How is the Theoretical Domains Framework applied in designing interventions to support healthcare practitioner behaviour change? A systematic review

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Abstract

Background: The use of theory is recommended to support interventions to promote implementation of evidence-based practices. However, there are multiple models of behaviour change which can be complex and lack comprehensiveness and are therefore difficult to understand and operationalise. The Theoretical Domains Framework sought to address these problems by synthesising 33 models of behaviour or behaviour change. Given that it is 15 years since the first publication of the TDF it is timely to reflect on how the framework has been applied in practice. The aim of this review is to identify and narratively synthesise papers in which the TDF, including frameworks that incorporate the TDF have been used in relation to practice behaviours, which go as far as to report on intervention development and/or testing.

Methods: We searched MEDLINE, PsychINFO, CINAHL and the Cochrane databases using the terms: "theoretical domains framework*" or TDF or COM-B or "behav* change wheel" or "BCW" AND implement* or improv* or quality or guideline* or intervention* or practice* or EBP or "evidence based practice" and conducted citation and key author searches. Included papers were those that used any version of the TDF published from 2005 onwards. Included papers were subject to narrative synthesis.

Results: A total of 3,540 papers were identified and 60 were included. Thirty-two papers reported intervention design only and 28 reported intervention design and testing. Despite over three thousand citations there has been limited application to the point of designing interventions to support best practice. In particular use of the framework has not been tried or tested in non-western countries and barely used in non-primary or acute care settings. Authors have applied the

framework to assess barriers and facilitators successfully but reporting of the process of selection of behaviour change techniques and intervention design thereafter was variable.

Conclusion:

Despite over three thousand citations of the framework there has been limited application to the point of designing interventions to support best practice. The framework is barely used in non-western countries or beyond primary or acute care settings. A stated purpose of the framework was to make psychological theory accessible to researchers and practitioners alike, if this is to be fully achieved further guidance is needed on the application of the framework beyond the point of assessment of barriers and facilitators.

Keywords

"Theoretical Domains Framework", "Behaviour Change Wheel", COM-B, Implementation, Psychological Theory, Systematic Review

Background

Estimates suggest that it takes on average 17 years for evidence to be adopted into practice [1, 2]. Whilst the need for evidence based practice (EBP) been recognised for a very long time [3] the means of achieving this has been less certain. Implementation strategies such as audit and feedback, educational meetings and reminder systems have been investigated and reviewed and the conclusions from these are "there are no magic bullets" [4, 5]. Adopting EBP will vary according to context. As a result, the Medical Research Council (MRC) guidelines for complex interventions recommend the use of theory to support interventions to promote implementation of EBPs [6]. Furthermore, systematic review evidence supports tailoring of interventions according to local needs [7]. Systematic reviews of existing evidence relating to supporting *health* behaviour change demonstrates that interventions to support desirable behaviours that are underpinned with psychological/behaviour change theory are more effective than those that are not [8, 9] and a similar approach is suggested for the support of *practice* behaviours [10]. That is, interventions underpinned with psychological/behaviour change theory are more effective than those that are not when it comes to health behaviours. It is expected that this is the case when it comes to practice behaviours. However, such an approach comes with challenges. Multiple models of behaviour change are used to support best practice (e.g. the Theory Planned Behaviour [11]) but such models can be complex and lack comprehensiveness. Their complexity means they can be difficult to understand and operationalise for both researchers and healthcare practitioners [10]. The large number of overlapping theories of behaviour make it difficult to select from the plethora that exist.

These challenge and the need for an overarching theoretical framework to support behaviour change in healthcare practice led to the development of the Theoretical Domains Framework (TDF) which brings together 33 models of behaviour or behaviour change and includes 128 separate constructs [10]. The TDF has 11 theoretical domains that outline determinants of behaviour (*knowledge, skills, social/professional role and identity, beliefs about capabilities, beliefs about*

consequences, motivation and goals, memory attention and decision processes, environmental context and resources, social influences, emotion and action planning). There have been frameworks that have developed from or include this first version of the TDF. These include a further validated TDF of 14 domains where *optimism, reinforcement* and *intentions* were found significant and added (rather than being embedded in the original [12]. Both versions are used according to users' familiarity and preference and can be used to guide data collection relating to barriers and facilitators to practice through a range of media (e.g. interviews, focus groups, structured observations and questionnaires) [13]. When barriers and facilitators to practice are assessed using psychological theory, a wider range of responses are achieved than when a non-theoretical approach is used [14]. It may be that such an approach mitigates cognitive biases, for example we are not always consciously aware of what influences our behaviour and without theory we may suggest a rationale that is influenced by logic more than truth [15], we may wrongly attribute external factors rather than personal factors as reasons for our behaviour (where undesirable behaviours are concerned) [16] or we may simply offer an automatic response [17]. In summary, the TDF offers a comprehensive and accessible means of using the plethora of available theory to understand the challenges to optimal practice behaviours.

The TDF has been linked to a more recently developed, simpler model of behaviour in the Capability, Opportunity, Motivation to Behaviour (COM-B) [18] which claims to offer a simpler approach to establishing influencers of practice behaviours. In theory capability, opportunity and motivation interact to produce behaviour and the TDF works within this to provide a more ~~detailed or~~ granular understanding of these elements [13]. COM-B fits within the Behaviour Change Wheel (BCW) [19] which takes into account contextual factors (e.g. legislation, fiscal) and offers potential intervention functions (e.g. training, modelling). An eight stage process to intervention design is recommended by the authors of the framework [19]

i) define the problem in behavioural terms (that is the actions rather than the goals),

ii) ii) select the target behaviour (most likely to address the problem),

iii) iii) specify the target behaviour and identify (who, needs to do what, when where how and, if relevant, with whom)

iv) iv) what needs to change (understanding the determinants of (barriers and facilitators to)) a practice behaviour,

v) v) intervention options (the means by which an intervention may effect change),

vi) vi) policy categories (e.g. guidelines, legislation, regulation),

vii) vii) behaviour change techniques (BCTs) and

viii) viii) mode of delivery (e.g. newspaper, poster, app, telephone helpline) [18].

and for the purposes of this paper we use this as a benchmark. However, it must be noted that this guide was published in 2011, six years after the publication of the first version of the TDF [10]. The author recommended a process of using psychological/behaviour change theory to support best practice through the framework.

