore the transferability of these findings to other contexts and examine how the identified practices and challenges manifest in different healthcare environments.

8.5.5 Reflective Practice and Peer Review

- **Lack of Peer Review in Reflective Activities**: The reflective activities in this study were not subject to peer review, which may limit the depth and criticality of the reflections. Incorporating peer review into reflective practice could enhance the quality of reflections and provide additional perspectives. Future research should explore the impact of peer-reviewed reflective practice on clinical decision-making and quality improvement.

By acknowledging these limitations, this study provides a transparent and balanced view of its findings. Addressing these limitations in future research will help build on the insights gained and contribute to the ongoing development of evidence-based practices in paramedic care. The next sections will discuss future research directions and final thoughts.

8.6 Future Research

This section outlines potential areas for future research that could build on the findings of this study. By addressing the limitations and exploring new questions that have emerged, future research can further enhance our understanding of paramedic practice, reflective practice, and quality improvement in the pre-hospital setting.

8.6.1 Expanding Sample Sizes and Diversity

- **Larger Sample Sizes**: Future studies should aim to include larger sample sizes to validate the findings of this research and enhance their generalisability. Increasing the number of participants in each phase will provide a more robust dataset and allow for more comprehensive analysis.

- **Diverse Participant Groups**: Including a more diverse range of participants, such as paramedics from different regions, varying levels of experience, and different clinical grades, will help ensure that the findings are representative of the broader paramedic community. This diversity will also provide insights into how different factors influence clinical decision-making and reflective practice.

8.6.2 Longitudinal Studies

- **Long-Term Impact of Reflective Practice**: Conduct longitudinal studies to examine the long-term impact of integrating reflective practice into paramedic training and practice. This research could explore how sustained engagement in reflective activities influences clinical decision-making, professional development, and patient outcomes over time.
- **Implementation of the TRIAD Model**: Investigate the implementation of the TRIAD Model (Triangulation of Reflective Improvement Activities and Dissemination) in various healthcare settings. Longitudinal studies could assess the effectiveness of this model in generating and implementing quality improvement ideas and its impact on clinical practice and patient care.

8.6.3 Comparative Studies

- **Comparison with Other Healthcare Professions**: Conduct comparative studies to explore how reflective practice and quality improvement initiatives are implemented in other healthcare professions. Comparing paramedic practice with nursing, medicine, and other allied health professions can provide valuable insights into best practices and potential areas for cross-disciplinary learning.
- **International Comparisons**: Explore how paramedic practice, reflective practice, and quality improvement initiatives vary across different countries and healthcare systems. International comparisons can highlight unique challenges and innovative solutions that can inform practice improvements globally.
-

8.6.4 Technological Integration

- **Use of Technology in Reflective Practice**: Investigate the role of technology in facilitating reflective practice among paramedics. Research could explore the use of digital tools, mobile applications, and online platforms to support reflective activities, peer discussions, and continuous professional development.
- **Impact of Telemedicine and Remote Support**: Examine the impact of telemedicine and remote support on paramedic practice, particularly in the management of head injury patients. Future research could assess how telemedicine can enhance decision-making, provide access to specialist advice, and improve patient outcomes in the pre-hospital setting.

8.6.5 Addressing Implementation Barriers

- **Strategies for Overcoming Implementation Barriers**: Conduct research to identify effective strategies for overcoming the barriers to implementing quality improvement initiatives identified in this study. This could include exploring organisational culture, leadership support, and resource allocation to facilitate the adoption of evidence-based practices.
- **De-Implementation of Inappropriate Practices**: Investigate the process of de-implementing inappropriate or outdated practices in paramedic care. Research could explore the challenges and strategies for replacing old practices with new, evidence-based approaches, ensuring that paramedics are equipped with the most current and effective tools and techniques.

8.6.6 Enhancing Reflective Practice

- **Peer-Reviewed Reflective Practice**: Explore the impact of incorporating peer review into reflective practice among paramedics. Research could assess how peer-reviewed reflections influence the depth and criticality of reflective activities and their contribution to quality improvement.
- **Reflective Practice in Education**: Investigate the integration of reflective practice into paramedic education programs. Future research could examine

how reflective activities are incorporated into curricula, their impact on student learning, and their role in preparing paramedics for professional practice.

By addressing these future research directions, the field of paramedic practice can continue to evolve and improve. These studies will build on the insights gained from this research, contributing to the ongoing development of evidence-based practices, reflective practice, and quality improvement in the pre-hospital setting. The next section will provide final thoughts and reflections on the research journey and its broader implications for the field of paramedicine and healthcare.

8.7 Final Thoughts

This research journey has provided valuable insights into the assessment and management of head injury patients by paramedics in the pre-hospital setting. By exploring current practices, decision-making processes, engagement with reflective discourse, and the potential for reflective practice to enhance quality improvement, this study has contributed to the ongoing development of evidence-based practices in paramedic care.

8.7.1 Reflecting on the Research Journey

The research began with a clear aim: to determine whether there is a need to introduce changes into clinical practice or how paramedics clinically practise to improve the assessment and management of pre-hospital head injury patients. Through a comprehensive exploration of paramedic practices, decision-making processes, and reflective activities, the study has provided a nuanced understanding of the complexities and challenges faced by paramedics in pre-hospital settings.

The integration of reflective practice into paramedic training and practice emerged as a key theme throughout the research. Reflective activities, such as written reflections, peer discussions, and problem-based learning, were found to play a significant role in enhancing clinical decision-making and fostering a culture of continuous improvement. The introduction of structured reflective models, such as the ‘What, Why, How, QI’ model, offers practical tools for paramedics to engage in meaningful reflection and drive quality improvement initiatives.

8.7.2 Broader Implications for Paramedicine and Healthcare

The findings of this research have broader implications for the field of paramedicine and healthcare. By highlighting the importance of clear, concise, and regularly updated guidelines, the study underscores the need for evidence-based practices that are practical and relevant to paramedics' needs. Involving paramedics in the development and review of guidelines can ensure that these tools are user-friendly and effective in supporting clinical decision-making.

The study also emphasises the value of continuous professional development (CPD) and the integration of reflective practice into paramedic education programs. By fostering a culture of reflective practice, paramedic services can support the ongoing professional development of their workforce, ultimately leading to improved patient care and outcomes.

The proposed TRIAD Model and QI Cognitive Continuum offer practical frameworks for generating and implementing quality improvement ideas. These models emphasise the importance of combining reflective practice with structured QI activities, providing a roadmap for paramedic services to drive sustainable improvements in clinical practice.

8.7.3 Concluding Remarks

In conclusion, this research has provided a comprehensive understanding of the assessment and management of head injury patients by paramedics, highlighting the critical role of reflective practice and quality improvement in enhancing clinical practice. By addressing the identified challenges and implementing the suggested recommendations, paramedic services can improve the quality of care provided to head injury patients and support the continuous professional development of paramedics.

The insights gained from this research contribute to the broader field of quality improvement and implementation science, offering valuable tools and frameworks for enhancing clinical practice and patient outcomes in the pre-hospital setting. As the field of paramedicine continues to evolve, the integration of reflective practice and evidence-based guidelines will be essential in ensuring that paramedics are equipped to meet the dynamic challenges of pre-hospital care.

This research journey has been both enlightening and rewarding, providing a deeper understanding of the complexities of paramedic practice and the potential for reflective practice to drive meaningful improvements in patient care. The findings and recommendations presented in this study offer a pathway for future research and practice improvements, ultimately aiming to enhance the quality of care provided to patients in the pre-hospital setting.

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Appendix 1 – Semi-structured interview questions used in Phase 1.

To ensure clarity and coherence in the research design, the guiding questions used in the interviews were created to align with the "what, how, why, QI" framework used within the thesis and research design.

Phase 1 Objectives and Guiding Questions

1. **What**: Investigate how participants currently assess and treat head injury patients.
    - **Guiding Question**: "How do you currently assess and treat head injury patients?"
        - **Follow-up Questions**:
            - "What are you looking for in your assessment and why?"
            - "How are you treating a head injury and why?"
            - "When did you learn this?"
            -
2. **Why**: Explore how evidence-based practice and continued professional development feature within participants' decision-making.
    - **Guiding Question**: "Can you tell me about the evidence-based practice and continued professional development that influence your decision making in these patients?"
        - **Follow-up Questions**:
            - "What is the source of your knowledge in this area?"
            - "What guidelines or protocols do you use?"
            - "What are your views on the suitability of the source of your knowledge?"
            - "What influences your attitude towards CPD and changing your clinical practice?"
            -
3. **How**: Understand how paramedics engage with reflective practices and how this relates to their decision-making.

- **Guiding Question**: "What thoughts do you have on changing practice in this area?"
  - **Follow-up Questions**:
    - "Thoughts about bringing ResQgard and ONSD Ultrasound into practice?"
    - "Do we need to change practice in this area?"
    - "What should we do and why when assessing and treating head injury patients?"

4. **QI (Quality Improvement)**: Establish if reflective practice can contribute to healthcare quality improvement and implementation science.
   - **Guiding Question**: Integrated within the "What, How, Why" questions to explore suggestions for change in practice and comparisons of ways of working among participants.

The "what, how, why, QI" framework is designed to provide a comprehensive understanding of paramedic practices in the assessment and management of head injury patients. By structuring the guiding questions around this framework, the research ensures that each aspect of the paramedics' clinical practice is thoroughly explored:

- **What**: Identifies the current practices and methods used by paramedics.
- **Why**: Explores the rationale behind these practices, including the influence of evidence-based practice and CPD.
- **How**: Investigates the engagement with reflective practices and the potential for change.
- **QI**: Integrates the findings to suggest improvements in clinical practice and contribute to healthcare quality improvement.

Appendix 2 – Phase 1 Participant Information Sheet

You are being invited to take part in a small-scale research project also forming part of my greater PHD work. Before you make a decision, please take time to read the following information and discuss it with others if you wish or ask me if there is anything that is not clear or if you would like more information about the project. Take time to decide whether or not you would like to part. Thank you for taking time to read this.

Project Title
Exploring current clinical knowledge and attitudes towards a change in clinical practice, amongst Paramedics, with regards to assessment and management of head injury patients.

Research Aims

To establish the current clinical knowledge and attitudes towards a change in clinical practice, amongst Paramedics, with regards to assessment and management of head injury patients

Research Objectives

This knowledge will allow a purposeful design to any future training resources and clinician support through a change of practice in this area. This work will also highlight any feasibility issues regarding staff attitude towards the possible introduction of new equipment and techniques in the assessment and management of head injury patients. The opportunity for guided reflection will aid the participants CPD activities thus ultimately benefiting patient care. The researcher aims to publish and disseminate the findings in the form of a journal article. Participants will be provided with the opportunity to view published outputs from the research and an email debriefing will be sent to participants informing them of the key outcomes of the research once it has been completed.

Methods

Data will be collected for this research project through semi-structured interviews also known as an Interview guided approach. This will allow guided reflection by the participants and exploration of their experiences through open questions with the flexibility for the interviewer to explore a particular question or answer in more detail if needed.

15 graduate and non-graduate participants will be randomly selected from the volunteers.

