Preventing heel pressure ulceration- a guide for nursing practice.

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Abstract

The heel remains a common site for pressure ulcer development, particularly in people who are supine or semi-recumbent with immobility. There is very little protective subcutaneous tissue and no muscle or fascia within the heel making it vulnerable to pressure, friction and shear forces. Heel pressure ulceration remains a clinical challenge for the nursing profession and the wider healthcare team, as well as a focus of pain and physical debilitation for the patient. This article critically reviews the risk factors to heel ulceration and examines patient assessment and the specific measures to prevent the development of heel pressure ulcers.

Keywords: ED note: Draw from Nursing Standard taxonomy

The Heel

Heel pressure ulcers are localised injury to the heel as result of pressure, sometimes in association with other factors (NICE 2014a). The heel is at the back of the foot, extending from the Achilles tendon around the plantar surface, it covers the apex of the calcaneum bone. It is a common site for pressure ulcer development, particularly in people who are supine or semi-recumbent with immobility (NICE 2014a).

The heel is a particularly vulnerable area mainly due to the nature of its anatomy. It is basically skin and bone with very little protective subcutaneous tissue and no muscle or fascia (Black 2004, Bosanquet et al 2016). External pressure when applied to the heel, has little means of being distributed through the tissues due to the absence of these underlying structures. High pressures are therefore easily created in the skin and within the tissues, causing the blood flow to reduce to critically low levels. Fowler et al (2008) describe the damage that can occur to heels through sustained pressure, primarily as a result of tissue damage due to this inadequate tissue perfusion. The authors also describe Mustoe et al's (2006) model of reperfusion injury which occurs as blood returns to the tissues, increasing damage by accumulated intra-cellular free radicals due to ischaemia, which further damage cells and DNA. Figure 1. illustrates the international pressure ulcer classification system.

Figure 1. International Pressure ulcer classification system

(Ed note. If possible, draw from Ellis M (2017) Pressure ulcer prevention in care home settings. Nursing Older People. 29, 3, p.32)

Additionally, friction and shear forces caused for example, by dragging heels up or along a bed due to poor repositioning techniques, can magnify the problem through tissue destruction. The blood vessels, when subjected to excessive shear forces distort and rupture, causing cell death. This can be misleadingly termed pressure damage. Hess (2004) succinctly defines the difference between friction and shear forces. They are separate phenomenon but often work together to cause tissue ischaemia and ulcer development (Hess 2004). Friction is the mechanical force exerted when skin is dragged across coarse surfaces, such as linen.

Subsequent damage will be visible (Bergstrom 1994, Hess 2004). Shear force is caused essentially by the bones pulling in one direction and the skin in the opposite. It is a mechanical force that acts on an area of skin in a direction parallel to the body's surface (Bergstrom 1994, Hess 2004). Shear injury will not be seen at the skin level because it causes damage beneath the surface (Hess 2004).

When pressure damage occurs at the heel the cells within the skin fail and die, with resultant necrosis (Nixon 2001). If the necrotic tissue then becomes detached, the underlying structure, i.e. bone, will often be exposed. Once this occurs, there is a risk of osteomyelitis (infection of the bone) which can be difficult to eradicate and causes a failure in ulcers to heal. Given this scenario, it is paramount that heel pressure ulcers are prevented.

Risk factors to heel pressure ulcer development

The specific risk factors putting the patient at increased risk of heel ulceration are notably multiple comorbidities, such as diabetes mellitus, lower extremity peripheral arterial disease (PAD), end-stage renal disease, any condition contributing to foot insensitivity, as well as patient specific factors such as advanced age, poor nutrition, obesity and immobility (Rajpaul and Action 2016). Consideration must also be given to additional factors such as pre-existing skin conditions including oedema, dehydration and external factors, such as skin that is moist or wet, notably with damaging fluid, such as urine.