As a result of this or a similar process we can see how the TDF may allow researchers and practitioners an accessible means of accurately assessing barriers and facilitators to optimal practice across a comprehensive range of potential behavioural determinants AND select the relevant, most effective BCTs to underpin interventions designed to support best practice.

It is now fifteen years since publication of the TDF. In 2012, a brief review assessed the extent of TDF-based research and identified 133 papers that cite the framework. Seventeen of these were empirical studies investigating health or practice behaviours [20]. None of the included studies had at that time used the framework to the point of intervention design to support practice behaviours. Since that review, there have been over 3,000 citations of the TDF and other frameworks that include the TDF (hereafter 'the framework'). The aim of this review is therefore to identify and

provide a narrative synthesis of papers in which the framework, has been used in relation to practice behaviours and with a specific focus on those which go as far as to report on intervention development and/or testing in order to i) suggest where and when the TDF might be most useful in influencing practice behaviours, ii) the process by which the TDF has been applied and challenges with application and from this iii) recommend how the framework might best be further developed.

Through including and critiquing papers that have completed intervention design, we are able to consider what process researchers have used and to what effect, we have been able to consider the full scope of the use of the framework and extracted its strengths and limitations to support its future use for both researchers and practitioners.

Aim:

To establish how the framework been used to inform interventions designed to support implementation of evidence based practice/to improve practice.

Objectives:

i) Identify the context in which the framework has and has yet to be used (date, country, targeted group and behaviour, intervention),
ii) Describe and critique the process with which the framework has been applied and the challenges of application,
iii) From this, make recommendations as to how the framework can best be developed for adoption in practice.

Methods

Search strategy and selection criteria

We searched MEDLINE, PsychINFO, CINAHL and Cochrane databases using the terms: “theoretical domains framework*” or TDF or COM-B or “behav* change wheel” or “BCW” AND implement* or

improv* or quality or guideline* or intervention* or practice* or EBP or "evidence based practice". We conducted citation searches of key papers [10, 12, 18, 19]] and key authors as the framework was not cited as the “Theoretical Domains Framework/TDF” until 2009. The search took place in September 2020. We included papers that used any version of the TDF, focused on implementation (healthcare practice) behaviours published from 2005 onward (the first publication of the TDF) [10]] and where the framework had been used to underpin interventions. We excluded papers where the framework had been used to support patient or health behaviours or where it had been used to support the development of theory (for full inclusion and exclusion criteria see table 1). Title, abstract and full texts were screened for eligibility by both authors; any disagreement was discussed to the point of resolution.

Table 1: Inclusion and exclusion criteria

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Analysis

Data extraction was completed equally by the two authors using a bespoke spreadsheet to ascertain study design, target group and behaviour, intervention (including quality of intervention reporting according to the Template for Intervention Description and Replication (TIDier) Checklist [21]), which framework was used, the process and study findings (where intervention evaluation was reported). Although the eight-stage approach to applying the TDF [19] was published more recently than the TDF itself, we considered many of the stages reported were intuitive steps in the design of interventions to support practice (e.g. problem identification, report of intervention components and mode of delivery). So whilst we did not explicitly judge “process” to this degree of detail against these eight stages we did consider whether authors had i) defined the problem/behaviour ii) considered the behavioural determinants of (barriers and facilitators to) the practice behaviour in

question, iii) identified relevant BCTs and iv) used these to underpin reported interventions. We conducted a narrative synthesis [22] of included papers according to the focus of our review.

Figure 1: Prisma Diagram

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Results

Included papers

The search yielded 3540 papers (after duplicates were removed) of which 60 are included in this review (see figure 1). Table 2 offers a summary of included papers followed by a summary of quality of reporting and study characteristics. A summary of the quality of intervention reporting is followed by context within which the framework was used (date, country, targeted group and range of behaviours and interventions), a narrative synthesis of reported papers follows arranged according to the framework used: TDF 2005, TDF 2012, COM-B/BCW and TDF/BCW combination and a summary of the process authors followed to design interventions, and where these were implemented measure the impact.

Table 2: Summary of included papers

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Quality of reporting

The quality of reporting of included papers was good. Nearly all authors (n=56 out of a possible 60) reported intervention rationale, materials, procedure and mode of delivery [exceptions were [49, 76, 86, 87]. Just over half (n=32) reported the expertise/background of the person delivering the intervention [23-25, 32-34, 37-39, 42-44, 47-49, 51, 56, 58, 64-67, 69-72]. Most (n=49) reported the timing and extent of the intervention [exceptions were [44, 49, 50, 55, 61, 71-73, 77, 86, 87]]. Nearly all (n=54) reported tailoring [exceptions [23, 26, 32, 54, 57, 67]. Of those that implemented interventions (see table 2) 6 out of 26 reported whether there had been intervention modification [34, 54, 57, 65, 70, 90] eleven reported fidelity planned [26, 34, 44, 51, 52, 54, 57, 65, 75, 85, 90] and six reported fidelity assessed [26, 44, 57, 65, 67, 75].