Consent and Withdrawal

If you chose to take part, you will be asked to sign a consent form. Participation is voluntary and you have the right to withdraw at any time, prior to the interview. You will then have two further weeks to withdraw before data analysis begins. After this time, due to anonymisation of data for the purposes of data analysis, it will not be possible to withdraw any contributions made, as it would be difficult to identify individual responses. All information will be stored securely and in line with University Policy will be destroyed after 10 years.
Interviews will be digitally recorded; these will then be transcribed into typed format and will remain strictly confidential whilst still in this format. Any identifiable information about individual participants will be removed during transcription. The digital recordings will be destroyed at the end of the project. Additional notes will also be taken throughout the one-to-one interviews. The transcribed work will be analysed for themes that are identified throughout the data collection, also any additional notes taken will be used for analysis.
There are no physical risks in taking part in this interview. The interview is not designed to make you feel uncomfortable, however if you do feel uncomfortable at any time the interview will be stopped. If you feel that you need to speak to someone after the interview you can contact me, and I will organise an independent counsellor to contact you.

Contact and Volunteering
If you would like to take part in the project, please reply stating your preferred contact details and your educational route into the Paramedic Profession (Graduate or Non-Graduate). If you have any further questions or would like more information, please contact me. My details are included below:
Rachael Hosznyak (nee Solomon)

Paramedic Science Programme Lead
Advanced Paramedic Practitioner
Birmingham City University

Rachael.hosznyak@bcu.ac.uk

If you have any concerns or complaints about the study, please contact my academic supervisor, Dr Andy Powell, Andy.powell@bcu.ac.uk 0121 3317113.

Appendix 3 – Phase 1 Participant Consent Form

Exploring current clinical knowledge and attitudes towards a change in clinical practice, amongst Paramedics, with regards to assessment and management of head injury patients.

Participant Consent Form

Permission
I have read and understand the information sheet and the conditions of this project. I have read and understand what you want me to do for this study, and my right to withdraw. I hereby voluntarily agree to participate in this project. I may withdraw my consent at any time during this phase of the project and before or during any of the data collection processes without penalty.

Name of Participant:

Signature:

Date:

Appendix 4 – Phase 2 Participant Information Sheet

Participant Information Sheet

You are being invited to take part in a small-scale research project also forming part of my greater PHD work. Before you make a decision, please take time to read the following information and discuss it with others if you wish or ask me if there is anything that is not clear or if you would like more information about the project. Take time to decide whether or not you would like to part. Thank you for taking time to read this.

Project Title

Assessment and management of head injury patients amongst paramedics.
A qualitative analysis of written reflections

Research Aims

Exploring the assessment and management of head injury patients in pre-hospital care by paramedic clinicians and the practice of reflection within paramedic practice.

Research Objectives

This knowledge will help to inform any future changes in paramedic training and clinical practice in the area of head injury assessment and management. The chosen methodology of this research will also help the profession better understand how paramedics reflect on their clinical interactions. I intend to publish and disseminate the findings in form of a journal article. Participants will be provided with the opportunity to view published outputs from the research. An email debriefing will be sent to participants informing them of the key outcomes of the research once it has been completed and to thank and acknowledge their participation.

Methods

Data will be collected for this research project through the collection of written reflective accounts from UK paramedic clinicians who have assessed and managed head injury patients.

Social media will be used to promote the research and recruit participants. 10 participants will be randomly selected from the volunteers.

Data Analysis

The research will use a modified constant comparison method of analysis, thus constructing categories and themes from open and axially coded data. The coding scheme will be created from the data as it is explored. Resulting themes will then be explored in comparison to the existing literature around reflective practice and the assessment and management of head injury patients.

Consent and Withdrawal

If you chose to take part, you will be asked to sign a consent form. Participation is voluntary and you have the right to withdraw at any time, prior to the sharing of your reflection. You will then have two further weeks to withdraw before data analysis begins. After this time, due to anonymisation of data for the purposes of data analysis, it will not be possible to withdraw any contributions made, as it would be difficult to identify individual responses. All information will be stored securely and in line with University Policy.
There are no physical risks in taking part in this research. The process of sharing your reflection is not designed to make you feel uncomfortable. If you feel that you need to speak to someone as a result of reflecting on your practice you can contact me, and I will organise an independent counsellor to contact you.

Please be reassured that this is a safe place to share your learning in line with HCPC standards and regulations, this is not an assessment or intended to judge ability; however, the researcher is a HCPC registered paramedic so has a duty to report any dangerous practice.

Volunteering
If you would like to take part in the project, please reply with confirmation of this. If you have any further questions or would like more information, please contact me. My details are included below:
Rachael Hosznyak (nee Solomon)

Phd Student – Birmingham City University
Advanced Paramedic

Rachael.hosznyak@nhs.net

If you have any concerns or complaints about the study, please contact my academic supervisor, Dr Andy Powell, Andy.powell@bcu.ac.uk 0121 3317113.

Appendix 5 – Phase 2 Participant Consent Form

Assessment and Management of head injury patients amongst paramedics.
A qualitative analysis of written reflections

Participant Consent Form

Permission
Please confirm your consent by ticking the following boxes, should you agree.

Statement	Tick if agree
I have read and understood the information sheet?	
I have had the opportunity to ask questions?	
I understand that participation is entirely voluntary?	
I agree to take part via the sharing of my reflection?	
I understand that I have the right to withdraw prior to anonymisation of data, without prejudice?	
I understand my right to anonymity / confidentiality?	

Name of Participant:

Signature:

Date:

Appendix 6 – Case Study 1 Information

It's late afternoon on a public holiday. The sun is shining and the birds' wheel lazily overhead whilst
you sit and stare at clouds with your crewmate. You're disturbed from your cloud watching by a drop
of ice cream which falls from its cone and on to your hand which makes you jump, throwing ice cream all over the cab. Whilst cleaning up
ice cream from the floor, your data terminal bursts into life.
'Cat 2 – Male. Head injury'
Arriving at the property; you are shown into the garden where you meet Jake, a 23-year-old man
who has slipped in a children's paddling pool during a large family BBQ. Jake tells you that he has
had 1 or 2 bottles of perry cider throughout the day and slipped in the pool whilst 'messing about.'
The fall has resulted in an abrasion to the cheek and chin sustained by hitting and scraping a redbrick
wall whilst falling (example photograph in comments.)

Case updates

The patient does not appear particularly intoxicated and was not KO'd. He retains total recall of events prior and after the incident.
He has no spinal tenderness on palpation. There is no crepitus, deformity or significant pain over the facial bones although pressing on the wound is a little sore. He has no epistaxis, rhinorrhoea or otorrhea. Pupils are size 3, ERRLA.

There is no loose teeth, dental bleeding or pain when biting down. The patient tells you that he has had a mild headache all day, but it has responded well to paracetamol. Cranial nerves I-XII appear grossly intact.

Obs
BP: 126/74
P:87
Sats: 98% on air
Resps: 13
GCS: 15/15
Temp: 36.7°C
BGT: 6.0

The patient's family (mum) have called immediately after the fall due to the wound, many of the family have also been drinking. The mechanism is as described with no seizure. The patient slipped in the pool and fell, scraping his chin and face during the fall against a wall.

Pain score: 1 - facial, from wound

PMH - Asthma, eczema.

DHx - Salbutamol, beclomethasone, hydrocortisone cream

Appendix 7 – Case Study 2 Information

It's mid-afternoon and you've just finished your lunch break; freshly made bacon sandwiches all round curtesy of station officer and you have just enough time to clean the ketchup from the front of your shirt when you receive notification of a dispatch.

You have been seconded recently to a new 'GP home visit' pilot within your local patch and a request has come in from a local GP surgery to visit an 84yr old male who's family are concerned that he has become much more noticeably confused in past week, slightly agitated, told daughter he saw someone in the kitchen today but there wasn't anyone else in the house, also more unsteady on his feet in past couple of days. He had a fall 4 weeks ago with no loss of consciousness but resulting in a # scaphoid and laceration to his forehead which was sutured by the local minor injury unit and splint applied to left wrist / hand.

On arrival at the patients house, you are greeted at the door by the patients daughter who lets you in and shows you the living room where the patient is asleep in a reclining armchair, you notice a commode and walking stick in the living room (both purchased by the patient privately in the past 6-12 months as he has noticed a decline in his mobility) and there is a general smell of urine. His medications are on the table next to him in a dosette box, with a Ventolin inhaler close by; you can confirm on his GP records that he is not on any other acute medications. The dosette box seems to be out of sync as there are some boxes open and some not, with no particular pattern regards date or time of day; this seems to be the case for the past 4 days.

PMH – COPD, Hypertension, mild LVF, Heart failure, #Scaphoid (left hand) 4 weeks ago, DVT 20yrs ago, awaiting referral for dementia review (no current diagnosis but mini cog assessment at GP surgery 3 months ago, revealed some potential issues; daughter noticed slowly increasing confusion over past 12 months). Daughter reports pt having 6 falls in the past 12 months, no other head wounds but unable to rule out bangs to his head as not witnessed and patient unsure, he did not seek any medical attention for these falls. Pt doesn't think he felt unwell before the falls but can't remember details well, he thinks it is due to stumbling forward when he walks and mobility getting gradually worse.

Meds – Ventolin inhaler PRN, Ramipril 2.5mg OD, Furosemide 40mg OD, Paracetamol 1g QDS, Atorvastatin 40mg OD

GCS 14 (normal for pt) E4, V4, M6, but daughter says he is more confused than normal.

SPO2 94% on air

BP 190/90 (sitting)

Pulse 60 with very occasional irregular beat noted.

RR 18

CBG 5.2

Temp 36.8

Looks well, no recent illness reported.
Social - coping with ADL's
Rockwood Frailty = 6

Abdominal

- Bowels open yesterday, 4 on Bristol stool chart. No recent history of constipation or diarrhoea
- No vomiting, reduced appetite, and nausea since yesterday
- Fluid intake approx. 1.5 litres per day
- Daughter thinks he is passing urine more often over the past week or so – pt not sure. Seems as though output is in keeping with input recently.
- No renal angle or kidney pain
- NAD on PR exam
- Urinalysis NAD
- Urine looks clear and not offensive to smell.

Respiratory

- Auscultation, palpation, percussion, and tactile vocal fremitus: NAD

Cardiac

- Mild pitting oedema to ankles – at baseline
- No palpitations
- CRT = 3secs
- Cardiac auscultation NAD
- No chest pain.
- No raised JVP noted.
- No clinical signs of anaemia

Neurological

- Drowsy, falling asleep during consultation while you are speaking to daughter.
- Feels confused, orientated to person and place but not time.
- No FAST signs
- Complaining of headache, 6/10 everywhere
- Complaining of vision seeming a bit ‘strange’
- Complaining of feeling dizzy on and off for past couple of days
- FAST neg
- No nystagmus
- PEARLA
- LIMBS x 4 = Cogwheeling noticed on assessment, normal sensation x 4, strength seems good x 4
- Failed mini cog.

- DANISH (Dysdiadochokinesia - positive, Ataxia - negative, Nystagmus - Negative, Intention tremor - positive, scanning dysarthria - slight, Heel / shin - struggled)

Exposure

- No rashes
- Sutured wound to head from previous fall.
- Splint on left hand / wrist.
- Able to walk with stick but seems unsteady, parkinsonian looking gait.
- ‘Cauliflower ears’ from many years playing rugby in his younger years (played for most of his adult life)

Appendix 8 – Case Study 3 Information

It is 1700 and you are stood in subway and have just declined salad on your meatball marinara footlong in fear that your radio will stop you getting your sub (despite not compromising time for cheese and toasted) when your radio fatally goes off, its control. However, all is not lost they have a job for you, but you can go after your meal break woooohoooo go on then “yes I will have a cookie and drink as a meal deal.”