The effects of peripheral arterial disease

Peripheral arterial disease (PAD) is a clear risk factor to heel ulceration. It is a reduction in blood supply to the peripheral areas of the body, such as the hands and feet. Gogalniceanu et al (2018) note that PAD is often caused by atherosclerosis, thrombosis or embolism. In addition, traumatic damage to the arterial wall, compression of the arterial lumen or changes in the arterial wall (e.g., thromboangiitis obliterans) may occur. Although this article focuses on direct assessment and management of the heel, Gogalniceanu et al (2018) emphasise a wider assessment of the patient for PAD, through a general examination. This includes checking the environment for clues as to the patient's functional status and tobacco staining of the fingers, indicating smoking as a possible cause.

The presence of PAD is identified as an increased risk factor in pressure ulcer risk assessment tools such as Waterlow (2005) and the more recent PURPOSE T (Coleman et al 2018). Within pressure ulcer assessment, structured tools aim to support clinical judgment by allowing the timely implementation of preventative strategies based upon a score of perceived risk. Many differing tools have been suggested over the years, indicating their need to support and not drive clinical judgment. Moore and Cowman (2014), in a Cochrane review, have suggested that assessment tools may be no better than a health professional's own judgment. Ellis (2017) makes the logical point that such an assertion relies on the individual knowledge and skill of the nurse to gather and interpret relevant information, while the key to any assessment tool is what is done with the information. However, over reliance on any tool, beyond clinical skill and judgment, may possibly encourage an avoidance of risk factors not explicitly mentioned in the tool.

Staff may only know if the patient has PAD, if an established diagnosis is recorded in the records. To this end, there are several methods of assessment to help determine the presence of this condition and thus aid risk assessment.

Assessing the capillary refill time (CRT), palpation of pulses in the foot and less commonly undertaking an ankle-brachial pressure index (ABPI), form part of a highly useful assessment of the circulation in the foot. Capillary refill time has been proposed as a marker for determining arterial circulation. It involves gently pressing on the pulp of the toe or the nail bed for 3 seconds and counting the time needed for reperfusion to occur. A refill time that is longer than 3 seconds is abnormal (Gogalniceanu et al 2018). It is important to review the CRT in the context of the presenting patient. It can be as slow as 4-5 seconds in the older person or in patients with other factors such as dehydration (Lewin and Maconochie 2008). Therefore, the nurse needs to both note this and work with the multidisciplinary team to correct such factors as part of the overall protection of vulnerable tissues.

The palpation of pedal pulses needs to be taught by a skilled practitioner and practised frequently. The dorsalis pedis pulse can usually be identified by asking the patient to lift the great toe upward. Anatomically, the pulse will be found lateral to the extensor hallucis longus tendon, which becomes visible when the great toe is in dorsiflexion. The posterior tibial pulse can be palpated behind the medial malleolus. This pulse is located halfway between the malleolus and the Achilles' tendon (Gogalniceanu et al 2018). Moffatt et al (1994) have highlighted, in a cohort of community nurses studied, that palpation of pedal pulse alone is a poor predictor of arterial leg disease. It also needs to be undertaken with caution because patients with neuropathy can have bounding pulses but a reduced circulation, so it is not a definitive test (Moffatt et al 1994).

Figure 1. Pulse within the foot (Ed note: add dorsalis pedis and posterior tibial)

ABPI is a validated test for assessing the arterial circulation to the lower leg (Keen 2008). It compares the blood pressure in the arm with the blood pressure in the leg (Gogalniceanu et al

2018). The patient lies in a comfortable and rested position and a blood pressure cuff is applied to each arm in turn. A hand held Doppler is placed over the brachial artery and allows the pulse to be heard. The cuff is inflated until the sound of the pulse stops. It is them deflated slowly until the sound returns. As it returns, the systolic pressure is noted, for example 110 mmHg. The highest value from the two arms is used. This is repeated with the blood pressure cuff on each ankle and performed on each of the two pedal pulses - dorsalis pedis and posterior tibial. Again, the highest of the fours systolic values is used.

The highest systolic ankle measurement is divided by the highest systolic arm measurement. For example, 110mmHg (ankle) / 110mmHg (arm) would create an index of 1.0. If there was a difference in the pressures, this would indicate a reduction of arterial blood flow to the lower limbs. For example, 95 mmHg (ankle) /110 mmHg (arm) = 0.86. Although there is controversy about what the ABPI should be for the presence PAD, the threshold most commonly used is $\leq$0.90 (Aboyans et al 2012). It is not routine to undertake an ABPI assessment on all patients on admission but may be part of a wider assessment for PAD.