Characteristics of included papers

Included papers were published in 2008 onward. Most studies took place in the UK or western Europe (n=30) [24, 27, 29, 30, 33, 34, 36, 44, 47, 50, 51, 53, 54, 56, 57, 62, 64, 70, 74, 76, 78, 80, 82, 85, 88-90] followed by Australia (n =16) [26, 37, 42, 43, 48, 52, 55, 61, 65-67, 72, 77, 83, 86, 87] and Canada (n=11) [23, 25, 28, 32, 39, 41, 49, 71, 73, 75, 79] with only two taking place in the USA [69, 91] and one in Uganda [38]. The practice behaviours that interventions targeted mostly related to supporting patients' health behaviours (n=12) [23, 26, 27, 32, 48, 59, 64, 66, 67, 75, 89, 90], patient safety (n=12) [24, 25, 37, 38, 55-57, 61, 62, 72, 77, 85], prescribing (n=11) [29, 30, 35, 47, 54, 71, 73, 74, 80, 88, 91] and pre- or re-habilitation [33, 34, 41, 49, 51, 52, 60, 65, 70, 83]. Only four papers considered pain management [28, 39, 42, 78] or psychological practices [27, 50, 69, 76] and only three considered infection prevention/hygiene [44, 46, 82] or falls prevention [86, 87, 92]. There were a vast array of intervention components (many interventions including more than one) however predominantly these were training workshops (n=49) face to face [23, 24, 27, 32, 37-39, 41, 46, 49, 50, 56-58, 60, 64, 65, 70, 71, 73-76, 78, 83, 86, 87, 91, 92], online [25, 26, 29, 30, 35, 42, 43,

48, 54, 61, 62, 85] or a combination of both [28, 55, 66, 67, 72, 77, 89, 90]. Less frequently used interventions included audit and/or feedback (n=10) [27, 39, 41, 44, 47, 52, 55-57, 61], opinion leaders (n=30, prompts or reminders (n=3) [47, 55, 58] and screening tools or protocols [33, 34]. There were two reports of using posters [45,46], mentoring [54, 55] and checklists and one report using sepsis bags [71], patient scenarios [77], action plans [33], educational outreach [36], newsletters [41] and graded tasks [42]. The practitioner groups targeted were mostly either primary care practitioners (n=20) [23, 26, 29, 30, 36, 39, 42, 43, 47, 50, 53, 71, 74, 75, 78, 80, 88-91] or acute hospital practitioners working in in-patient units (n=20) [24, 25, 38, 41, 44, 46, 48-50, 52, 54, 55, 61, 62, 65-67, 76, 77, 82, 85]. Nine studies were conducted in outpatient departments [32-34, 58, 64, 70, 79, 86, 87] three in emergency departments [37, 72, 83], two with care home staff [56, 57] midwives [27, 51] or psychiatrists [27, 69] and a single study with community pharmacists [74] and chiropractors [28].

TDF 2005

The TDF (2005) [10] was used in 25 studies [24, 28-30, 42-44, 47, 49, 52, 53, 55, 61, 62, 66, 67, 71, 77, 78, 85-88]. Twenty-three studies used this version of the TDF to underpin or analyse interviews, focus groups or questionnaires to identify barriers to the desired behaviour, or, to categorise barriers already identified in the literature [24, 28-30, 42-44, 47, 49, 52, 53, 55, 61, 62, 66, 67, 71, 77, 78, 85-88]. In the two studies remaining, use of the TDF was unclear with authors simply reporting "the components of the intervention were developed using domains of the TDF" [43] and domains were "addressed during the conception of the intervention" [35]. All except five [49, 54, 66, 67, 71] explicitly report mapping BCTs to identified barriers. Eleven studies designed but did not implement interventions. There were 14 implemented interventions and their performance in supporting best practice was assessed [30, 43, 44, 46, 49, 52, 54, 61, 66, 71, 85-87]. Assessment of intervention performance was by way of feasibility testing [30], (clinician judgement of acceptability), cluster RCT

[43, 44] (measuring intentions to behaviour and hygiene compliance respectively) and pre and post intervention evaluation [49, 52, 61, 71, 87] one with a comparison group [85]. Pre and post evaluation measurements were largely clinician compliance with the relevant practice behaviour [49, 52, 61, 71, 85, 87] with just three reporting patient related outcomes, urinary continence [52], malnutrition [66] and falls [71].

TDF 2012

The TDF 2012 [12] was used in 12 studies [23, 32, 37, 39, 70, 72, 75, 76, 79, 82, 83, 91]. Of these, nine used this version of the TDF to underpin or analyse interviews, focus groups or questionnaires to identify barriers to the desired behaviour, or, to categorise barriers already identified in the literature [23, 37, 39, 70, 72, 76, 79, 82, 83]. In the other three the use was unclear; Ogunleye et al [75] report the TDF has "informed the nature of the intervention", Campbell-Scherer et al [32] "intervention pragmatically informed by domains of the TDF" and Zimmerman et al [91] reports "the domains of the TDF were used to guide an intervention that addressed knowledge, skills and feasibility barriers". There is insufficient detail to establish how they went about this. Seven of the 12 studies using this version of the TDF went on to use the framework to select BCTs [37, 70, 72, 79, 82, 83, 91], Eilayyan [39] selected from a taxonomy; it is not clear if or how the TDF was involved in selection. Four of the 12 studies using the TDF 2012 implemented interventions and these were assessed by post intervention observations and interviews (relating to compliance with practice behaviour) [23] interviews (intervention acceptability) [70] questionnaires [75, 91] (practice behaviour and acceptability respectively) and notes audit (practice behaviour compliance) [76].

COM-B/BCW

COM-B/BCW was used in 23 studies [25-27, 33, 34, 38, 41, 48, 50, 51, 56-58, 60, 64, 65, 69, 73, 74, 80, 89, 90]. Twelve followed the detailed 8-stage process outlined by COM-B/BCW [33, 34, 36, 56-58, 60, 69, 73, 74, 89, 90]. Thirteen used COM-B/BCW to underpin or analyse interviews, focus groups or questionnaires to identify barriers to the desired behaviour, or, to categorise barriers already identified in the literature [26, 27, 38, 41, 48, 50, 51, 64, 69, 73, 80, 89, 90], ten to identify BCTs [26, 27, 51, 64, 65, 69, 73, 80, 89, 90]. One paper reported using COM-B/BCW to inform mode of delivery [26]. Nine reported intervention implementation and assessment of interventions [26, 27, 34, 38, 50, 51, 57, 65, 90] and assessment included pre and post intervention measurements involving patient outcome [57, 65] (pressure ulcers and upper limb movement respectively) clinician compliance with practice behaviours [26, 27, 38, 50] and changes to perceived barriers [51, 90]. There was one case of post-intervention feedback [34].