After your meal break your job comes through you are going to a 73 male who was seen by an NQP 1.5 hrs ago, the patient was in Tesco and slipped over hitting the back of their head on the floor. The NQP took them back to their house and have left them at home needing wound care and referred back to control for a paramedic practitioner to attend and now you as the local PP have been given the job. You arrive at the patient’s house and are welcomed into his sitting room.

Details and findings updated as requested……. (Open to all grades from the outset)

******NQP ePCR looked up and reads as follows*****:

PC: Head Injury

HPC: Fall in shop today, hit head, not KO’d, feels well. Has wound to back of head.

PMH – MI, T2DM, ETOH, COPD, HTN, IHD, RTKR

DHx – With patient

NKDA.

OBS:

HR – 74

RR - 18

BP 142/78

BM – 6.8

GCS 15/15

T – 36.7c

EXAM

A- Clear self-maintained

B- Chest clear, equal expansion

C- Radial pulse, rate 74, crt < 2 seconds

D- GCS 15, FAST negative, not KO'd,

E- Wound to back of head.

Imp – head injury.

Plan

1- Taken pt back to his house

2- Referred to paramedic practitioner for sound care likely needs glue / suturing

3- 999 SOS

YOUR ASSESSMENT FINDINGS SO FAR:

HPC from pt: Pt in Tesco reaching up to grab crate containing an 8 6x 2L bottles of larger, which due to how heavy it was, caused him to off balance and fall backwards on floor, hitting back of head on floor of aisle. The large crate fell away from him, and he confirms this at no point landed on / or hit him. He felt dazed but denies any loss of consciousness. He did not feel unwell prior to the fall. He has some mild tenderness around the wound site at back of his head only. The fall was unwitnessed but within moments a member of staff had come around the coroner and called the first aider who called the ambulance. The initial paramedic had assessed him and brought him home. Apart from feeling a little nauseous he feels well in himself.

No global headache, no vomiting, no dizziness, no slurred speech, no limb/ arm weakness, No neck pain

PMH - MI, T2DM, ETOH, COPD, HTN, IHD, RTKR

DHx - Ramipril, Clopidogrel, Candesartan, Inhalers, GTN, Paracetamol PRN, Vitamin B, Thiamine

Allergies – NKDA

SHx – Lives alone, no local family, smoker 10/day, admits to drinking approx. 1x2l bottle of larger per day. Mobilises independently. No PoC.

O/E:
GEN:
Pt answered door and invited you in. Consented to assessment by you, capacity assessed as per MCA – pt has capacity despite having some alcohol today. Drinking is a daily occurrence for him, and he has drank what her normally would. He is A+O to time, place, and person. Not SOB, speaking in full sentences. Looks well. Good colour, no pallor, no cyanosis, no jaundice. Skin warm and dry.
CVS:
Normal rate/ character / strength bilaterally radial pulses. No radio radial delay

CRT < 2 secs.
JVP normal.
No scars to chest wall.
No heaves/ thrills palpable.
HS S1+S2+0.

RS:
Airway clear and self-maintained, no stridor, no angioedema.
Normal rate/ rhythm/ depth / efficacy of breathing.
Normal oxygen saturations
Trachea central,
No recession, no accessory muscle use, no deformity or asymmetry.
Equal expansion, no surgical emphysema, no crepitus
Percussion note - resonant throughout.
Auscultation - clear, global AE, no adventitious sounds.

CNS:
FAST negative.
No acute confusion/ delirium noted. No behavioural disturbances, no hallucinations.
AMTS 10/10.
No tremors.
CN II-XII appear intact – NAD,
Pt denies changes to sense of smell.
Visual acuity grossly reported as normal for patient, PERRLA C+D size 4, no diplopia, no blurred vision, no visual disturbances reported. Visual fields intact, no hemianopia. No ptosis, no nystagmus, no strabismus.
All CN sensory and motor functions appear normal. No acute change to normal hearing. No dysphagia, No uvula deviation.
Normal tone symmetrically upper and lower limbs.
Normal sensation symmetrically upper and lower limbs.
Normal 5/5 power symmetrically upper and lower limbs
Normal co-ordination symmetrically upper and lower limbs
No weakness/ paresis. No paraesthesia/ no numbness/ no sensory changes reported on exam. No rigidity, no laxity,
No dysdiadochokinesia.
No bruising to eyes/ behind ears. No fluid from ears/ nose. No Amnesia.
Pt witnessed to mobilise – gait normal, no ataxia.

MSK:
ROM and power in upper limbs as patient’s norm, no pain in UL reported.
ROM and power in lower limbs as patient’s norm, no pain in LL reported.
ROM and power at hip as patient’s norm, No hip/ pelvic pain. No shortening/ rotation.
No c-spine / central bony back pain on palpation, normal spinal ROM for patient.
OBS:
HR 79
RR 16
BP 138/84
BM 7.1
GCS 15/15

T 36.4

Wound Exam:
2.5cm laceration to the occiput that is gaping. It is deep but the base can be visualised no bone is present. It is not boggy or soft. There are no foreign bodies or signs of infection. The wound will need suturing closed and the wound itself would comfortably be closed within your skill set. If you are happy with the rest of the patient presentation.

Appendix 9 – Case Study 4 Information

It's the middle of the day on a glorious September weekend afternoon and you are just in the process of applying a thick layer of clotted cream to the top of a scone, whilst informing your student and ECA of the overwhelming body of evidence supporting the Scone, cream, Jam application. Also known as the "Modified Devonshire" or "Correct" method when the radio sounds.

You are dispatched to a Category 1, major trauma call. 65-year-old male, pedestrian verses van on a 50mph country road. On route to the scene, you are updated by control that there is an off-duty paramedic on scene, the patient is GCS 3, and they are supporting the airway.

Nearest ED / TU – 18 minutes by road

Nearest MTC - 30 minutes by road

Critical care /HEMS - unavailable

Nearest BASICs responder – out of county 65 minutes away.

On arrival at the scene, you are met by a fire responder. They inform you; the patient has been walking along the road when they have been struck at speed in the back of the head with the wing mirror / side of the van.

Assessment:

Ch – No catastrophic bleeding

A – airway is clear, paramedic on scene is holding a jaw thrust in place. No Maxilla-Facial injury noted.

B – No signs of chest injury anteriorly or posteriorly, no sub cut emphysema, no tracheal deviation, no laryngeal crepitus, Shallow gasping breaths RR approx. 8/min auscultation difficult due to noisy environment. Slight cyanosis, SPo2 88% with a good pulse trace.

C - Some external haemorrhage from a large occipital head wound. No other wounds found.

Abdomen is soft non tender, pelvis is equal, feels intact, ASIS equal, no scrotal haematoma, no genital or PR bleeding. Femurs intact and legs equal size.

HR - 58bpm, 194/96

D- GCS 5/15 E 1, V 1, M 3 (decorticate posturing) , Pupils are pinpoint and, unable to detect reactivity bilaterally, Large headwound to occiput, underlying structures visible, some periosteum of skull visible. No bleeding from ears, no CSF visible.

- Patient tolerated an OPA well, bagging improves SPo2 o 90-92%
- ETCO2 = 6.2KPa

Appendix 10 – Parameducate Group Rules

These rules have been taken from the Parameducate Facebook page (Parameducate, 2016).

1. Confidentiality
2. Debate, professional argument, and discussion is encouraged but please be professional. Back up any argument you have with evidence-based practice.
3. *"Please be respectful of other people's opinions and remain professional in your response. Opinions will not be limited to JRCALC and will encompass a wide variety of knowledge and evidence-based practice. Please remember that just because you as an individual have an opinion on correct practice or appropriate management, does not mean that others who have experience / knowledge in a topic are wrong or encouraging risky practice. Your individual practice is down to you however this page will encourage learning, education, and development around topics as its purpose is for theoretical discussion."*
4. *"Please do not post derogatory or hateful comments about individuals or organisations. Posts or comments with information that may be used to identify patients, trusts or organisations will be removed (unless available for all o view in public domain from source)."*
5. *"Clinicians, students and future students, feel free to ask clinical questions and ask others for their opinion, advice and evidence base."*
6. *"Any posts felt by the admin team to break these rules will be removed and members may be removed from this group."*
7. *"Please speak to admin before advertising any services or for sale items."*
8. *"Share any learning experiences you have such as CPD courses, conferences, online learning, interesting texts and literature, tweets etc."*
9. *This is not a platform for medical advice and no advice should be given to patients or those with current illness / injury. It is for educational / learning paramedic theory and case studies only. If you feel someone is seeking medical advice, please refrain from commenting and report post to an admin."*
10. *Please us clinical rational to back up arguments and not comments such as remarks about coroners or legal ramifications (the exception being if the post is directly discussing medicolegal debate). It is about patient care and*

remember things that in your area of practice might seem maverick is often routine and better practice in other fields / areas of paramedicine e.g. paramedics in ambulance vs paramedics in GP surgeries. Similar clashes often exist between ambulance service teaching and advanced practice education, so beware what might seem odd could be normal."

11. *"Disclaimer: This group will consist of a variety of clinicians who have experience, exposure, confidence, competence, and education in varying areas including advanced practice. Safe ideas and variation in practice will be discussed and is encouraged with the aim of education only. Please remember however that as per HCPC standards you are individually responsible and accountable for your own practice and therefore should not take any advice, discussion, treatment, or management from this group as sufficient guidance to alter your practice away from trust / local / national guidance and HCPC standards. This group accepts no responsibility for the comments made by any of its members including admins who are individually accountable for their views, comments, and clinical practice. Also consider some clinicians scope of practice will be different than others and therefore a management plan available to some may not be appropriate for others. Please keep in mind the HCPC standards regarding social media when commenting."*

<u>Appendix 11 – Phase 3 Participant Information Sheet</u>

It has been noted that you have contributed to discussions on a case study posted within the 'Parameducate' Facebook group. The case study you contributed to had been created specifically with a research objective in mind and you will notice that there was some information pertaining to this in the opening of the case study to ensure you were aware of this before you contributed. You are now being invited to formally consent to take part in this small-scale research project which also forms part of my greater PHD work. Before you make a decision, please take time to read the following information and discuss it with others if you wish or ask me if there is anything that is not clear or if you would like more information about the project. Take time to decide whether or not you would like to part. Thank you for taking time to read this.

<u>Project Title</u>

Head Injury assessment and management within paramedic practice; a social media case study analysis.

<u>Research Aims</u>

Explore how paramedics interact with 4 fictional head injury case studies in a 'closed' social media group setting within an open conversation amongst other peers.

<u>Research Objectives</u>

This knowledge will help to inform any future changes in paramedic training and clinical practice in the area of head injury assessment and management. The chosen methodology of this research will also help the profession better understand how paramedics use social media as a platform for education. I intend to publish and disseminate the findings in form of a journal article. Participants will be provided with the opportunity to view published outputs from the research. An email debriefing will be sent to participants informing them of the key outcomes of the research once it has been completed and to thank and acknowledge their participation.