The evidence base to support the link between PAD and heel pressure ulceration is based primarily on opinion with limited research evidence. Two studies investigated this area with differences in findings. Twilley and Jones (2016) noted more patients with heel pressure ulcers having an ABPI reading of either >1.3 or <0.9 -0.8 in the case matched subjects, but no real difference when <0.8. Meaume and Faucher (2007) found the opposite, a difference in the <0.8 group with heel pressure ulcers but no difference in the >1.3 or <0.9 -0.8 in the case matched subjects. Although differing in the degree of PAD identified as significant, both did find its presence was more prevalent in the heel pressure ulcer group. Both studies had small study populations. In light of this, further research in this area with a sufficiently powered population (a sample size large enough to detect an effect if present), would be valuable to determine the degree of PAD which might be associated with higher risk. These early potential results, combined with McGinnis et al (2014a) noting the presence of PAD as a prognostic factor impacting on the healing of heel pressure ulcers, suggest that ABPI assessment could potentially be useful clinically.

The assessment process to determine PAD could be a logistical issue because the necessary staff with the training and competency to undertake this assessment may not be available in all areas. More recently, newer automated ABPI machines may assist in overcome time obstacles because they are easier to learn to operate and also reduce the time required for assessment to as little as 5 minutes.

Foot insensitivity

McGinnis et al (2014b) and Gorecki et al (2009) have argued that patient experience of local pain or discomfort at a potential pressure ulcer site may be a precursor to pressure damage. Pain could therefore be seen as a risk factor. Patients who normally feel pain react to this sensation by moving pressure off the area and therefore reducing the ulceration risk. This is a normal physiological response and occurs so automatically it may go unnoticed. When patients are unable to move themselves and relieve pressure, this becomes a pressure ulcer risk. This immobility is included in assessment tools by Waterlow (2005), PURPOSE T (Coleman et al 2018) and PPURA (Health Improvement Scotland 2010). It should also be noted that some patients who are able to move easily may be unable to feel pain. This lack of pain sensation is a vital cue to put in place ulcer preventative measures. In some patient groups, the loss of pain sensation may relate particularly to the foot area.

Diabetic patients are one such group and pain insensitivity is a risk in both types 1 and 2. The disease is known to have multiple detrimental effects on the body and can contribute to PAD in both the large and small blood vessels (Turner and McLeod Roberts 2002). Diminished sensitivity to pain can also occur in patients who have neurological conditions such as stroke, multiple sclerosis, Alzheimer's disease and other forms dementias (Borsook 2012). The ability to verbally or non-verbally communicate pain may also be affected in some of these conditions. One method of assessing the potential loss of protective function of pain can be the use of a 10g monofilament tool on the base of the foot in various testing sites. In the diabetic patient, this test is routinely conducted as part of an annual foot check (Mishra et al 2017). The test can be carried out in a few minutes and the equipment required is of minimal cost. A patient who has lost the ability to feel the pressure of the microfilament pressing against the sole of the foot has potentially lost some or all of their protective sensation of pain function. A simpler version, The Ipswich Touch Test, has been proposed and requires no equipment (Sharma et al 2014). For this, the nurse uses their index finger to touch the tips of the patient's great, middle and little toes lightly and briefly on each foot. If unable to feel the touch, they have lost sensation (Sharma et al 2014). These patients should then be classed as having a higher risk of developing pressure ulceration.

Risk assessment

One of the first activities upon admission to the clinical area or healthcare facility is to undertake a pressure ulcer risk assessment (NICE 2014b). Clinical judgment, as well as local and national guidelines, utilising a structured approach, needs to be followed with regard to patient assessment and frequency. In the UK, a structured risk assessment needs to be undertaken as soon as possible and within eight hours of admission to the care facility (NPAUP 2014). Such risk assessments should assess multiple factors, including patient mobility, perfusion and oxygenation status as well as skin health (Rajpaul and Acton 2016). A reassessment is undertaken as often as required by patient acuity and if there is any significant change in the individual's condition (NPAUP 2014).