Process followed

Although only twelve out of 60 included papers explicitly adopted the eight step process advocated by Michie et al. [19], many adopted a systematic and conscientious process [e.g. [24-26, 28, 37, 38, 44, 47, 48, 50, 53, 78, 79] whereas in others there was a lack of clear detail [e.g. [23, 49-52, 54]. All 60 included papers i) defined the problem and used behavioural terms to do so. Fifty five out of 60 included studies reported ii) behavioural determinants (barriers and facilitators) to the behaviour in question; five did not [36, 46, 55, 75, 91]. Fewer (n=49) claimed to use one of the frameworks to iii) guide identification of relevant BCTs and iv) used these to underpin intervention design; 11 did not [23, 32, 38, 42, 46, 49, 54, 71, 75, 76, 91]. All of those claiming to have identified BCTs report using these to underpin their reported interventions.

Problems identified with the approach

Some authors commented on application of the framework. For example, several noted that the approach was resource intensive [33, 43, 59, 62, 77]. Mangurian [69] reported the process was lengthy and that it is not possible to address all barriers identified. Craig [37] and Bull [27] suggests the need to advance understanding of who the best placed person to inform intervention development is and in particular the criteria to use BCTs. Glidewell [47] and Tavender [83] identify a lack of guidance on how best to operationalise use of theory and combine BCTs for enhanced effectiveness. Munroe [72] suggests implementation strategies may be subject to interpretation. Sinnott [80] reports that the BCW is not a "magic bullet", suggesting the researcher has to make a series of subjective and pragmatic judgements which can seem at odds with the scientific approach. Steinmo [82] found the TDF with mapped BCTs were useful in adapting an existing intervention and considered this approach more representative of the real world. Bonner [26] identified a problem and lack of guidance on "de-implementing" practices, in particular, when a behavioural substitute may be needed and how to identify one. Fahim [41] found the approach challenging and suggests the need for additional methods to prioritise barriers and facilitators and intervention strategies.

Discussion

To summarise, our narrative review identified 60 papers that used the framework to support health care practitioner behaviours to the point of intervention development and/or testing. The 2005 version of the TDF has been most frequently used (25 studies compared with 12 for the 2012 TDF and 23 for COM-B/BCW). Thirty two papers reported intervention design only and 28 reported intervention design and testing. Description of interventions in published literature is generally poor, for example, a review of non-pharmacological interventions found only 39% were described adequately [93]. However, the papers included in our review on the whole were well reported and we are confident in the conclusions we draw relating to these.

When considering context, the framework has been used in only eight countries, all but one [38] with western cultures. Borg [94] has extensively investigated the adoption of infection prevention related best practices in non-western cultures and questions the appropriateness of behaviour change frameworks and techniques in influencing non-western clinical practice. Through the lens of Hofstede's model of national cultures [95] Borg suggests that cultural models can explain between 25 and 50% of the variance in infection prevention related practices suggesting a need for deep insight into the nuances of behaviour change in non-western cultures; a "copy and paste" approach is "doomed to fail" [94]. Nearly all studies took place in either primary or secondary care settings. There was only one study (two papers [56, 57]) conducted in nursing homes for older people, only two studies took place in Mental Health care facilities [27, 69] and we found no papers that reported studies taking place in community settings (e.g. a service users own home or community clinics). In terms of practice behaviours considered, studies focused mostly on supporting patients' health behaviours, patient safety related practices, prescribing and pre/rehabilitation. We therefore suggest that although the TDF has been used with some success in a range of western acute and primary care settings its scope of application is as yet limited. There may be challenges in applying the framework in non-western cultures and it is possible that barriers and facilitators to best practice in non-acute or primary care settings may be vastly different to those in settings where the TDF has been applied to date. Although we have found a wide interventions resulting from application of the TDF, most authors chose to deliver intervention by way of workshops (n=49). Workshops can be expensive to deliver and reach relatively small numbers of practitioners; this is reflected in authors' comments about use of the framework being resource intensive [33, 43, 59, 62, 77] and the ambiguity in selecting BCTs and designing intervention strategies from these [41, 80]. Similar challenges were identified in papers included in a review of using the TDF for *health* (rather than practice) behaviours [96] with the process being cited as time consuming and requiring intervention developers to have knowledge of both the process and of BCTs [97].

In considering how the framework can be best developed for adoption in practice the first step must be to justify the choice of the TDF in the first place. It comprehensively includes constructs from all published models of behaviour or behaviour change, so if a behaviour change approach is adopted the TDF is an intuitive choice. However, Nilson [66] suggests a number of alternative approaches to the implementation of EBP, process models to describe and guide translation of research into practice, i) determinant frameworks (including the TDF) that consider barriers and facilitators, ii) process models that offer a step by step approach to translating research into practice, iii) classic theories from traditional fields such as sociology and psychology, iv) implementation theories which have been developed to provide understanding of aspects of implementation and v) evaluation theories that measure success of strategies. This offers a useful overview of existing approaches but no guidance on selection of an approach. Braithwait et al [67] suggest there is no single approach to implementation, complex systems with varying characteristics enmeshed in social norms and subject to multiple forces and influences require more than a linear step by step process. Lynch et al [68] consider ten commonly used and highly cited theoretical approaches (including the TDF approach) and conclude that there is no right or wrong way of selecting theory. Rather, an approach likeliest to add value within the projects purpose, scope and resources should be selected and only by doing so and reflecting on successes and challenges will we have sufficient evidence to offer nuanced advice on how to best implement research findings in practice. It may well be that this accounts for the lack of use of the TDF in non-western countries and some clinical environments, but future research using the TDF in these areas is necessary to make this conclusion. A more structured way of choosing an implementation framework would be of benefit to researchers in the field.

From our included papers, use of the TDF, as recommended to guide data collection relating to barriers and facilitators to practice [13] appears to have been achieved. What is less clear in the majority of included papers is how BCTs were selected and translated into pragmatic interventions. The two versions of the TDF are very similar but papers suggesting BCTs according to the domains of

the TDF demonstrate little agreement (e.g. Cane et al. [98] compared with Michie et al. [99]). For example, both authors agree that "rehearsal/practice" is a BCT useful if there are skills barriers and "demonstrating" the behaviour is useful where the barriers are in the domain "social influences" but these agreements occur infrequently. Mostly these authors do not agree within which domains BCTs are effective. This necessitates expert involvement at this point.