<u>Methods</u>

Analysis of peer conversation regarding the assessment and management of 4 fictional head injury case studies. These 4 case studies will be designed to capture a range of possible assessment and management options through a spectrum of severity of injury, patient demographics, and clinical findings.

<u>Data Analysis</u>

The research will use a modified constant comparison method of analysis, thus constructing categories and themes from open and axially coded data. The coding scheme will be created from the data as it is explored. Resulting themes will then be explored in comparison to the existing literature around use of social media as an educational platform, peer learning and peer influence on decision making, as well as guidelines on head injury assessment and management.

Consent and Withdrawal

If you chose to take part, you will be asked to sign a consent form. Participation is voluntary and you have the right to withdraw in the next 4 weeks, after such time the transcripts from the case study will be downloaded, your contribution annonymised and the original case study removed from social media; thus, making it impossible for the researcher to identify your original contributions. All information will be stored securely and in line with University Policy until the completion of my PhD which is anticipated to conclude in 2022.
There are no physical risks in taking part in this research. The process of sharing your thoughts in this case study is not designed to make you feel uncomfortable. If you feel that you need to speak to someone as a result of reflecting on your practice you can contact me, and I will organise an independent counsellor to contact you.

Please be reassured that this is a safe place to share your learning in line with HCPC standards and regulations, this is not an assessment or intended to judge ability; however, the researcher is a HCPC registered paramedic so has a duty to report any dangerous practice.

Volunteering
If you would still like to take part in the project, please return the consent form included. If you have any further questions or would like more information, please contact me. My details are included below:
Rachael Hosznyak (nee Solomon)

Phd Student – Birmingham City University
Advanced Clinical Practitioner (Paramedic)

Rachael.hosznyak@nhs.net

If you have any concerns or complaints about the study, please contact my academic supervisor, Dr Andy Powell, Andy.powell@bcu.ac.uk 0121 3317113.

Appendix 12 – Phase 3 Participant Consent Form

Head Injury assessment and management within paramedic practice; a social media case study analysis.

Participant Consent Form

Permission
Please confirm your consent by ticking the following boxes, should you agree.

Statement	Tick if agree
I have read and understood the information sheet?	
I have had the opportunity to ask questions?	
I understand that participation is entirely voluntary?	
I agree to take part via the sharing of my comments within the case study?	
I understand that I have the right to withdraw prior to anonymisation of data, without prejudice?	
I understand my right to anonymity / confidentiality?	

Name of Participant:

Signature:

Date:

Appendix 13 – Phase 3 Participant Questionnaire

Head Injury assessment and management within paramedic practice; a social media case study analysis.

Thank you for contributing to this study. In order to analyse contributions could you please answer the following 3 questions?

1) What is your role / title / position?

2) Why did you decide to contribute to this case study?

3) What has been the impact of, or what have you gained from, contributing to this case study?

Many Thanks
Rachael Hosznyak (nee Solomon)

Phd Student – Birmingham City University
Advanced Clinical Practitioner (Paramedic)

Rachael.hosznyak@nhs.net

Appendix 14 – Ethics Approval for Phase 1

Faculty of Health, Education and Life Science Research Office Faculty of Health, Education and Life Sciences
Birmingham City University
Westbourne Road

Birmingham B15 3TN

HELS_Ethics@bcu.ac.uk

07/02/2017
Mrs. Rachael Hosznyak

Birmingham City University, Seacole Campus Westbourne Road, Edgbaston, Birmingham
B15 3TN

United Kingdom

Dear Mrs. Rachael Hosznyak

Re: Exploring current clinical knowledge and attitudes towards a change in clinical practice, amongst Paramedics, with regards to assessment and management of head injury patients. - Hosznyak /Jan /2017 /RLRA /0789

Thank you for your application and documentation regarding the above study. I am happy to take Chair's Action and approve the study which means you may begin your research.

The Committee's opinion is based on the information supplied in your application. If you wish to make any substantial changes to the research, please contact the Committee and provide details of what you propose to alter. A substantial change is one that is likely to affect the

safety and well-being of the participants; scientific value of the study;
conduct or management of the study.

The Committee should also be notified of any serious adverse effects arising as a result of this research. The Committee is required to keep a favourable opinion under review in the light of progress reports.

I wish you every success with your study.

Yours sincerely,

Dr. Hafiz Khan FRSPH
On behalf of the Faculty Academic Ethics Committee

Appendix 15 - Ethics approval for phase 2

Faculty of Health, Education & Life Sciences Research Office Seacole Building, 8 Westbourne Road
Birmingham
B15 3TN

HELS_Ethics@bcu.ac.uk

06/Feb/2019

Mrs Rachael Hosznyak rachael.hosznyak@nhs.net

Dear Rachael,

Re: Hosznyak /2034 /R(A) /2019 /Jan /HELS FAEC - ICP Pocus

Thank you for your application and documentation regarding the above activity. I am pleased to take Chair's Action and approve this activity.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may begin your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Health, Education & Life Sciences Faculty Academic Ethics Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact HELS_Ethics@bcu.ac.uk I wish you every success with your activity.
Yours Sincerely,
Dr. Alex Wade

On behalf of the Health, Education & Life Sciences Faculty Academic Ethics Committee

Appendix 16 – Ethics Approval amendment for phase 2

BIRMINGHAM CITY
University

Faculty of Health, Education & Life Sciences Research Office Seacole Building, 8 Westbourne Road
Birmingham
B15 3TN

HELS_Ethics@bcu.ac.uk

06/Jun/2019

Mrs Rachael Hosznyak rachael.hosznyak@nhs.net

Dear Rachael,

Re: Hosznyak/2034/Am/2019/Jun/HELSFAEC -ICPPocus

Thank you for your application for approval of amendments regarding the above study. I am happy to take Chair's Action and approve these amendments.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may continue your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact HELS_Ethics@bcu.ac.uk I wish you every success with your activity.
Yours Sincerely,
Dr. Alex Wade

On behalf of the Health, Education and Life Sciences Faculty Academic Ethics Committee

Appendix 17 – Ethics Approval for Phase 3

Faculty of Health, Education & Life Sciences Research Office Seacole Building, 8 Westbourne Road
Birmingham
B15 3TN

HELS_Ethics@bcu.ac.uk

23/Jul/2019

Mrs Rachael Hosznyak rachael.hosznyak@nhs.net

Dear Rachael,
Re: Hosznyak/3462/R(A)/2019/Jul/HELSFAEC -Head Injury assessment and management within paramedic practice; a social media case study analysis.

Thank you for your application and documentation regarding the above activity. I am pleased to take Chair's Action and approve this activity.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may begin your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Health, Education and Life Sciences Faculty Academic Ethics Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact HELS_Ethics@bcu.ac.uk I wish you every success with your activity.
Yours Sincerely,
Professor Trixie McAree

On behalf of the Health, Education and Life Sciences Faculty Academic Ethics Committee

Appendix 18 – Ethics Approval amendment for Phase 3

BIRMINGHAM CITY University

Faculty of Health, Education & Life Sciences Research Office Seacole Building, 8 Westbourne Road
Birmingham
B15 3TN

HELS_Ethics@bcu.ac.uk

12/Mar/2020

Mrs Rachael Hosznyak rachael.hosznyak@nhs.net

Dear Rachael,
Re: Hosznyak/3462/Am/2020/Mar/HELSFAEC **-**Head Injury assessment and management within paramedic practice; a social media case study analysis.

Thank you for your application for approval of amendments regarding the above study. I am happy to take Chair's Action and approve these amendments.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may continue your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact HELS_Ethics@bcu.ac.uk I wish you every success with your activity.
Yours Sincerely,
Professor Trixie McAree

On behalf of the Health, Education and Life Sciences Faculty Academic Ethics Committee

Appendix 19 – References within written reflections

Type	Date	Title	Source	Reflection
Guidelines	2013 2018	UK ambulance services clinical practice guidelines	JRCALC	1, 2
Article	2002	Effect of cervical hard collar on intracranial pressure after head injury.	ANJ Journal of Surgery	1
Article	2001	Cultures for improving patient safety through learning: the role of teamwork,	BMJ Quality and Safety	2
Guidelines (non-clinical)	2013	Road Policing- Management of Incidents	College of Policing	2
Guidelines (non-clinical)	2015	Guidance for Ambulance Service Response to Incidents on the Motorway Network (Including Smart Motorway),	NARU	2
Article	2006	Airway Management after Major Trauma	Continuing Education in Anaesthesia Critical Care & Pain Journal	2
Article	2011	Doctor on board? What is the optimal skill-mix in military pre-hospital care?	Emergency Medicine Journal	2
Book	2013	Principles of Biomedical Ethics. 7th Edition	N/A	3
Consensus Statement	2018	Management of Perceived Devastating Brain Injury After Hospital Admission: A Consensus Statement.	FICM	3
Article	2017	Traumatic Brain Injuries in Older Adults – 6 Years of Data for One UK Trauma Centre: Retrospective Analysis of Prospectively Collected Data,	Emergency Medical Journal	3
Article	2016	Traumatic Brain Injury in England and Wales: Prospective Audit of Epidemiology, Complications, and a Standardised Mortality,'	BMJ Open	3,6
Article	2016	'The Head Injury Transportation Straight to Neurosurgery (HITS-NS) Randomised Trial – A Feasibility Study,'	Health Technology Assessment Journal	3
Article	2009	'Critical Care in the Emergency Department: Traumatic Brain Injury,'	Emergency Medical Journal	3
Guidelines	2017 2014	Head Injury: Assessment and Early Management.	NICE	3, 5
Article	2011	'I.F.E.A.R. Reflection: An Easy to Use, Adaptable Template for Paramedics,'	Journal of Paramedic Practice	3
Guidelines	2012	Adult Major Trauma Decision Tree.	Southeast Ambulance Service	3
Guidelines	2009	Early management of patients with a head injury	SIGN	5
Webpage	2017	Vertigo (NHS patient guidance)	NHS	5
Article	2010	Influence of alcohol on early Glasgow Coma Score in head injured patients	Journal of Trauma	6

Article	2016	Trends in alcohol use during moderate and severe traumatic brain injury: 18 years of neurotrauma in Pennsylvania	Journal of Brain Injury	6
Article	2019	Violence-related traumatic brain injury	Journal of Brain Injury	6
Article	2017	The epidemiology, prognosis, and trends of severe traumatic brain injury with presenting Glasgow Coma Scale of 3	Journal of Critical Care	6
Article	2013	Traumatic Intracranial Injury in intoxicated patients with minor head trauma.	Academic Emergency Medicine Journal	6
Article	2018	Head injury on Warfarin: likelihood of delayed intracranial bleeding in patients with negative initial head CT	BMC Research Notes Journal	9
Article	2016	*No detail in reference*	Critical Care Medicine Journal	9
Article	2015	Intracranial Bleeds after Minor and Minimal Head Injury in Patients on Warfarin	The Journal of Emergency Medicine	9
Article	2017	The illusion of informed consent	Association of anesthetists of Great Britain and Ireland	9
Article	2003	Diagnostic criteria and the use of ICD-10 codes to define and classify minor head injury	Journal of Neurology	9
Article	2018	Reflection revisited: how physicians conceptualize and experience reflection in professional practice – a qualitative study	BMC Medical Education Journal	9
Article	2017	Time to Improve Informed Consent for Dialysis: An International Perspective	Clinical Journal of the American Society of Nephrology	9
Guidelines (non-clinical)	2013	Consent to treatment - adults with capacity	British Medical Association	9
Article	2018	Incidence of Delayed Intracranial Hemorrhage in Older Patients After Blunt Head Trauma	JAMA Surgery Journal	9
Article	2019	Lack of informed consent for surgical procedures by elderly patients with inability to consent: a retrospective chart review from an academic medical center in Norway	Patient Safety in Surgery Journal	9
Guidelines	2016	Guideline for obtaining valid consent for gastrointestinal endoscopy procedures, Department of Gastroenterology	Leeds Teaching Hospital	9
Guidelines (non-clinical)	2014	Standards of Proficiency, Paramedics	HCPC	9
Guidelines (summary)	2014	Early management of head injury: summary of updated NICE guidance	NICE / British Medical Journal	9
Article	2017	Paramedics declare death – A lifesaving decision	Health Policy and Technology Journal	9
Article	2016	Should all anticoagulated patients with head injury receive a CT scan? Decision-analysis modelling of an observational cohort	BMJ Open	9

