Preventing pressure ulceration in surgical patients

Pressure ulcers are a common, but often preventable, condition that occur most often in high-risk patients. The development of pressure ulcers is a cause for concern in any healthcare setting. They can occur at any stage in the patient journey, however, one clinical setting that is often overlooked is the operating theatre. Many patients may be at higher risk of developing a pressure ulcer in the perioperative period (Rogan, 2007).

KEY WORDS
- Pressure ulcer
- Operating theatre
- Prevention
- Multidisciplinary approach

Early research by Versluysen (1986) on people with hip fractures served to raise awareness that patients were at risk of skin damage from the moment they enter the healthcare setting, and that more attention should be paid to those in A&E departments, operating theatres and postoperative wards.

Estimates vary as to the exact number of patients developing pressure damage in the operating theatre, however, it is thought to be significant, with estimates ranging from 8.5–66% (Versluysen, 1986; Aronovitch, 1999).

A pressure ulcer is defined as an area of skin discolouration or damage that persists on the removal of pressure (Department of Health[DH], 1993). An ulcer is most likely to develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period (Walton-Geer, 2009).

Recent government initiatives have highlighted the importance of pressure ulcer prevention by implementing the 'quality improvement through innovation productivity and prevention' (CQUIN) payment framework, which targets the reduction of specific grades of pressure ulcer in any given healthcare setting (Newton, 2010). The key aims of CQUIN payments are to reward high-quality improvements and innovation, which actively contribute to improving patient care by reducing healthcare-acquired pressure ulcers.

Dowsett (2010) discusses the QUIPP agenda in relation to a High Impact Actions and pressure ulcer reduction programme carried out in Newham, London. The team were able to demonstrate a reduction in category/grade 3 and 4 pressure ulcers through a change in how patients were managed in their own homes.

Central to any debate around the impact of pressure ulcers is the negative effect they can have on patients. There is no doubt that patients developing pressure ulcers are likely to remain as inpatients for longer, are at greater risk of infection and will take longer to recover, in addition to experiencing added anxiety and stress (Graves et al, 2005).

This paper focuses on how pressure ulcers can develop during the peri-operative period and how simple interventions may help to prevent them.

HOW DO PRESSURE ULCERS DEVELOP?

Pressure ulcers normally occur due to a combination of extrinsic and intrinsic factors. Extrinsic factors are those that can be controlled or altered

SHARON BATEMAN
Lead Nurse Wound Care, Healthcare Governance Directorate, South Tees Hospitals NHS Foundation Trust, The James Cook University Hospital, Middlesbrough

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by clinicians. Intrinsic factors include those inherent patient-related features that may predispose them to developing pressure ulcers, such as previous or chronic conditions that may leave them susceptible to injury. Pressure ulcers are often described as emanating from direct pressure, shear and friction forces acting on the skin (DeFloor, 1998).

Pressure refers to the compression of soft tissue over a bony prominence and an external surface. It is often discussed in terms of magnitude or intensity and duration (Walton-Geer, 2009). When pressure exceeds normal capillary filling pressure (32mmHg), local blood flow is occluded, which can lead to tissue ischaemia and subsequent necrosis of the skin and subcutaneous tissues (Landis, 1930). However, this figure has since been disputed due to the use of young healthy volunteers who would be more likely to have higher capillary closing pressures compared with elderly frail patients with additional co-morbidities (Rogan, 2007).

McClemont (1984) discovered that the pressure exerted on the deeper tissues was far greater than that at the surface, resulting in a greater degree of tissue damage nearer the bone than on the skin surface. This phenomenon is known as McClemont's 'cone of pressure theory' (McClemont, 1984). Initial tissue damage is often limited to a simple hyperaemia, which, if the pressure is relieved, will disappear or blanche on light finger pressure (Cooper, 2006).

If the pressure is not relieved, this hyperaemic response may increase leading to a local release of histamine. In this case, the tissue is already damaged and the hyperaemia/erythema will not disappear under light finger pressure (Cooper, 2006).

This is known as non-blanching erythema. If pressure continues, there is a risk of ischaemia to the area. The continued release of histamine causes increased vessel permeability, which, in turn, causes the tissue to appear oedematous. Under ischaemic conditions, cell death will occur, with harmful cellular contents spilling out into the surrounding tissues, creating further necrosis.