Preventative measures

There have been a number of methods to elevate the heel, known as 'off loading' and seen in nursing over the years. It is important to note that some of these are now regarded as having limited benefit in clinical practice and should not be used. These include: placing water filled latex gloves or infusion bags under the heels, cutout ring or donut-type devise and synthetic sheepskin pads (NPAUP 2014). Other methods are used in nursing practice and are described below.

Beds and Mattresses

Foam mattresses made from high specification or viscoelastic foam are designed to allow the pressure load to be spread over a larger area (NPUAP, 2014). Low air loss mattresses work in a similar fashion. Alternating pressure mattresses provide regular pressure relief, loading and unloading the pressure at the body and heel, commonly over a 10-minute cycle. Some of these mattresses have a special heel zone with cells that can be deflated and remain so to remove heel contact with the mattress (Masterson and Younger 2014). However, despite the routine use of these products, heel pressure ulceration remains a risk, so additional methods may be required to reduce the incidence of heel pressure ulceration (Donnelly et al 2011).

Profiling beds: Fletcher (2015) determined that the action of some profiling beds, where the mattress does not contour closely to the bedframe, can cause the lower leg to move down the bed by some 15-20 centimetres. When raising the head of the bed, this potentially results in the heel being subjected to shear and friction. The raising of the knee section might mitigate the effect. In at risk patients, it might be worth considering methods to try to reduce the effects of this by the use of slide sheets when repositioning or low friction bootees (see below).

Other methods to protect the heel fall into two categories: the aforementioned off loading of the heel, so it is no longer in direct contact with any surface; or materials applied to the heel itself, which aid in the prevention of friction and shear forces and, in some instances, may also reduce interface pressure.

Off loading

This refers to the heel(s) being raised off the surface by some form if intervention. This could be with the use of pillows, a foam wedge or by use of a device applied to the foot and lower leg which prevents the heel from direct contact with the surface areas, such as the bed.

Pillows and wedges: Pillows are cheap, can be a multi-patient device and are widely available. However, the effectiveness of different types of cushions in the prevention of heel pressure ulcers is poorly studied (Heyneman et al 2009). When used, pillows should be placed length-wise under the the lower leg so that the foot is raised off the bed and the heel is free from pressure. However, the foot is not supported in an upright position, with the risk of foot drop. In addition, the patient can easily lift their leg off the pillow or it does not stay in place (Fowler et al 2008; Campbell et al 2010; NPUAP 2014). There remains limited studies to demonstrate the effectiveness of pillows used in this way. In studies such as Tymec et al (1997) and

Campbell et al (2010), where pressure relieving methods are examined in relation to heel peruse ulcers, sample sizes are small and differing approaches makes comparisons extremely difficult.

Heyneman et al (2009) pooled data from two previous studies to compare a bed-wide viscoelastic foam wedge under the lower legs and a pillow. Both groups developed pressure ulcers to the heels but patients with a wedge-shaped cushion under the lower legs had an 85% less chance in developing a heel pressure ulcer ($p = 0.02$). Patients in the wedge-shaped cushion group developed significantly fewer heel pressure ulcers ($p = 0.03$). More research across different settings with a larger population would be useful to explore the findings further to determine to if this is useful in practice. If found to be useful, it would also be of value to identify the most appropriate foam and the optimum depth of the product. Foot drop could be a potential problem when using this product because the foot is not fully supported.

Heel-lift devices: There are several different types of heel-lift devices available. The commonality is the ability to envelop the foot and some of the lower leg, causing the heel to be lifted free and so avoiding pressure. Versions made from various types of foam are fabric covered, while others are plain foam. Plastic air filled devices are also available. The boots usually have an opening over the heel zone to provide a zero-pressure area to achieve offloading (Masterson and Younger 2014). Only those covered with material which can be cleaned are are suitable for multi-patient use. Some products are fastened around the foot and lower leg, while in others the foot and lower leg rest against the product. The benefits of these products is that the foot is supported at a 90-degree angle, so there is no issue with the user developing foot drop when in place.