Book	1996	The Calgary-Cambridge Referenced Observation Guides		9
Article	2017	Capacity and consent: Knowledge and practice of legal and healthcare standards	Nursing Ethics Journal	9
Legal Case	1985	Sidaway v Board of Governors of the Bethlem Royal Hospital Governors		9
Article	2019	Understanding complaints about paramedics: a qualitative exploration in a UK context	Australian Journal of Paramedicine	9
Article	2014	The ahead study: Managing Anticoagulated patients who suffer Head Injury	Emergency Medicine Journal	9
Legal Act	2005 and 2007	Mental Capacity Act	Gov UK	9
Legal Act	2013	Mental Capacity Act Code of Practice	Gov UK	9
Article	2012	Consent Under Pressure: The Puzzle of Third-Party Coercion	Ethical Theory Moral Practice Journal	9
Manual	2012	NICE Guidelines Manual – Assessing cost effectiveness	NICE	9
Framework	2019	NHS England Gold Standards Framework	NHS England	9
Article	2017	Do EMS Providers Accurately Ascertain Anticoagulant and Antiplatelet Use in Older Adults with Head Trauma?	Prehospital emergency Care Journal	9
Book	2001	Critical reflection in nursing and the helping professions: a user's guide		9
Article	2019	Inpatient observation following a normal brain CT in patients with minor head injury on warfarin	Critical Care Medicine Journal	9
Article	2013	Assessing Bleeding Risk in Patients Taking Anticoagulants	Journal of Thrombosis and Thrombolysis	9
Article	2016	The Implications of Meno's Paradox for the Mental Capacity Act 2005	Medical Law Review Journal	9
Guidelines	2019	Clinical Guideline for Head Injury	Southwestern Ambulance Service	9
Article	2004	Application of the Canadian CT head rules in managing minor head injuries in a UK emergency department: implications for the implementation of the NICE guidelines	NICE / Emergency Medical Journal	9
Article	2018	We all reflect, but why? A systematic review of the purposes of reflection in higher education in social and behavioral sciences	Educational Research Review Journal	9
Article	2019	Informed consent practice for obstetric and gynecologic procedures: A patients' perspective from a developing country	Evaluation in Clinical Practice Journal	9
Article	2012	Redefining hypotension in traumatic brain injury	Injury Journal	10
Article	2017	Optimal Fluid Therapy for Traumatic Hemorrhagic Shock	Critical Care Clinics Journal	10
Article	2006	History of the Cushing Reflex	Neurosurgery Journal	10
Guidelines (non-clinical)	2016	Standards of conduct, performance, and ethics	HCPC	10
Article	2011	The revision of the primary survey: a 2011 review	Journal of Paramedic Practice	10

Article	2013	Risk adjustment in neurocritical care (RAIN)-prospective validation of risk prediction models for adult patients with acute traumatic brain injury to use to evaluate the optimum location and comparative costs of neurocritical care: a cohort study	Health Technology Assessment Journal	10
Article	2012	Short-term, mild hypothermia can increase the beneficial effect of permissive hypotension on uncontrolled hemorrhagic shock in rats.	Anaesthesiology Journal	10
Guidelines	2016	Major trauma: assessment and initial management Guidelines	NICE	10
Article	2013	Raised intracranial pressure: What it is and how to recognise it	Continuing medical education journal	10
Article	2017	Blood pressure in trauma resuscitation: 'pop the clot' vs 'drain the brain'?	Association of Anaesthesia	10
Article	2010	Becoming a reflective practitioner: frameworks for the prehospital professional	Journal Paramedic Practice	10

Appendix 20 – References within Case Studies

Type	Date	Title	Source	Case Study
Article	2017	Severe Asymptomatic Hypertension: Evaluation and Treatment	American Family Physician Journal	2
Article	2016	Appropriate Management of Asymptomatic Hypertension	JAMA Internal Medicine Journal	2
Article	2002	Chronic subdural haematoma in the elderly	BMJ Postgraduate Medical Journal	2
Article	2021	Pfizer, BioNTech Submit Initial Data to FDA Seeking EUA for COVID-19 Vaccine in Children Ages 5-11	Pharmacy Times	3
Article	2012	Immediate and delayed traumatic intracranial haemorrhage in patients with head trauma and preinjury warfarin or clopidogrel use	Annals of Emergency Medicine Journal	3
Article	2007	Does clopidogrel increase morbidity and mortality after minor head injury	Emergency Medicine Journal	3
Guidelines	2017	Head Injury: Assessment and Early Management.	NICE	3
Article	2007	Does clopidogrel increase morbidity after minor head injury	Emergency Medicine Journal	3
Article	2017	Student paramedic rapid sequence intubation in Johannesburg, South Africa: A case series	Africa Journal of Emergency Medicine	4
Article	2001	Survival of trauma patients who have prehospital tracheal intubation without anaesthesia or muscle relaxants: observational study	BMJ	4
Article	2015	Significant modification of traditional rapid sequence induction improves safety and effectiveness of pre-hospital trauma anaesthesia	Critical Care Journal	4

Introduction to Appendix 21,22,23 and 24

The following four appendices are the conversational analysis matric created for each of the case studies in phase 3 of the research.

Each matrix has mapped the type of interaction within each case study comment. These comments were categorised into either a ‘question’, ‘reply / answer’ or statement and this was then subcategorized in either ‘Admin to participant’, ‘peer to peer’ or ‘Participant to Admin’. The following table of abbreviations has been used to allow for identification of these categories within each matrix.

Table 81 - Abbreviations used in conversational analysis.

Response	Interaction	Code
Questions	Admin to Participant	Qq
	Peer to Peer	qq
	Participant to Admin	qQ
Reply / Answer	Admin to Participant	Rr
	Peer to Peer	rr
	Participant to Admin	rR
Statement	Statement by Admin	SA
	Statement by Participant	SP

Each comment was then further categorised into the type of language used and theme for which the comment identified with.

Each comment may be coded with multiple times.

Comments withdrawn from analysis are greyed out.

Appendix 21 – Case Study 1 (conversation analysis matrix)

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
6	8	24	21	40	20	1	12	49	24	7	35	16	6	46	34	7
							X					X				
				X							X					
		X						X								
			X								X					
		X						X						X		
			X					X								
		X						X						X		
X			X					X			X					
					X			X						X		
					X			X						X		
			X								X	X	X			
		X						X				X		X		
			X					X								
		X						X						X		
			X					X								
		X						X						X		
			X								X					
					X						X					
		X						X						X		
		X						X						X		

			X					X								
		X					X	X						X	X	
X						X					X					
	X			X			X				X			X		
		X			X				X					X		
			X					X								
		X							X					X		
		X												X		
			X					X								
		X					X	X	X					X	X	X
				X							X			X		
X								X						X		
					X			X	X			X		X		
X			X					X						X		
					X				X					X		
					X			X						X		
X			X					X			X		X	X		
					X			X						X	X	
	X	X						X								X
				X							X					X
		X										X		X		
				X				X								X
				X							X			X		
				X							X				X	
					X			X						X		
				X					X		X			X		
				X							X				X	
				X	X			X						X		
	X	X						X						X		
					X			X						X		

					X		X	X	X						X	
				X						X					X	
	X			X					X						X	
				X					X			X			X	
			X								X				X	
		X						X						X	X	
			X					X								
		X						X						X	X	
			X					X								
					X						X					
		X						X						X		
			X					X								
							X	X						X	X	
X			X								X				X	
				X	X						X			X		
							X			X				X		
					X			X						X		
					X				X			X	X			
				X							X					
				X							X	X	X			
							X	X						X		
		X					X	X						X	X	
				X							X	X			X	
				X					X			X	X	X		
				X							X	X				
			X						X		X	x				
					X						X					
		X						X						X		
			X					X								
					X							X				

		X					X	X						X		
				X					X						X	
				X						X					X	
				X							X	X			X	
				X					X		X				X	X
		X		X				X	X						X	
	X			X					X						X	
				X					X						X	
				X							X				X	
	X			X						X	X				X	
	X			X					X	X					X	
				X					X					X	X	
				X					X						X	
				X					X		X				X	X
				X							X				X	
				X			X		X		X				X	X
				X							X					
				X							X					
		X						X						X		
				X				X								
			X								X					
					X							X				
			X									X	X			
	X								X					X		
							X							X		
				X					X	X					X	
				X				X							X	
				X						X					X	

Appendix 22 – Case Study 2 (conversational analysis matrix)

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
5	9	30	23	30	4	4	20	81	14	4	25	2	1	61	6	1
		X						X						X		
			X					X								
X											X					
		X			X			X				X		X		
			X					X								
		X						X						X		
X								X								
			X					X								
					X			X						X		
		X						X						X		
			X					X								
		X						X						X		
		X					X	X	X					X	X	
			X					X								
X								X								
		X						X						X		
		X						X						X		
		X						X	X							
			X						X		X					

		X						X								
		X						X						X		
		X						X						X		
							X	X								
X								X								
						X					X					
		X						X						X		
			X								X					
		X						X						X		
			X					X								
					X						X					
							X	X						X		
				X				X						X		
				X						X					X	
				X					X					X		
				X				X						x		
	X							X						X		
				X				X						X		
	X							X						X		
				X						X				X		
				X							X				X	
						X					X					
				X							X				X	
				X					X					X		
				X					X							
				X					X							
				X							X					
				X					X							

				X					X	X				X		
				X							X			X		
				X							x					
				X				X						X		
				X					X		X		X	X		
	X							X						X		
				X				X						X		
			X					X								
		X						X						X		
	X	X										X				
			X					X								
		X						X						X		
			X					X								
		X						X						X		
			X					X								
				X					X							
		X						X						X		
			X					X								
		X						X						X		
			X					X								
		X						X						X		
			X					X								
		X					X	X						X		
			X					X								
		X					X	X						X		
			X					X								
		X						X						X		
			X					X								
							X	X						X		

														X		
X			X					X			X					
							X	X						X		
		X					X	X						X		
			X					X								
		X					X	X						X		
	X									X						
				X					X		X					
				X			X	X								
			X					X								
					X		X	X			X			X		
	X							X						X		
				X					X							
							X	X						X		
							X	X						X		
		X						X						X		
							X	X						X		
							X	X			X			X		
				X							X			x		
							X	X						X		
				X							X			X		
							X	X						X		
							X	X						X		
						X		X			X					
							X	X						X		
		X						X						X		
	X							X						X		
				X							X				X	
				X					X		X				X	