Pressure ulcers may first present with blue/black or purple discolouration of intact skin — often a sign of deeper tissue damage (Walton-Geer, 2009).

Patients who are undergoing surgery requiring them to be immobile for long periods may be at increased risk of pressure damage if preventative strategies are not in place. Although early studies were aimed at the elderly population, it could be said that patients who are rendered immobile, such as those under- going surgery, may be at greater risk. Early studies of pressure ulcer development highlighted the lack of spontaneous movements in sleeping elderly bed-bound patients. Exton-Smith and Shirwin (1961) discovered that patients who moved less than 21 times per night were most likely to develop pressure ulcers.

In a study into microcirculation, Kosiak (1959) found that low pressure experienced for long periods of time was as damaging to the skin as high pressure for short periods of time. The enforced immobility of patients in theatre is, therefore, likely to significantly increase their risk of developing a pressure ulcer.

Shear

Shearing refers to the pulling of the skeleton (normally by gravity) downwards, while the skin adheres to the surface of the bed, trolley or chair. This results in the tearing of capillaries and can increase the severity of a pressure ulcer when shear and pressure forces are present (Walton-Geer, 2009).

During surgery, certain positions that are necessary in order to gain access to the affected area may also leave the patient at risk of shearing forces.

Friction

Friction describes the forces at play when two surfaces rub across one another — if this persists, patients can develop friction ulcers. Friction may compound the effects of pressure and shearing and potentially lead to loss of epidermis (Walton-Geer, 2009).

Moisture

Moisture is implicated in the development of some pressure ulcers due to the effect of the skin being overhydrated. If the skin is excessively

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moist, the epidermis becomes weaker and more fragile — this can lead to skin breakdown in the presence of pressure, shear and/or friction.

When considering the skin integrity of patients undergoing surgery, preventative measures should include actions that can be taken to reduce pressure, shear, friction and moisture build-up.

Intrinsic factors

Intrinsic factors are those that are physically manifest in the patient and can also increase his or her susceptibility to developing a pressure ulcer. These include co-morbidities, such as cardiovascular disease, conditions that reduce mobility, such as stroke, nutritional deficits, anaemia, obesity, and cachexia.

Table 1 lists some of the key risk factors that may predispose the patient to developing a pressure ulcer and why surgical procedures may increase this risk.

CATEGORY/STAGES OF TISSUE ULCERATION

Historically a number of grading or staging tools for pressure ulceration have been identified. However, to reduce confusion and present a unified international tool, the National Pressure Ulcer Advisory Panel (NPUAP) and European Pressure Ulcer Advisory Panel (EPUAP) cooperated on a classification system, which is now recognised as the 'gold standard' (EPUAP, 2009).

International NPUAP/EPUAP pressure ulcer classification system

Category/stage 1: non-blanchable redness of intact skin

Category/stage 1 damage is represented by intact skin with non-blanchable erythema of a localised area, usually over a bony prominence (EPUAP/NPUAP, 2009) (*Figure 1*). Discolouration of the skin, warmth, oedema, hardness or pain may also be present. Darkly pigmented skin may not have visible blanching. The area may be painful, firm, soft, warmer or cooler as compared with adjacent tissue. Category/stage 1 damage may be difficult to detect in individuals with dark skin tones. Category/stage 1 damage may indicate an 'at-risk' individual.

Figure 1: Category/stage 1 pressure damage, non-blanching erythema.

Figure 2: Category/stage 2 pressure ulcer, note the breach of the epidermis and exposed dermis.

Category/stage 2: partial thickness skin loss or blister

Category/stage 2 damage is represented by partial thickness loss of dermis presenting as a shallow open ulcer with a red/pink wound bed, without slough (*Figure 2*). It may also present as an intact or open/ruptured serum-filled or sero-sanginous-filled blister, as well as a shiny or dry shallow ulcer without slough or bruising. This category/stage should not be used to describe skin tears, tape burns, incontinence-associated dermatitis, maceration or excoriation.

Category/stage 3: full thickness skin loss (fat visible)

Category/stage 3 damage is represented by full thickness tissue loss (*Figure 3*). Subcutaneous fat may be visible, but bone, tendon or muscle are not exposed. Some slough may be present. May include undermining and tunnelling.