Strengths and limitations: Although systematic in our searching we cannot guarantee that all papers using the framework have been included. The framework was first cited as the "Theoretical Domains Framework" in 2009 [100] so papers prior to this may not have been identified. However, our extensive citation and key author search should have addressed this to a large extent. The strength of this review is that it is the first to comprehensively and systematically synthesise both the use of the framework for the design of interventions to support the implementation of evidence based practice.

Recommendations for future research relating to the development and use of the TDF include: i) research in non-western cultures to understand the range of determinants to practice behaviours and identification of culturally acceptable BCTs and improvement strategies across different countries; ii) the value of the TDF in non-acute or primary care environments; iii) further investigation into the appropriateness and selection of BCTs according to domains of the TDF and, if the TDF and associated process is to be accessible to non-experts, practitioners seeking to implement best practice, iv) more work is needed to guide the process from behaviour identification to intervention design, implementation and evaluation.

Conclusion

Despite over three thousand citations of the framework there has been limited application to the point of designing interventions to support best practice. In particular use of the framework has not been tried or tested in non-western countries and barely used in non-primary or acute care settings. One of the stated purposes of the framework was to make psychological theory accessible to researchers and practitioners alike if this is to be fully achieved further guidance is needed on the application of the framework beyond the point of assessment of barriers and facilitators. Where the framework has been used to support implementation of best practice, whilst the process was not always clear intervention reporting was good.

End-matter

Contributorship

JD and FC have been equal contributors in the production of this manuscript. Both authors have read and approved the final manuscript.

Ethics and other permissions

Was not required.

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Conflict of interest

No known conflict of interests.

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Figure 1: Prisma Diagram

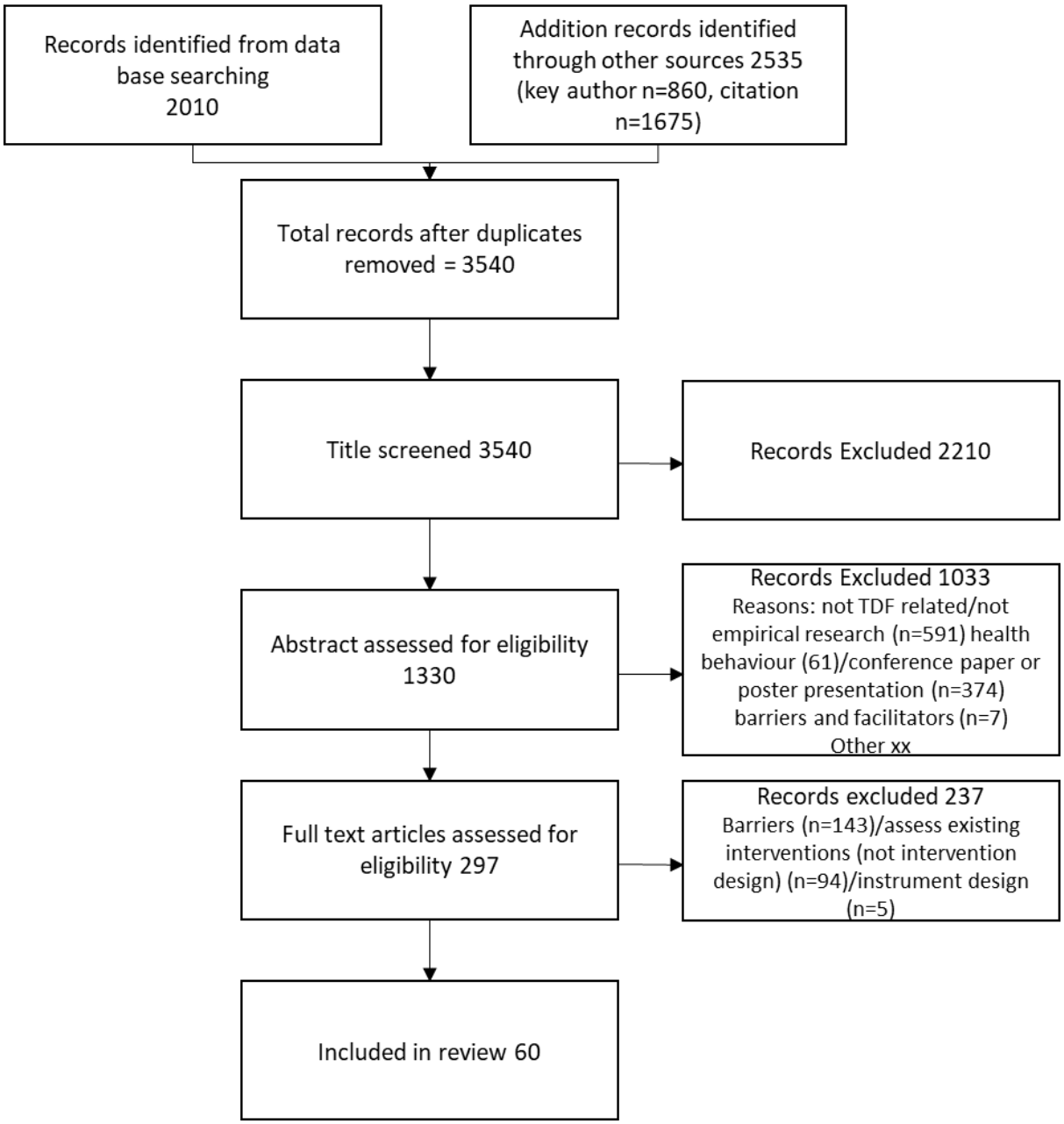

Table 1: Inclusion and exclusion criteria

Inclusion	**Exclusion**
Published from 2005 (original publication of the TDF) onwards	
Published in English language	Published in languages other than English (as there were no resources for translation)
Papers focusing on implementation (clinical practice) behaviour	Papers focusing on health (or other) behaviours
Report development and or testing of interventions underpinned by the framework	