				X							X					x
			X					X								
		X					X	X						X		
	X							X								
				X							X			X		
	X							X						X		
				X							X					
		X						X						X		
			X								X					
						X		X								

Appendix 23 – Case Study 3 (conversational analysis matrix)

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
7	6	23	24	23	16	1	39	95	13	9	19	4	6	51	27	1
		X						X						X		
			X					X								
					X						X					
			X					X								
		X						X								
		X						X								
		X						X						X		
		X						X						X		
			X					X								
		X						X						X		
							X	X						X		
		X						X						X		
			X					X								
		X						X						X		
	X							X					X			
				X				X								
				X				X							X	
			X					X								
	X							X							X	
				X					X						X	
				X					X						X	

				X					X							
				X					X						X	
				X					X						X	
				X							X					
		X						X						X		
			X					X								
			X					X								
							X	X						X		
				X							X			X		
		X					X	X						X		
			X					X								
X								X								
					X			X								
					X			X								
					X			X						X		
					X			X							X	
	X	X					X	X						X	X	
							X		X			X				
				X								X	X			
							X	X						X		
				X					X					X		
			X					X							X	
			X					X								
X								X								

		X						X						X		
			X					X								
		X						X						X		
			X					X								
		X						X						X		
		X						X						X		
			X					X								
							X	X						X	X	
X								X								
	X							X								
					X				X					X		
				X							X					
					X		X	X						X		
		X						X						X		
			X					X								
							X	X						X		
							X	X						X		
X										X						
					X			X					X			
	X	X		X			X	X						X		
		X						X						X		
			X					X								
							X	X						X		
							X	X						X		
							X	X						X		
X								X								
					X			X						X	X	

				X							X					
					X			X								
					X			X							X	
							X	X						X		
							X	X						X		
							X	X	X					X	X	
X										X						
					X					X						
					X					X						
							X	X						X		
				X					X			X				
							X	X						X		
				X								X	X			
				X							X					
							X	X						X	X	
				X							X				X	
				X					X		X				X	
	X	X					X	X							X	
				X						X	X			X	X	
				X							X				X	
			X					X								
							X	X								
							X	X						X	X	
							X	X								
			X					X								
							X	X			X		X	X		

							X	X						X		
						X		X								
							X	X						X		
							X	X						X	X	
X								X								
					X			X						X	X	
							X	X						X		
				X						X	X				X	
							X				X					
							X				X					
				X						X	X		X		X	
							X	X							X	
		X					X			X				X		
			X					X								
		X					X	X	X					X		
			X					X								
					X			X								
			X					X								
							X	X						X		
							X				X			X	X	
			X							X	X					
							X	X								
							X	X						X		
			X					X			X					
					X						X					
		X						X								

			X					X								
							X	X						X		
		X						X	X						X	
			X					X								X

Appendix 24 – Case Study 4 (conversational analysis matrix)

Question			Answer / Reply			Statement		Language						Theme		
Qq	qq	qQ	Rr	rr	rR	SA	SP	Neutral	Defensive / Inflammatory	Opposing	Supportive	Humorous	Use of Emojis	Assessment / Treatment	Implementation	QI
6	6	5	11	34	6	2	15	51	3	9	18	1	3	32	20	4
			X					X								
			X					X								
		X						X						X		
			X					X								
					X			X								
			X					X								
		X						X						X		
			X					X								
			X								X					
							X	X						X		
							X	X								
							X	X						X		
X			X					X								
X								X								
					X			X						X	X	
X			X								X					
					X			X						X	X	

							X	X						X		
			X					X								
				X						X					X	
				X							X				X	
				X							X				X	
	X							X						X		
				X				X						X		X
	X			X				X						X		
	X			X				X								
				X				X								X
				X				X						X		
				X							X					
							X	X								X
				X							X					
				X							X			X		
				X					X	X				X	X	
							X	X						X		
	X							X								
				X				X						X		
				X				X						X		
X								X								
					X			X					X	X		
							X	X						X	X	
							X	X						X		
	X	X					X	X						X		
				X						X						
				X							X					
			X								X					
				X				X								

	X	X						X							X	
				X							X					
		X						X						X		
X			X					X								
					X			X								
							X	X				X		X	X	
				X						X					X	
				X					X		X				X	
							X	X						X		
							X	X						X		
				X				X						X		
				X				X						X		
				X				X						X		
							X	X						X	X	
							X	X						X	X	
				X						X	X				X	
				X						X	X				X	
				X							X					
				X						X					X	
				X					X						X	
				X							X					
				X						X	X					
						X		X								
							X	X						X		
X				X				X								

					X			X					X	X	X	
				X						X						
				X				X			X		X	X		
				X							X					X
						X										

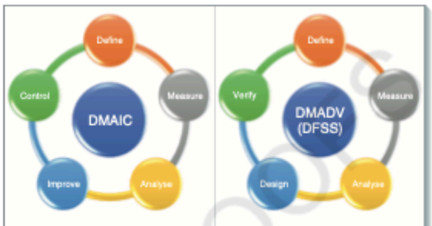
Appendix 25 - Audit and Quality Improvement Published Chapter

55 Audit and quality improvement sciences

Figure 55.1 Lean methodology – eight wastes.
Source: [1]McGraw-Hill

1.	Defects (waste from a product or service failure)
2.	Overproduction (more product than demand)
3.	Waiting (time waiting for the next step in a process)
4.	Unused talent (underutilised talent, skills or knowledge)
5.	Transportation (unnecessary movement of products or materials)
6.	Inventory (excess products and materials)
7.	Motion (unnecessary movement by people)
8.	Extra processing (more work or higher quality than required)

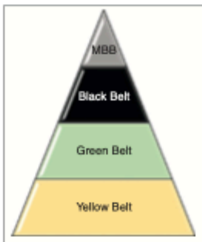
Figure 55.2 Six Sigma DMAIC and DMADV comparison[9]



Improving existing processes | Creating new processes

Define	Project	Define	Project
Measure	Current process and historic data	Measure	Need and specifications
Analyse	Root cause of defects	Analyse	Design of proposed options
Improve	Eliminate defects	Design	Process to meet requirements
Control	Monitor new performance	Verify	Process meets needs

Figure 55.3 Lean Six Sigma organisational hierarchy.
Source: Adapted from [18,19]



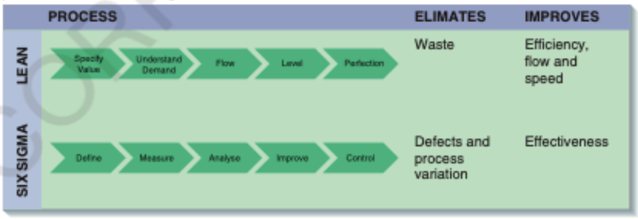
Master Black Belt (MBB) – Experienced Black Belt, leading LSS across an entire organisation with future strategy planning

Black Belt – Holds the role of a full-time project manager, cross-functional strategist and mentor to lower belts

Green Belt – Ability to utilise LSS tools and processes such as DMAIC as a short-term project manager

Yellow Belt – Has a basic awareness of LSS and can contribute to projects

Figure 55.4 Comparison of Lean and Six Sigma. Source: Adapted from [21,22]



Advanced Clinical Practice at a Glance, First Edition. Edited by Barry Hill and Sadie Diamond Fox.

Figure 55.5 Lean Six Sigma tools overview. Source: Adapted from [31,32]

Define	Measure	Analyse	Improve	Control
Identification of stakeholders	Process characteristics and metrics (including key performance indicators)	Correlation and regression analysis	Kaizen	
Critical to x requirements	Process maps and flow charts	Testing of hypothesis	Poka-Yoke	
Benchmarking	SIPOC	Failure Mode and Effects Analysis (FMEA)	5S System	
Business Performance Measurements	Data Type and Measurement Scale	Gap Analysis	Kanban	
Financial Measurements	Data Collection	The 5 Whys	Standard Operations	Statistical process control
Voice of the Customer	Sample Strategies	Pareto Diagram	Operator's work instructions	Total Productive Maintenance (TPM)
Kano's Customer Satisfaction Levels	Fishbone diagram	Tree diagram	Cycle time reduction and takt time	Visual Factory
Juran's Customer Needs	Relational Matrices or prioritisation matrix	Non-value-added activities	Continuous Flow Manufacturing (CFM)	Maintain Controls
Market Research	Basic Statistical Tools	Cost of poor quality	Single Minute Exchange of Die (SMED)	Sustaining Improvements
Critical to Quality (CTQ) Flow-down	Analytical Statistics		Design of experiments (DOE)	
Quality Function Deployment (QFD)	Gauge r & r		Theory of Constraints	
Performance Metrics	Process Capability Analysis		Risk Analysis	
Project Charter	Value Stream Mapping Tools			
Chart Negotiation				
Project Management plan and baselines				
Project Tracking				

Figure 55.6 Continuous iterative approach to the PDSA cycle.
Source: Adapted from [37]

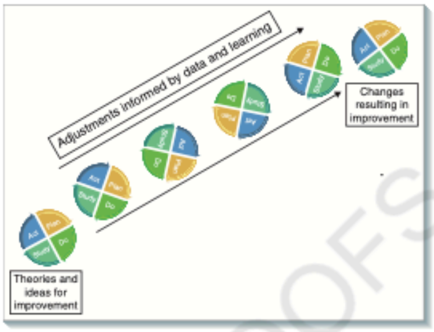


Figure 55.7 Experience-based codesign cycle.
Source: Adapted from [31]

It could be argued that advanced practitioners are in a unique position to influence quality improvement given their spread of knowledge, experience and practice across the four pillars of education, leadership, research and clinical practice. However, influencing quality improvement requires a level of understanding of this subject matter and the wider field of improvement science.[1,2]

Despite quality improvement having a specific 'healthcare' focus in recent years, contributed to through improvement science, there is still a recognised urge to act when services are felt to be insufficient or varying from others, without necessarily first considering the evidence, effectiveness, risk or cost of proposed changes. As such, the end result can lead to the opposite effects intended, thus further negatively affecting productivity and quality of services delivered.[3,4]

Within healthcare quality improvement (QI), a few key models have proven to be transferable and used with great success or created specifically with healthcare in mind; these include Lean methodology, Six Sigma, model for improvement and experience-based codesign (EBCD).[4]

Lean methodology

Lean is arguably a continuous QI methodology and therefore differs in its purpose when seeking to identify improvement in the absence of a problem, in contrast to other methodologies which may only seek to find a solution to an identified problem.[5]

The eight wastes of Lean methodology are shown in Figure 55.1.[6]

Six Sigma

Six Sigma is a statistically focused improvement methodology which aims to achieve a 99.99966% defect-free process.[7] To put this in perspective within healthcare, the difference between 99% efficiency and 99.99966% is the difference between 200 000 and 68 prescription errors per year.[8]

The two project methods within Six Sigma are DMAIC and DMADV, also known as DFSS (Design for Six Sigma).[9] Both methods comprise five interlinked phases, as depicted in Figure 55.2. As Six Sigma utilises a set of tools and methods to measure and reduce product variation and eliminate defects, it can present challenges when utilised in healthcare, given the difficulty in defining clear metrics of unacceptable variation in service delivery.[10] The reliance on statistical tools is the main criticism of Six Sigma as it can be a costly process, requiring specialist project managers, and arguably with an overfocus on statistics rather than other considerations such as staff experience or cultural aspects of productivity.[10–12]