The depth of a category/stage 3 pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have adipose subcutaneous tissue and category/stage 3 ulcers can be shallow in these areas. By contrast, areas of significant adiposity can develop extremely deep category/stage 3

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Table 1
Key risk factors that may predispose the patient to developing a pressure ulcer and why surgical procedures may increase this risk

Health status	*People who become acutely unwell and require emergency surgery may have periods of hypotension and extended time in surgery, which may contribute to skin breakdown. Additionally, those who have had chronic illness may also be vulnerable due to the systemic impact of their illness prior to surgery*
Mobility	*Immobility may be the greatest risk to skin integrity. The normal response to pressure is to move or reposition. A person's ability to move in response to pressure while in surgery is severely compromised, therefore, placing them at high risk of pressure ulcer development*
Posture and correct positioning	*Positioning for certain types of surgery will place pressure on areas which may not normally be associated with pressure. Failure to take account of this may lead to skin breakdown*
Sensory impairment/loss of consciousness	*Reduced awareness of pressure leading to reduced spontaneous movement. People who have had strokes or those with a spinal cord injury are among those who would be vulnerable due to sensory impairment, however, general and spinal anaesthesia both render the patient unable to respond to stimuli*
Nutritional status	*There is a significant link between poor nutritional status and pressure ulcer risk. Patients who have chronic disease prior to surgery may be at risk of malnutrition and this risk could be reduced with appropriate preoperative nutrition. Also consider adequate hydration*
Pain status	*When we are in severe pain we may reduce the number of times we move or reposition ourselves. It is important to assess a person's pain regularly in the post-operative phase and if necessary make sure they have adequate analgesia to allow them to reposition themselves with comfort*
Moisture/continence/wound exudate	*Whether due to incontinence, excessive perspiration and/or wound exudate, excessive moisture can make the skin more fragile and at risk of damage*
Previous pressure damage	*Scar tissue, for example, from an old pressure ulcer, is never as strong as undamaged tissue. In some areas it may have little or no blood supply. It is more vulnerable to breakdown*
Medication	*Anaesthetic agents in theatre will render the patient unable to respond to stimuli. Steroid therapy can affect collagen in the skin making it more susceptible to breakdown and will negatively affect healing. Inotrope therapy can reduce peripheral circulation, putting patients at risk of reduced skin integrity*
Extremes of age	*Neonates and very elderly people have more fragile skin. In the elderly, several changes occur in the skin and its supporting structures, which may predispose their skin to pressure, shearing and friction related ulcers*

pressure ulcers. Bone/tendon is not visible or directly palpable.

Category/stage 4: full thickness tissue loss (muscle/bone visible)

Category/stage 4 damage is represented by full thickness tissue loss with exposed bone, tendon or muscle (*Figure 4*). Slough or eschar may be present. These ulcers often include undermining and tunnelling. The depth of a category/stage 4 pressure ulcer varies by anatomical location. As above, the bridge of the nose, ear, occiput and malleolus do not have (adipose) subcutaneous tissue and these ulcers can be shallow. Category/stage 4 ulcers can extend into muscle and/or supporting structures (e.g. fascia, tendon or joint capsule) making osteomyelitis or osteitis likely to occur. Exposed bone/muscle is visible or directly palpable.

PRESSURE ULCERS IN THE SURGICAL PATIENT

What is the extent of the problem?

Patients undergoing surgery will often be temporarily at higher risk of pressure ulceration due to a combination of their comorbidities and the need to be immobilised and anaesthetised to prevent pain and to allow the procedure to take place.

Bliss and Simini (1999) discussed the need to acknowledge that surgery is often a high-risk procedure for patients due to number of events that may collude to leave them at risk of skin damage. They also mention emergency surgery, where the patient may have been in shock due to

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Figure 3: Category/stage 3 pressure ulcer.

blood loss and have spent excessive time on a trolley, as well as fasting in readiness for the procedure.

Excessive pain may also leave the patient immobile and Bliss and Simini (1999) question the role of anaesthetic drugs in tissue breakdown. The use of sedatives, hypnotics and paralysing agents can cause reduced awareness and enforce immobility, while hypotension is often induced, which can influence the peripheral circulation and potentially increase the risk of pressure ulcer development.