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
Asselin 2015 [23] Canada	Primary care practitioners/weight management	Evaluation (interviews/ observation): 5As Team (5AsT) obesity management, 6-month programme (biweekly for 2 hours). Expert speaker, sharing, goal setting.	TDF [10] informed barriers interviews. Field notes categorised to the TDF.	Observations suggested obesity management was embedded in practice
Backman 2015 [24] UK	Hospital staff/guideline adoption suspected viral encephalitis	Design: Training day, action planning, audit, feedback, newsletter and quiz.	TDF [10] informed barriers interviews subsequently mapped to BCTs which underpinned the intervention.	
Bérubé 2015 [25] Canada	Acute care practitioners/guideline compliance adults with traumatic spinal cord injury	Design: Online training, 7 hours, prevention of complications, spine stabilisation, pain and prevention of pressure ulcers.	TDF [12] to assess barriers and BCW/COM-B guided selection of BCTs [18] which underpinned the intervention	
Bonner 2019 [26] Australia	Primary care GPs/ assessment of CVD risk and advice	Design and evaluation (survey): Online using CVD prevention guidelines, risk calculators, decision aid and a self-directed audit tool.	BCW [18] to establish most important barriers (from	73% of GPs accessed the intervention, there were

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
			previous literature review), BCTs and mode of delivery	no significant pre/post outcomes.
Bull 2019 [27] England	Health and social care professionals/a) integrated care in psychiatric ward, b) moving heart failure care to community, c) midwives offering 'flu' jabs	Design and evaluation (pre/post audit): a) Training and changes to the environment (e.g. location of family visits) b) not reported c) feedback tool and addressing environmental barriers.	COM-B/ BCW [18] to assess determinants of practice behaviours and to design the intervention.	a) There were 17 activities pre and 18 post intervention and range of activity doubled (4 to 8), c) barriers reduced post intervention.
Bussières 2015 [28] Canada	Chiropractors/ management of neck pain	Design: Face to face introduction followed by 3x60 min webinars, online vignettes, decision making exercises and learning.	TDF [10] to assess barriers and enablers and as the basis of selecting BCTs	
Cadogan 2016 [29] UK	GPs/appropriate prescribing (polypharmacy)	Design: Short online video demonstrating prescribing and action planning	TDF [10] to assess determinants and identify BCTs	

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
Cadogan 2018 [30] UK	GPs/appropriate prescribing (polypharmacy)	Evaluation (feasibility survey): A short online video	TDF [10] to identify determinants [31] and BCTs mapped to these to underpin the intervention.	GPs and patients considered the intervention acceptable
Campbell-Scherer 2014 [32] Canada	Practitioners/ weight management	Design: "5 As of obesity management", involving bi-weekly learning collaborative sessions for six months.	5As intervention "pragmatically informed" by the domains of the TDF [12]	
Connell 2015 [33] UK	Physiotherapists/ screening for and providing arm exercises	Design: A screening tool to identify patients that should receive the exercises, an exercise pack to patients and an audit tool.	COM-B/BCW 8 stage process [18].	See below [34]
Connell 2016 [34] UK	As above [33]	Evaluation (interviews and audit): PRACTISE (Promoting Recovery of the Arm: Clinical Tools	As above [33]	Exercises were given to up to 88% of patients, staff

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
		for Intensive Stroke Exercise) outlined above [33]		were positive, patients had mixed opinions.
Courtenay 2019 [35] UK	Nurse and independent prescribers/ appropriate antibiotic prescribing	Design: Electronic learning activity comprising a consultation scenario to provide information and demonstrate behaviour.	COM-B/BCW 8 stage process [18]. Barriers and facilitators previously assessed by the TDF (reported elsewhere [36])	
Craig 2017 [37] Australia	Emergency Department and stroke clinicians/ triage	Design: An interactive education programme, opinion leaders, reminders and site support.	TDF [12] to categorise barriers and to form the basis of selection of BCTs.	
Cummings 2017 [38] Uganda	Acute hospital practitioners/ "quick check" tool for early recognition of severe illness	Design and evaluation (pre/post audit): Training in severe illness care, collaborative meetings, audit and feedback and mentoring.	Barriers assessed using the three domains of the COM-B [18].	Increase in vital signs monitoring and patients more likely to be appropriately diagnosed with sepsis.

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
Eilayyan 2020 [39] Canada	Primary care practitioners/ adopting Patient Reported Outcome Measures (PROM) for lower back pain	Design: Educational materials, half day training workshop, feedback, an opinion leader to provide coaching on PROMs.	TDF [12] based survey to identify barriers and BCTs selected from a taxonomy (reported elsewhere [40]).	
Fahim 2020 [41] Canada	Surgeons, oncologists and pathologists/ high quality cancer consultations	Design: Knowledge Translation Multidisciplinary Cancer Conference Strategy consisting of workshops, training, intake forms, checklist, audit and feedback.	TDF [12] to identify barriers and facilitators and BCW/COM-B [18] to develop the intervention	
French 2012 [42] Australia	Primary care practitioners/ management of acute low back pain	Design: Facilitated workshops consisting of delivered content, group work, patient vignettes, activity log and action plans.	TDF [10] to assess barriers and enablers and identify BCTs	
French 2013 [43] Australia	GPs/ cease referrals for unnecessary X-rays for acute low back pain	Evaluation (cluster RCT): As above	TDF [10] based survey to assess GP's behavioural determinants	Small changes in GP's intentions; no change in behaviour

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
Fuller 2012 [44] UK	Hospital clinical staff/ hand hygiene (HH)	Evaluation (wedge cluster RCT): "Feedback" intervention involving observations, feedback and co-created action plans.	TDF [10] to inform intervention design (reported elsewhere [45])	Increases in observed HH (10-13%) and an increase in soap/gel use in ITU
Gerlich 2015 [46] Germany	Hospital staff providing acute care/regulations relating to hygiene	Design: Training delivered by the study team, provision of information, posters, site visits by the study team and a hotline for questions.	TDF [10] domains were "addressed during the conception of the intervention" and BCTs taken into account. No detail offered.	
Glidewell 2018 [47] UK	Primary care practitioners/diabetes and blood pressure control, risky prescribing, anticoagulation	Design: Audit, educational outreach and computerised prompts and paper-based reminders	TDF [10] based interviews to explore the determinants of adherence and BCW process 8 stage process was adopted throughout [18].	
Gould 2017 [48] Australia	Health providers/ delivery of stop smoking counselling to pregnant women	Design: ICAN QUIT, interactive training webinar, desktop guide, motivational videos and testimonials.	BCW/COM-B [18] to categorise barriers.	