However, the project methodologies within Six Sigma have been proven to be transferable to healthcare improvement project management, which may be explained somewhat because the design originated with the Plan, Do, Study, Act cycle.[9,13] Six Sigma has also been shown to be of benefit in healthcare via the use of statistical process control (SPC) charts to monitor variation in the system. Before SPC, performance had traditionally been measured using a system of Red, Amber or Green (RAG) ratings, but SPC has allowed for a more indepth understanding of the cause of a variation and dip in performance and whether an improvement initiative could make a positive impact.[10,14,15]

Lean Six Sigma

Although implementing Six Sigma in healthcare can be problematic, it has proven successful in specific areas, and it is more readily adaptable when combined with Lean methodology.[13] Lean Six Sigma (LSS) is a recognised and certified discipline in which both philosophies complement each other,[16,17] with an established hierarchy, as seen in Figure 55.3.[18,19] Despite successful implementation of LSS in healthcare, further research is needed to evolve continuous improvement in healthcare settings.[20]

Although the differences between Lean and Six Sigma may seem subtle, they do have clear individual aims and approaches, as seen in Figure 55.4, with Lean focusing on reducing waste and improving flow through the use of mainly visual management tools, whereas Six Sigma is focused on reducing variation and errors in processes with the use of predominantly numerical analytical tools, as seen in Figure 55.5.[10,21,22] However, when combined, the Six Sigma tools can help solve the problems identified through the Lean process, thus creating an obvious benefit in overcoming their individual limitations.[21,23–26]

Model for improvement

The model for improvement was developed by the Institute of Healthcare Improvement, to expand the existing Plan, Do, Study, Act (PDSA) model by asking an additional three questions pertaining to the project and proposed change.[27]

1 What are we trying to accomplish?
2 How will we know that the change is an improvement?
3 What change can we make that will result in improvement?

The PDSA cycle is one of the most widely utilised, researched and wellknown 'testing models' in healthcare.[27] Utilising the PDSA cycle within the model for improvement allows for ease of use as most clinicians find the cycle simple to follow. However, a degree of knowledge and effort is required to cycle effectively through the iterative process, as shown in Figure 55.6.[28]

One criticism of the PDSA cycle is that it is often used in its simplistic format without prior preparation or adequate focus on each individual phase.[28,29,30]

Experience-based co-design

Experience-based codesign is a patient-focused, six-stage method depicted in Figure 55.7, which utilises qualitative data gathered through indepth patient and staff interviews, group discussions or observations, relating to their experiences as service users.[31] The discourse created from these various qualitative methods is then analysed for both positive and negative emotionally significant events known as 'key touch points'. Harnessing the power of storytelling in this way, patients and staff are then able to codesign services and patient pathways because of a narrative-based approach to change.[10,31–33] A criticism of the tool is the presence of inconsistency in reporting and approach to elimination of variation in the advised stages.[34]

Appendix 26 – ITD Published Paper

Literature review

BPJ

COLLEGE OF paramedics
leading the development of the paramedic profession

Does impedance threshold device therapy have a place in the treatment of increased intracranial pressure in pre-hospital patients? A literature review

British Paramedic Journal
2016, vol. 1(2) 18–23

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Abstract
Hypotension and raised intercranial pressure are well-known poor prognostic indicators in patients suffering traumatic brain injuries based on the combined benefits of the impedance threshold device in increasing mean atrial blood pressure and decreasing intercranial pressure. The evidence presented in this literature search presents devices which create subatmospheric intrathoracic pressure, such as ResQGARD, as viable opportunities to rapidly lower intercranial pressure and raise cerebral perfusion pressure using safe non-invasive therapeutic interventions in traumatic brain injuries. The use of intrathoracic pressure regulators in intubated and mechanically ventilated inpatients has already been assessed in a pilot study, which indicated positive effects on intercranial pressure and cerebral perfusion pressure. There now exists a clear need for a proof of clinical concept study to show that application of an impedance threshold device can be used as a safe and effective non-invasive method to increase cerebral perfusion pressure and decrease intercranial pressure in spontaneously breathing patients with raised intercranial pressure following traumatic brain injuries in a pre-hospital setting.

Keywords
head injury; impedance threshold device; intracranial pressure; paramedic; ResQGARD

Introduction

In 1998 Advanced Circulatory Systems started working with NASA and the US Army using the impedance threshold device (ITD) in spontaneously breathing volunteers, leading to the creation of the ResQGARD (Lurie, 2010). Breathing through an ITD, such as the ResQGARD with a resistance of only –7 cm H_2O, lowers intrathoracic pressures, enhances blood flow back to the heart and lowers intercranial pressure (ICP) (Convertino et al., 2011). Guerci et al. (1985), in their research, have tried to find the main route of intrathoracic and ICP pressure transfer during CPR using canine subjects. The findings of their research show that pressure is transferred through the thoracic spine to the cerebral spinal fluid and the non-valvular veins around the spinal cord. ResQGARD studies have demonstrated that a positive intrathoracic pressure will result in an increase in ICP, while negative

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pressure deflections in intrathoracic pressure are instantly transferred to the ICP as well. Generation of negative intrathoracic pressure by indirectly increasing inspiratory effort or by applying a direct airway vacuum between positive pressure ventilations resulted in a remarkable decrease in ICP by a direct transfer of positive pressure and increasing venous drainage. This is demonstrated by the immediate pressure changes of the ICP correlating with the changes in airway pressures. Blood volume has also been noted in research papers as a critical component, as pressure transfer was seen to be eliminated with exsanguination; however, restricting blood flow in the carotid arteries and jugular veins did not have a significant effect. A mechanical process through the venous channels of the paraspinal plexuses and the increase of venous return by the jugular veins also seem to assist in the effect of decreasing ICP (Yannopoulos, McKnite, Metzger, & Lurie, 2006).

Around a decade ago when data were starting to accumulate on the potential benefits of inspiratory resistance, Victor Convertino, a research physiologist, and colleagues, reviewed the evidence arising from their laboratory regarding how an ITD can affect haemodynamic responses in human subjects. There was strong evidence suggesting applicability of ITD in a range of settings including orthostatic hypotension, hypotension during renal dialysis and hypotension after blood donation (Convertino, Cooke, & Lurie, 2005b). A separate review, by Convertino et al. (2005b), presented evidence to support the use of inspiratory resistance to treat patients at risk of hypovolemia and as prophylaxis against circulatory collapse associated with orthostatic instability and haemorrhagic shock. This review suggested that ITDs might be used to support brain perfusion in individuals suffering severe traumatic blood loss (Convertino, Cooke, & Lurie, 2005a). As more evidence accumulated, Convertino and colleagues presented a further comprehensive review (Convertino et al., 2011). The authors clearly explained the mechanisms involved in how ITDs harness the physiological underpinnings of ventilation to increase circulation to the heart and brain. Convertino et al. (2011) describe how the majority of evidence currently exists in those with hypotension secondary to hypovolemia but that there are other potential clinical areas where ITD may be applied, which are currently under-researched. Specifically, the review emphasised how evidence suggests an opportunity exists to harness the beneficial effects of ITD on cerebral blood flow, in particular in the treatment of patients with traumatic brain injuries (TBI) and those suffering uncontrolled haemorrhage. This area of research is still new and the use of ITD in head injury patients warrants urgent further research. Some studies exist which focus on mean atrial blood pressure (MAP), cerebral perfusion pressure (CPP) and intracranial pressure (ICP), representing vital variables in the treatment of head injury patients.

Methods

To date there have been 23 human clinical trials and 12 animal studies – the majority of which involve pigs due to their similar anatomy – evaluating ResQGARD for the treatment of low blood circulation (Advanced Circulatory Systems, 2012). The following databases were searched, using key words (ResQGARD, impedance threshold therapy), for relevant studies that may not have been included in the above resource: CINAHL, MEDLINE, PUBMED, Cochrane. The website clinicaltrials.gov was also searched and further studies were identified by examining the reference lists of included articles. A selection of these studies will now be described. An adapted PRISMA chart can be found in Figure 1 (Moher, Liberati, Tetzlaff, & Altman, 2009). Papers and evidence included have a strong link to the ResQGARD product; the author has no interest in, or link to the product to declare.

Results and discussion

There have been 12 studies with ResQGARD in animals using models of hypovolemia and haemorrhagic/heat shock. For example, Marino et al. (2004) and Sigurdsson et al. (2006) studied haemodynamic effects of ITD and showed beneficial outcomes on hypotension secondary to hypovolemia. Meanwhile Samniah et al. (2003) used a randomised design in 13 anaesthetised pigs subjected to profound haemorrhagic shock by gradual withdrawal of just over half of estimated blood volume. The objective was to study the protective effects of transcutaneous phrenic nerve stimulation used in conjunction with an inspiratory impedance threshold. A key finding was that these interventions improved haemodynamic variables of transaortic, transpulmonary and transmitral valve blood flow, coronary perfusion and systolic aortic blood pressures (BP), suggesting improved cardiac preload. A further potential clinical application for ITD is heat-stroke which can be associated with high mortality rates. Voelckel, Yannopoulos, Zielinski, McKnite, & Lurie (2008) employed a heat-stroke model which induced hypovolemia, and hence hypotension. These seven animals were treated with ITD to determine the success in treating hypotension. Results were encouraging since the addition of ITD significantly improved MAP and reduced the respiratory rate, supporting the potential for clinical benefits of ITD in heat-stroke.

A series of animal experiments has also been performed to investigate intrathoracic pressure regulation for intracranial pressure management. Lurie, Idris, McKnite, Nadkarni, & Yannopoulos (2003) investigated cardiocranial interactions in spontaneously breathing pigs following resuscitation after laboratory induced cardiac arrest. Results indicated reduced ICP when the inspiratory ITD was employed. Following this initial investigation Lurie et al. (2004) performed a feasibility study using

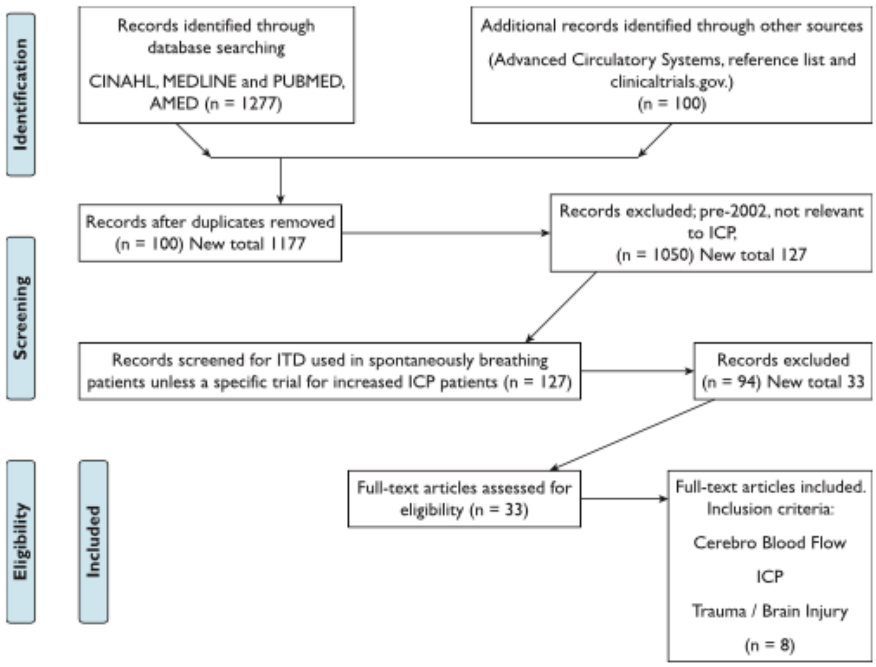

Figure 1. PRISMA flow diagram.