A number of studies have established a link between pressure ulcer formation and surgery. For example, Hoshowsky and Schramm (1994) found that a variety of factors played a part in pressure ulcer development, however, the duration of surgery is thought to be a major component. Schoonaven et al (2002) studied a group of 208 patients all of whom had undergone surgery lasting longer than four hours, and some in excess of nine hours. Skin was assessed before surgery and then after for a period of 14 days. Forty-four patients (21%) developed 70 areas of pressure damage ranging from category/stage 1 to necrosis.

Versluysen (1986) examined 100 hip fracture patients, of which 66% developed pressure damage. The author attributed these ulcers to long periods of immobility on high pressure surfaces in casualty departments, theatre and in hospital wards.

Aronovitch (1999) carried out a nationwide study of more than 1,000 patients who had surgery lasting longer than three hours. The patients with the highest number of recorded pressure ulcers were those who had surgery lasting between 5–6 hours (9.9% of patients), with the majority of recorded ulcers being category/stage 1.

Hoshowsky and Schramm (1994) studied 505 patients and calculated odds ratios according to patient co-morbidity and other surgical factors, concluding that the most consistent predictor of surgical pressure ulceration was the duration of the surgery.

Prevention of surgical pressure ulcers

Recently, a simple care bundle has been developed that allows clinicians to measure interventions and justify the reasons for their actions (Whitlock et al, 2011).

Included in this bundle (SSKIN) are the following practice points:

- Surface: which type of surface is the patient on, and is it appropriate?
- Skin inspection: have you examined the patient's skin and documented this? Was there anything unusual?
- Keep moving: is the patient undergoing regular changes of position or maintaining mobility?
- Incontinence: if the patient is incontinent, how is this being managed and is this appropriate?
- Nutrition: is the patient malnourished and/or dehydrated, and how is this being addressed?

The key messages that underpin perioperative pressure ulcer prevention strategies include:

- Risk assessment
- Pressure redistribution
- Skin assessment
- Hypothermia.

Risk assessment

This involves identifying the patients who

Figure 4: Category/stage 4 pressure ulcer.

'Excessive pain may also leave the patient immobile'

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'Gel and high density foam products help prevent shearing, support the patient and prevent bottoming out'

are most at risk of developing a pressure ulcer perioperatively. This would involve assessing pre-existing conditions, length and type of surgery, the position used and the recovery time for the patient to regain mobility.

Risk assessment tools are available, however, many are not specifically related to surgery. The Waterlow Score includes surgery as a specific risk factor (Waterlow, 1985). Major surgery of duration greater than two hours receives a score of 5, while greater than six hours receives a score of 8. These scores would significantly increase the Waterlow score of the patient, and, therefore, would indicate the need to carry out preventative measures.

Although the Braden Risk Assessment Tool does not acknowledge 'surgery' directly, as in the Waterlow tool, it does, however, refer to known risk factors, such as moisture, mobility, nutrition, friction and shear, which indicate a greater need for preventative measures such as repositioning, preoperative nutritional input and perioperative pressure surface protection (Braden and Bergstrom, 1989).

Pressure redistribution

Due to the importance of positioning patients for surgery, it can be difficult to turn or move patients during an operation. Positioning is often key to allowing the surgeon and anaesthetist to carry out the procedure as safely as possible. However, care must be still taken when placing patients into position, to avoid straining joints and, where possible, positions that impact on blood flow (Walton-Geer 2009).

Transferring of the patient using glide sheets and slide boards is essential to minimise the risk of friction-related skin damage. High-risk areas should be identified before the patient is positioned, to allow pressure-reducing devices to be put in place. A pressure-redistributing theatre mattress should be used to protect the back and sacrum (depending on position). As pressure ulcers most often occur over bony prominences, these sites should be checked once the patient is in position, and appropriate pressure-redistribution products put in place. There are a number of pressure-redistributing products available, some made from high density, single patient use foam, gel, and static and dynamic air. Static air overlays allow air to circulate through a number of chambers, whereas dynamic air mattresses have a pump, which creates cycles of inflation and deflation. The problems of using dynamic air mattresses intraoperatively relate to patient movement, which can be problematic for the surgeon.