McInerney (2008) reduced the incidence of heel pressure ulcers by the use of heel lifts. However, other equipment was also changed, which could also have impacted on the reduction from 2.6% to 0.7%. Donnelly et al (2011) used the heel lift suspension boot in a randomised controlled trial comparing with standard care (mattresses designed as pressure-redistributing support surfaces) in elderly patients with hip fractures. In the heel lift group, no pressure ulcers at the heel developed compared to 17 at the heel in the standard care group. An agreed early stopping rule was implemented following pre-planned analysis at the halfway stage, to ensure patients were not receiving infective care. Due to the statistical significance of the results, and the power level being acceptable, the result can be viewed with confidence. Not all patients found the device comfortable (weight and bulk of the boot, heat and discomfort) and this affected concordance. Despite this, the results demonstrated a potentially effective product to consider in practice. The remaining products are those which are applied or are in direct contact with the heel and which are generally used to reduce friction and shear.

Heel protectors: These products can be made from foam, fibre-filled or sheepskin and are essentially a boot, with the product enveloping the foot, heel, ankle and Achilles tendon. The products may help reduce friction and shear and to some extent interface pressure, the extent of the reduction in these forces is currently not widely published. The clear advantage over the use of pillows is they stay in place and help prevent foot drop by supporting the foot (Rajpaul and Acton 2016). The latter authors reviewed their use at two large London hospitals and suggested an inverse relationship between the number of heel protection devices and the occurrence of heel pressure ulcers recorded. In addition, was the implementation of robust assessment, allowing early identification of skin damage. The work also emphasised the importance of staff education, notably in applying the device at a clear time point and not in an ad hoc manner, and thus the importance of strong clinical leadership in pursuing ulcer prevention (Rajpaul and Acton 2016).

Low friction material: As had been highlighted, friction that causes shear of tissues in the heel area remains a critical risk factor in heel ulcer formation (Gleeson 2016). Such friction is caused by the interaction of a surface material such as a bed sheet with skin on the heel, and leads to tangential forces in the tissue when the surface of the skin is prevented from sliding as a patient moves on the surface (Gleeson 2016). To off set this risk factor, low friction material has been utilised in the form of sliding sheets to protect heels during movement and repositioning, as well as low-friction bootees to assist the heels to glide over coarse material, when patients move and during repositioning.

In addition, the use of dressings in the prevention of heel pressure ulcers have also been reviewed within the literature. Santamaria et al (2015 a & b) examined the use of Mepilex® boarder heel dressing in preventing pressure ulcers. Two randomised controlled trials both in critical care patients, demonstrated an incidence of 5/219 and 0/191 heel pressure ulcers with the use of Mepilex® compared to 19/221 in both studies with usual care. Finite element modelling is a powerful numerical tool to evaluate internal tissue loads and isolate the influence of biomechanical characteristics from other potential risk factors, such as impaired circulation. Its application in a study by Levy et al (2015) has suggested the dressing's success could be due to the five layers within the dressing providing movement against itself rather than the skin, something which was less successful in a single-layer foam dressing. Other studies have demonstrated success in the use of dressings in smaller scale studies (Bots and Apotheker 2004; Torra I Bou et al 2009). Whilst results are promising, more work is needed to determine if the results can be generalised more widely and which specific type of dressing is more successful in the prevention heel pressure ulcers.

In conclusion, this article has explored the vulnerable structure of the heel to pressure ulceration. It has reviewed the risk factors and called for a structured approach to risk assessment using validated tools and a need to act on this, avoiding an ad hoc approach to prevention. Off loading is seen as the most appropriate method to prevent heel ulceration and the various methods of achieving this have been reviewed, along with methods to reduce friction and shear forces. There is a need for all nurses to continue to evaluate and critically review management options and work as a team, formed around strong clinical leadership, to ensure a high standard but consistent approach to patient care in this area.

https://www.diabetes.org.uk/guide-to-diabetes/complications/feet/touch-the-toes touch the toes test

https://www.diabetes.org.uk/resources-s3/2017-10/0527C%20BRIGHT%20IDEAS%20NUMBER%205_SB_Digital.pdf Diabetes UK Bright idea #5 Adapting the Ipswich Touch Test to increase foot risk assessments at the Royal Free Hospital

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