39 spontaneously breathing anesthetised pigs treated with ITD at different pressures under normovolemic and hypovolemic conditions (the latter induced via haemorrhage). Results indicated sequential increases of inspiratory impedance producing significant increases in systolic BP and cardiac output. These researchers subsequently used their animal model to perform further studies on cardio-cranial interactions in pigs. Thus Yannopoulos et al. (2006) investigated vital organ perfusion in 12 anaesthetised pigs at different intrathoracic pressures under hypovolaemic conditions. They measured variables relating to cerebral blood velocity dynamics, namely ICP, aortic pressure, right atrial pressure, arterial blood gases and end tidal CO2. Decreased intrathoracic pressure caused an immediate, proportionate reduction in ICP. In addition, the mean arterial, cerebral and coronary perfusion pressures were improved. These animal studies demonstrate a clear correlation between negative intrathoracic pressure, intracranial pressure, aortic pressure and cerebral blood flow. The projection is that by imposing an increased negative intrathoracic pressure the aortic pressure increases, ICP is lowered and cerebral perfusion is enhanced.

Studies with ITDs have also been performed in human volunteers during hypotension, for example during simulated haemorrhagic shock and orthostatic challenge. A randomised, blinded, controlled trial in 20 human volunteers investigated haemodynamics associated with ITD (ResQGARD) compared with a sham device. Results showed how the ITD produced significantly higher cardiac output and systolic BP (Convertino et al., 2004). Subsequently a prospective, randomised, blinded trial performed in human volunteers with induced central hypovolaemia and impending cardiovascular collapse was conducted in which nine volunteers were studied when either breathing through an ITD (ResQGARD) or a sham device. Results of this trial indicated significantly lower systolic BP, diastolic BP and MAP with the sham device than with ResQGARD and supported the notion that ResQGARD increased systemic BP and delayed the onset of cardiovascular collapse (Convertino et al., 2007). ResQGARD therefore provides non-invasive haemodynamic support in patients with hypovolemic hypotension. In a study of 18 normotensive volunteers, Convertino et al. (2007) demonstrated that breathing through an ITD improved cardiovascular function in response to an orthostatic challenge. Thus inspiration through a low level of resistance can delay onset of orthostatic intolerance symptoms, providing a theoretical basis for other indications relating to improved cerebral perfusion (Convertino et al., 2005c). Similar results were found by Cooke, Lurie, Rohrer and Convertino (2006) when a sham and ITD were tested in eight volunteers in the supine position breathing either spontaneously or at a rate of 25 breaths/

min. These results were supported by Rickards, Ryan, Cooke, Lurie and Convertino (2007) in a further study with eight human volunteers whose cerebral blood flow velocity (CBFV) was measured continuously via transcranial Doppler. The study involved breathing through an ITD or sham device during progressive levels of central hypovolaemia arising from exposure to lower-body negative pressures (LBNP). Subjective measurements of symptoms such as dizziness or nausea were also collected. Using the ITD significantly increased LBNP tolerance time and delayed onset of symptoms of syncope. Differences in mean CBFV did not reach statistical significance; however, frequency of oscillations in mean CBFV were statistically greater with ITD (Rickards et al., 2007). A similar study indicated that ITD served to reduce the severity of orthostatic symptoms in eight out of nine symptomatic subjects. Although no significant difference was found in the reduction of mean CBFV with ITD, again higher oscillations in CBFV were found with the ITD suggesting improved cerebral perfusion may account for the improvement in symptoms (Rickards et al., 2008).

Evidence described in the review by Convertino et al. (2011) provides definitive support for the physiological benefits of a device providing inspiratory resistance resulting in a pressure difference of 7 cm H_2O. As described previously, the review covered a range of potential applications of ITDs in conditions associated with hypotension. Since this review, research in this area has continued to investigate the potential of ITDs to help treat serious and often life-threatening circulatory disorders. Recently a prospective, non-randomised study investigated the ITD in 39 patients who developed hypotension secondary to blood loss or trauma in the pre-hospital setting. The results proved the device was successful in improving arterial perfusion pressures. The haemodynamic variables collected did not include direct measures of cerebral blood flow or ICP; however, clinical symptoms potentially associated with these parameters were recorded as secondary variables. There were clear improvements in feelings of well-being and significant elevation of pulse pressure following application of the ITD. The authors concluded that these data would suggest a potential positive relationship between the application of the ITD and increased stroke volume and cerebral perfusion but that further research was required (Convertino et al., 2012). The same investigators performed a similar prospective, non-randomised study aimed at providing further proof of the clinical benefit of the ITD in patients with traumatic injuries in a pre-hospital setting (Wampler et al., 2014). This time MAP was calculated before, rather than after, ITD use, as a representation of the primary endpoint. A total of 29 patients were classified as having suffered trauma and their MAP was shown to significantly increase with the ITD intervention. As in their previous study, systolic and diastolic BPs were also significantly improved with the ITD.

Hypotension and raised ICP are well-known poor prognostic indicators in patients suffering TBI; therefore, based on the combined benefits of the ITD in increasing MAP and decreasing ICP, a strong theoretical clinical benefit exists for the intervention in this patient population. The inverse correlation between high ICP and favourable outcome in TBI was supported over a decade ago in a study involving 846 TBI patients. Patients whose ICP was < 20 mmHg by 48 hours had a mortality rate of 14%, in contrast to those with ICP > 20 mmHg whose mortality rate was 34% (Jiang, Gao, Li, Yu, & Zu, 2002). Guidelines for managing pre-hospital emergency care of severe TBI published by the Brain Trauma Foundation in 2007 suggest healthcare professionals should target abnormal CPP, blood oxygenation and BP parameters to optimise patient outcomes. These recommendations were subsequently revised and updated and a more comprehensive edition published. The new guidelines provided more extensive information on the latest diagnostic approaches and treatments to be implemented for improved outcomes in TBI patients (Bratton et al., 2007). These guidelines describe the relationships between various variables and their potential prognostic value in TBI. Emphasis is placed on the need for intensive monitoring of severe TBI patients in order to ensure adequate cerebral perfusion and oxygenation is maintained, with several possible approaches being described to strive to achieve successful outcomes. Specifically, scientific evidence indicates a number of measurements represent indirect measures of cerebral perfusion such as systemic hypotension, intracranial hypertensions and CPP (Chesnut et al., 1993; Marmarou et al., 1991; Schoon, Benito Mori, Orlandi, Larralde, & Radrizzani, 2002). Moreover, Bratton et al. (2007) describe how CPP values of < 50 mmHg are associated with poor outcomes in TBI patients. Research evidence also demonstrates how accurately estimating CPP and cerebral hypo-perfusion relies on continuous monitoring of BP and ICP (Chambers, Treadwell, & Mendelow, 2000, 2001; Miller et al., 2004; Rosner & Daughton, 1990); however, benefits of invasive ICP monitoring must be weighed against the potential risks and costs of this intervention (Brain Trauma Foundation, American Association of Neurological Surgeons, & Congress of Neurological Surgeons, 2007; Bratton et al., 2007).

Notably, the scientific evidence underpinning the Brain Trauma Foundation guidelines are level II–III evidence (Brain Trauma Foundation et al., 2007). Of particular relevance is that there is no robust level I evidence from randomised controlled trials investigating the use of medical devices, such as the ITD, to treat raised ICP or suboptimal CPP arising from TBI. There has, however, been one pilot clinical trial performed to date in this area. The objective of the clinical trial was to explore the impact of a novel intrathoracic pressure regulator (ITPR) device on patients with elevated ICP, from a variety of diagnoses, including trauma. A number of haemodynamic variables (systemic BP, central venous pressure, CPP and ICP) were recorded as primary variables at baseline, prior to the intervention, and on several occasions following application of the intervention. ICP was measured using an external ventricular drain or ICP monitor. Application of the intervention involved the introduction of randomly assigned endotracheal tube pressure (either a –5 mmHg pressure or a –9 mmHg pressure) via an ITPR. The haemodynamic and ICP variables were measured sequentially at 2-minute intervals over a 10-minute period when the first device was in place. Thereafter the device was turned off for 10 minutes, the device with the alternative pressure was applied and the procedure then repeated. A total of six females and four males aged from 17 to 60 years completed the study. All had elevated ICP arising from intracranial haemorrhage (n = 4), trauma (n = 2), obstructive hydrocephalus (n = 2), or diffuse cerebral processes (n = 2). The baseline ICP measured ranged from 12 to 38 mmHg. From the total of 20 device applications, the ICP was observed to decrease in 16 instances. The mean maximal decrease recorded was significant, reaching 3.3 mmHg during treatment with the –5 mmHg device (baseline 21.7 mmHg vs. intervention 18.4 mmHg). This was simultaneously associated with a significant increase in CPP of 6.5 mmHg (baseline 58.2 mmHg vs. intervention 64.7 mmHg). Interestingly, treatment with the –9 mmHg device resulted in a lesser effect on ICP, but which nevertheless did reach statistical significance (mean maximal decrease of 2.4 mmHg in ICP; baseline 21.1 mmHg vs. intervention 18.7 mmHg). Additionally, once again there was a concurrent increase in CPP of 6.5 mmHg (baseline 59.2 mmHg vs. intervention 65.7 mmHg). Although the sample size was small these preliminary results are highly encouraging for this first-in-humans trial (Kiehna, Huffmyer, Thiele, Scalzo, & Nemergut, 2013). It is worth noting that a similar study in head injury patients was commissioned by Advanced Circulatory Systems in collaboration with the US Army Medical Research and Materiel Command in 2014. The aim was to prove application of ITPR results in an increase in CPP and a decrease in ICP in this patient population. The protocol specified application of two pressures: –7 cm H_2O ITPR and –12 cm H_2O ITPR to 40 mechanically ventilated intubated patients. The intervention allocation was randomised and the study was a blinded crossover design. Primary assessments included change in ICP from baseline compared with the ICP during 15 minutes of ITPR use, measurement of mean and maximum CPP during ITPR use and time to maximum increase in CPP. Lung compliance and arterial blood gases were also monitored. No study results are currently available and the status of this study is reported as terminated (clinicaltrials.gov, 2014).

Conclusion

The evidence presented in this literature search presents devices which create subatmospheric intrathoracic pressure, such as ResQGARD, as potentially invaluable opportunities to rapidly lower ICP and raise CPP using safe non-invasive therapeutic interventions in TBI. The use of ITPR in intubated and mechanically ventilated inpatients has already been completed in a pilot study, which indicated positive effects on ICP and CPP. There now exists a clear need for a proof of clinical concept study to show that application of an ITD can be used as a safe and effective non-invasive method to increase CPP and decrease ICP in spontaneously breathing patients with raised ICP following TBI in a pre-hospital setting.

Conflict of interest

None declared.

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