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
Gramlich [49] 2017 Canada	Surgeons and anesthetists/ use of Enhanced Recovery After Surgery (ERAS) guide	Evaluation (pre/post notes audit): Training, "support" meetings to explain ERAS and networking opportunities	TDF [10] to categorise barriers and facilitators.	Compliance with ERAS increased from 40% to 65%.
Hanbury 2013 [50] UK	Primary care practitioners/ referral for treatment for mild to moderate postnatal depression	Evaluation (pre/post): Educational materials, a meeting tailored to assessed needs and a reminder system	BCW [18] to categorise barriers and inform intervention components	The intervention had an 11% effect on referral in the short term, not sustained at 10-months
Henshall 2018 [51] UK	Midwives/optimal place of birth discussion	Design and evaluation (pre/post surveys): A standardised script to support place of birth discussions, regular meetings and appointment of a "place of birth" lead.	BCW/COM-B [18] to categorise barriers and identify appropriate BCTs.	Midwives knowledge and confidence increased
Hirschhorn 2014 [52] Australia	Urologists/pre-prostatectomy pelvic floor muscle training (PFMT)	Evaluation (pre/post): A summary of evidence, audit and feedback newsletters, a provider directory and guides for patients.	TDF [10] to assess barriers and facilitators and select intervention components/BCTs.	Increase in patients receiving PFMT and self-

First author, year, location	Target group/ behaviour	Intervention design and/or evaluation (methods): Nature and content of the intervention	Framework Use	Findings related to evaluation where relevant
				reported urinary incontinence
Hrisos 2008 [53] UK	GPs/management of upper respiratory tract infections	Design: One off intervention targeting "self-efficacy" using graded tasks and a second targeting "anticipated consequences"	Behavioural determinants mapped onto the TDF [10] to support the identification of BCTs	
Johnson 2015 [54] UK	Cardiology clinicians/ appropriate investigation and prescribing	Evaluation (pre/post audit): "Optimising the Management of Angina", web based clinical decision support system	Components of the intervention developed using domains in the TDF [10].	Patients appropriately referred pre/post 50% to 59%
Kourouche 2019 [55] Australia	Clinical staff/ care bundle for a blunt chest injury	Design: Blunt chest injury care bundle video, educational sessions, an electronic reminder, change champions and audit and feedback.	TDF [10] to assess barriers and facilitators and BCTs selected according to the BCW [18].	
Lavallee 2018 [56] England	Nursing home care staff/ adopting a pressure injury prevention care bundle	Design: Training, skin champions, paperwork to complete, posters and feedback.	Intervention functions and BCTs identified using the BCW and	Described below [57]

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			followed the 8 stage BCW process [18].	
Lavallee 2019 [57] England	Described above	Evaluation (pre/post): Described above [56]	Described above [56]	Pre intervention 5 new pressure ulcers, post 0
van Leeuwen 2020 [58] Netherlands	Hearing health professionals/use of hearing assessment tool	Design: Opinion leaders, workshops educational materials, guidelines, digital reminders and flagging systems	BCW process 8 stage process [18]. The COM-B and the TDF to identify barriers and enablers. (reported elsewhere [59])	
Loft 2017 [60] Denmark	Stroke rehabilitation nurses/rehabilitative approach to support patient goals	Design: "Rehabilitation 24/7" a seven week educational programme of group training (face to face) and materials including a log book.	BCW/COM-B 8 stage process [18].	

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Long 2018 [61] Australia	Cancer care clinicians/ referring patients at high risk of Lynch syndrome for genetic counselling	Design: Changes to referral forms and multidisciplinary team meetings, audit and feedback, training and information sheets.	Questionnaire [62], underpinned by the TDF [10] to assess barriers and BCTs selected from a taxonomy [63].	Improvements in testing (from 0/1% to 67/ 88%)
McSharry 2016 [64] Ireland	Cardiac rehabilitation staff/sexual counselling group sessions to patients	Design: "CHARMS" (Cardiac Health and Relationship Management and Sexuality) a 2 hour, workshop delivered by a credible educator and including an intervention manual and booklet for patients.	Barriers to sexual counselling (from previous studies) were coded using COM-B and the BCW [18] to identify potential BCTs	
McCluskey 2020 [65] Australia	Occupational therapists/ offer stroke survivors upper limb constraint-induced movement therapy (CIMT)	Evaluation (pre/post): Education and training, individual barrier identification, mentoring and a community of practice.	COM-B to consider barriers and the BCW [18] to identify potential BCTs	Statistically significant changes in upper limb function recorded.

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Mackay 2019 [66] Australia	Nurses in haemodialysis unit/referrals to dieticians	Evaluation (pre/post): Face to face knowledge and skills based training with online training, a learning guide and mentoring.	Barriers categorised to the TDF 2005 [10]. BCW to determine interventions [18].	No statistical change in malnutrition
Mackay 2020 [67] Australia	Health care practitioners/ hyperglycemic care	Design: Educational activities (workshops, online resources), electronic health record, advice from a respected colleague, guidelines.	TDF [10] to assess barriers to care delivery (reported elsewhere [68]) informed intervention design.	
Mangurian 2017 [69] USA	Psychiatrists/ cardiovascular screening in people with severe mental illness	Design: "CRANIUM" (Cardio metabolic Risk Assessment and treatment through a Novel Integration Model) involving a patient registry and screening protocols.	BCW/COM-B 8 stage process [18].	
Matthews 2015 [70] Ireland	Physiotherapists/ promoting patient self-management	Design and evaluation (interviews): KEDS (Knowledge Exchange and Delivery Support) involving a one-off meeting to inform,	TDF [12] informed focus groups to identify barriers and facilitators and to select appropriate BCTs	The intervention was feasible and acceptable