Gel and high-density single patient use foam products help prevent shearing, support the patient and prevent 'bottoming out'. These devices can be used to protect the patient's bony prominences and are available to help position the patient's body and as operating table overlays. These pressure-redistributing products work by spreading the 'load' or weight of the patient over a larger surface area. Therefore, instead of pressure being concentrated on one small area, the force is dissipated across the foam and away from the patient, thereby reducing the interface pressure.

The flexibility of single patient use foam supports and the ease of manufacture also means that there is an abundant variety of devices available for every scenario.

In a study of 446 patients undergoing major elective surgery, Nixon et al (1998) found a decreased incidence of pressure ulceration in patients where single patient use foam mattress overlays were used on operating tables.

Skin assessment

Walton-Geer (2009) suggests that it is the responsibility of the perioperative nurse to examine the patient's skin prior to surgery, thereby establishing a baseline, which can be compared with the skin post-operatively. The skin should be checked for signs of redness, rashes, dermatitis, maceration and infection. Recording a score on the Waterlow chart may help to identify the risk status of the patient and allow preventative measures to be taken prior to surgery.

The National Institute for Health and Clinical Excellence's (NICE) pressure ulcer guideline states: 'All individuals undergoing surgery and assessed as being vulnerable to pressure ulcers should, as a minimum provision, be placed on either a high-specification single patient use

foam theatre mattress or other pressure-redistributing surface' (NICE, 2005).

It is essential, therefore, that all patients have their skin examined before, during and after surgery to prevent and to ensure early diagnosis of skin damage. It is also vital that any preoperative and postoperative skin changes are documented clearly and communicated to the continuing care clinician to ensure preventative management is seamless.

Nutrition

Nutritional deficit has been linked with the development of pressure ulceration in some studies, however, there is some debate in the literature regarding this Johnson (2007).

Allman et al (1995) conducted a prospective cohort study of pressure ulcer risk factors in a group of 286 patients and, using multivariate analysis, concluded that lymphopenia and decreased body weight were indicative of patients going on to develop an ulcer, and that hypoalbuminaemia, which is often used as a measure of malnutrition, was not an accurate predictor of pressure ulceration.

Anthony et al (2000) countered this and suggested that serum albumin is an accurate measure of malnourishment which should be included in risk assessment tools.

In another study of 501 patients, Ek et al (1991) found almost 30% of patients to be malnourished, with 35% of these patients developing pressure ulcers — compared with 20% of non-malnourished patients.

It is common sense that patients who are malnourished are at risk of skin damage and other systemic complications, therefore, it is the responsibility of all clinicians to ensure that these factors are addressed, prior to, during and after surgery. The implementation of the MUST (Malnutrition Universal Screening Tool) (Elia, 2003) is a major step forward in providing a visible and recordable score of nutritional status.

Hypothermia

Rogan (2007) reviewed a number of studies suggesting that perioperative hypothermia could contribute to pressure ulceration, however, due to methodological variability, the author could not make this conclusion with any degree of certainty. Perioperative hypothermia does, however, remain a significant risk with respect to surgical site infection, so should be prevented (McNeil, 1998).

CONCLUSION

Pressure ulcers are a significant risk for all patients undergoing surgery, due to the unpredictable nature and length of operations as well as the use of anaesthetic agents. Walton-Geer (2009) suggests classifying all patients who are 'at risk' of pressure ulcer development in order to ensure that appropriate preventative intervention methods are employed.

Assessing the patient's skin and carrying out a risk assessment (such as the Waterlow/Braden scores) should be routine components of the pre-operative preparation for the patient. Consideration of the duration of surgery and the positioning of the patient should also signal the potential for pressure-reducing equipment to be used.

When patients are being positioned for surgery, bony prominences should be protected with the use of high-density single patient use foam or gel pads, which can be shaped to body contours. Considerations should be made regarding reusable versus single patient use from an infection control and performance perspective.

Operating table mattress overlays should also be considered, especially for surgical procedures lasting over 2.5–3 hours.

Regular skin inspections should be carried out and, where possible, patients should be moved or repositioned to prevent pressure build up over at-risk areas.

It is also clear that strong leadership and a motivated multidisciplinary team can help to coordinate the approach to reducing pressure ulceration, as changing the mindset of clinicians may be the most important step in reducing pressure ulcer incidence (Whitlock, 2011). WUK

'It is vital that any preoperative and post-operative skin changes are documented clearly and communicated to the continuing care clinician'