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		encourage and set goals and two individual coaching sessions.		
Moorhouse 2015 [71] Canada	Physicians/adoption of frailty treatment for hypertension for people in nursing homes	Evaluation (pre/post): A 60 minute interactive presentation delivered by two geriatricians, supported by pharmacists, a written summary, poster and stickers placed in prescription charts	Barriers assessed using TDF [10] and intervention designed in response to these.	Blood pressure medication use and falls decreased
Munroe 2018 [72] Australia	Early career emergency nurses/use patient-assessment framework	Design: Training (e-learning and delivered by nurse educators), audit, documentation template and social support from senior colleagues	Barriers and facilitators categorised to domains of TDF [12], further categorised to COM-B and BCW (18) to identify BCTs.	
Murphy 2014 [73] Canada	Community Pharmacists/ i) support for people with mental health problems, ii)	Design: "More than Meds" a training day with community pharmacists and people with MH	BCW/COM-B [18] to understand the target behaviours and select BCTs	

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	prescribing for type 2 diabetes.	problems, a community of practice using "train the trainer" model		
Murphy 2017 [74] Ireland	GPs/appropriate prescribing for Type 2 diabetes	Design: A training programme, "finder tool" to help GPs identify patients with sub-optimal control of their diabetes and a web-based clinical decision support system.	BCW/COM-B [18] 8 stage process.	
Ogunleye 2015 [75] Canada	Primary care practitioners/ obesity management	Design and evaluation (observation, interviews and survey): 12 x one hour interactive face to face workshop sessions delivered by experts.	Content of the intervention designed according to domains of the TDF [12]	Self-reported behaviour change and increased confidence.
O'Neill 2015 [76] UK	Nurses in secondary care/ alcohol screening and a brief intervention	Design and evaluation (survey and notes audit): A face to face training session (1 hour) and follow-up e-learning including education materials, audit and feedback.	TDF [12] to understand barriers and facilitators from which the intervention was designed.	Post intervention 1180 out of 1598 patients were offered the brief intervention.

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Page 2017 [77] Australia	Medical and nursing staff working on Neonatal Critical Care Units/ optimal nutrition to preterm babies	Design: Education (training, newsletter and e-learning), redesign of work processes and changes to the ordering of perinatal nutrition	TDF [10] to categorise barriers and facilitators BCW (18) to identify BCTs	
Porcheret 2014 [78] UK	GPs/ enhanced consultation for patients with osteoarthritis joint pain	Design: Workshops led by opinion leaders on consultation skills, practice and feedback, discussion of case histories, action planning.	TDF [10] to assess the determinants of behaviour change and select BCTs.	
Sibley 2016 [79] Canada	Physiotherapists in rehabilitation settings/ delivering measurement of reactive balance to treating adults at risk of falls	Design: "REACT", seven interactive 60 minutes group sessions facilitated by researchers and members of clinical teams, demonstrations and discussion of concerns and local champions.	TDF [12] to categorise barriers and facilitators and to map BCTs.	
Sinnott 2015 [80] Ireland	GPs/ medicines management in multi-morbidity	Design: MultimorbiditY Collaborative Medication Review and Decision making (MY	Com-B/BCW [18] to frame behavioural determinants (reported elsewhere [81]) and identify relevant BCTs.	

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		COMRADE); GPs conducting medicines reviews, guided by a medication checklist and incentives for hours completed		
Steinmo [82] 2016 UK	Nurses, doctors and midwives/use the sepsis-six bundle	Design/ modification: Provision of sepsis bags, FAQ information sheet and expectations of commitment.	TDF [12] to establish barriers and map to BCTs	
Tavender [83] 2015 Australia	Emergency department staff/prospective assessment of post-traumatic amnesia	Design: Training, demonstration and scenarios using a "train the trainer" model and local opinion lead.	TDF [12] to assess barriers and facilitators (reported elsewhere [84]) and identify BCTs	
Taylor 2013 [62] UK	Hospital staff who manage nasogastric (NG) tubes/pH testing as first line method for checking the position	Design: Tailored according to local need including an awareness day/week, screensavers, posters, employment of an enteral feeding nurse and e-learning.	TDF [10] to assess the determinants of behaviour change and map to appropriate BCTs.	

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Taylor 2014 [85] UK	As above [62]	Evaluation (pre/post audit): As above [62]	TDF [10] to identify barriers and guide the selection of BCTs.	pH first line increased compared post intervention
Thomas 2014 [86] Australia	Physical therapists/adoption of falls guidelines	Design: Face-to-face training session, a "pathway" to guide the management of risk of falls, standardised processes for transfer of information and a booklet for consumers.	Barriers and enablers identified in focus groups categorised to TDF [10] and BCW [7] to identify intervention components/BCTs	Reported elsewhere – see below [87]
Thomas 2016 [87] Australia	As above [86]	Evaluation (pre/post audit): As above [86]	As above [86]	Patients identified at risk (6.3% to 94.8%), documentation frequency (68.6% to 90.9%) and quality (34.9% to 92.9%)

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Treweek 2014 [88] UK	GPs/management of patients with upper respiratory tract infections without antibiotics	Design: Two training scenarios and GPs asked to devise an action plan.	TDF [10] based survey to identify barriers, mapped onto BCTs, which underpinned the intervention.	
Webb 2016 [89] UK	Nurses in primary care/ delivery of brief advice on exercise to cancer patients	Design: Sixty minutes face-to-face or online training including information, modelling and persuasion.	BCW/COM-B [18] 8 stage process.	See below [90]
Webb 2016 [90] UK	As above [89]	Evaluation (interviews and survey): As above [89]	As above and the capability, opportunity and motivation of nurses to deliver advice was measured post intervention using a COM-B [18] based survey	The intervention improved capability, opportunity and motivation.

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Zimmerman 2020 [91] USA	Physicians and advanced practice providers/de-prescribing	Design and evaluation (survey): Face to face, six workshops.	Domains of TDF [12] guided an intervention addressing knowledge, skills and feasibility barriers	Attendees reported being more likely to implement changes in practice as a result of the intervention.