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Original Citation

Eastburn, Sara, Ousey, Karen and Rippon, Mark G. (2015) A review of blisters caused by wound dressing components: can they impede post-operative rehabilitation and discharge? *International Journal of Orthopaedic and Trauma Nursing*. ISSN 1878-1241

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Abstract

This review highlights that some wound dressings can be the cause of blistering. It also presents the mechanisms by which blisters may be caused by poor choice of dressings. The subsequent impact of the blisters on preventing patient mobility - and hence rehabilitation in terms of physiotherapy – are also identified. The possibility that the clinical sequelae (e.g. delayed wound healing, restricted joint range of motion (ROM), muscle atrophy and increased risk of deep vein thrombosis (DVT)) resulting from this might have a significant and deleterious impact upon patient-related outcomes is discussed. Strategies for the treatment and prevention of blisters are proposed, based upon current knowledge and expertise. The criticality of the wound care specialist and the physiotherapist working together to overcome these challenges and enhance patient care, are underlined. This article is a review of the relevant literature combined with opinions based upon experience and knowledge of the authors.

Key words: Post-surgical blisters, Mobility, Physiotherapy, Rehabilitation, Wound Dressings

Introduction:

Using information sourced from a thorough literature review, this article aims to highlight the evidence which supports the hypothesis that the presence of blisters associated with a wound could significantly impact patient mobility (due to pain or fear of wound dehiscence) and delay the rehabilitation process, possibly leading to more severe clinical complications such as an increased risk of deep vein thrombosis (DVT).

Background:

Rehabilitation of patients with post-operative wounds, whether they be acute or chronic, is primarily incumbent upon a clinical team of nurses and physicians of which the physiotherapist is part. It is logical to assume that the treatment regimen of these patients will impact to a greater or lesser extent on patient rehabilitation. Specifically this will relate to any wound dressings used that might aid, or interfere with, the mobility of the patient. Of great importance is the presence of a clinical condition (allied to the wound) that might also interfere with early mobility, rehabilitation and discharge of the patient. In the experience of the authors one such condition that significantly impinges on these aspects is the presence of blisters. A blister is defined as a sacular skin vesicle filled with serous fluid, which separates the epidermis and/or dermis, and which may be linked to shearing forces caused by trauma, friction, burn, or a vesicatory agent (Segen's Medical Dictionary, 2012). Examples of blisters are shown in Figures 1 - 4. In patients who have undergone surgical procedures, blisters caused by wound dressings are common, painful, and may ultimately become infected (Ravenscroft *et al.*, 2006). The result of this might be that patient rehabilitation, mobilisation and ultimately discharge is delayed, leading to increasing associated costs. Additionally, there is a danger that the delayed mobilisation of the patient (required in some surgical procedures to occur within 24 hours of surgery) may also increase the risk of DVT (Pearse *et al.*, 2007).

The role of the physiotherapist and interaction with clinicians undertaking wound care is very important. Physiotherapy can play a vital role in the effectiveness of many surgical procedures (orthopaedic surgery especially) and, in some cases, can influence the outcome (Husted *et al.*, 2015). While the repair of damaged structures is accomplished during surgery, the rehabilitation process is

extremely important to ensure that healing is complete and that full function is recovered. As such, it is essential that the challenges of wound care and rehabilitation are understood across all disciplines, in order that the best possible care be provided.

Methods:

A literature review using MEDLINE (National Library of Medicine, Bethesda, MD, USA) was searched to identify systematic reviews and primary research relating to blisters in patients with acute (post-surgical) wounds. Google Scholar was also used as a search engine to find information of relevance to the following research questions:

1. Can wound dressings cause blisters and, if so, how?
2. What is the impact of the blisters on a patient's medical and surgical rehabilitation and quality of life?
3. What are the treatment / preventative strategies for blisters?

Search Terms: Surgical wounds, Incidence, Aetiology, Causes, Blisters, Mobility, Physiotherapy, Rehabilitation, Wound Dressings – no time limit was applied

The first step of the review process was to gather studies for possible inclusion in the database, using defined search strategies relating in the first instance to surgical wounds. Search terms were then selected for each identified term that was related to the objective eg Incidence, Aetiology, Causes, Blisters, Mobility, Physiotherapy, Rehabilitation, Wound Dressings – no time limit was applied. It must be noted that a fairly small (less than 40 core papers) were captured relating to the specific objectives of the review. However this was deemed sufficient to provide an adequate overview of the current thinking (with the experience and views of the authors) with regards to the impact of blisters on patients with surgical wounds and the potential clinical implications.

Can wound dressings cause blisters and, if so, how?

The incidence of skin blistering varies according to surgical specialty, and a number of authors have published differing results. For example, the incidence of blistering in patients with hip blisters in the United Kingdom has been estimated to be between 13 and 35% (Wright, 1994). An audit of blistering after hip surgery reported the incidence of tape-related injuries as 21.4% (Polatsch et al., 2004), whereas another study, involving the use of a variety of different dressings, reported the incidence of blistering as 13% (Jester *et al.*, 2000). In a prospective study of patients undergoing hip or knee surgery, the post-operative blistering rate ranged from 6% to 24%, depending on the dressing used (Cosker *et al.*, 2005). A prospective clinical audit of wound blistering undertaken on an orthopaedic unit in the United Kingdom took into account more than 1,000 hip and knee arthroplasties, and demonstrated a blister rate of 19.5% (Clarke *et al.*, 2009). This shows that skin blistering associated with wounds is highly variable and dependent upon a number of factors - not least the choice of dressing.

Three extrinsic factors may also contribute to the formation of dressing-related blisters. These are applied shear and frictional forces in conjunction with microclimate (moisture/humidity and

temperature), the latter of which makes the skin more fragile and hence susceptible to damage. These are discussed in more detail below (Gerhardt *et al.*, 2008).

Shear - When a wound dressing is applied to a patient, the adhesive component maintains a rigid cohesive force at the dressing-skin interface (epidermis). If horizontal movement of the dressing in relation to the skin occurs (e.g. when a patient moves), then the epidermis is held static and movement of sub-epidermal skin components such as the dermis causes mechanical separation at the epidermal-dermal junction, the gap then filling with fluid and forming a sub-epidermal bulla (blister) (Knapik *et al.*, 1995; Geerligs *et al.*, 2011; Guerra and Schwartz, 2012; Hatje *et al.*, 2015). Non-elasticity and poor flexibility of wound dressings have been implicated in the formation of blisters in this way (Jester *et al.*, 2000).

Friction - Friction blisters occur when there is contact, pressure and movement between the skin and something touching it. In this case, it might be that the dressing itself is not properly attached to the skin and is rubbing at the adhesive interface when the patient mobilises. This is especially true in patients with epidermolysis bullosa, who have extremely fragile skin (Lara-Corrales *et al.*, 2010).

Microclimate - Blisters also form more quickly if pressure and movement on the skin is severe or the skin is damp. This is because the presence of moisture (e.g. wound exudate, perspiration or urine) can increase friction forces and soften the skin, which weakens its outer layers (Gerhardt *et al.*, 2008; Johansson *et al.*, 2012; Ousey *et al.*, 2011).

Additionally, if the patient has fragile skin due to age or a pathological condition, they will be more susceptible to blister formation (Hafttek *et al.*, 2013). It has also been suggested that the creation of shear forces at the dermal-epidermal junction, in association with a decreased blood supply in the dermis, is one of the contributing factors to the development of post-operative blisters (Bhattacharyya *et al.*, 2005).

Postoperative peri-wound blistering is a well-recognised phenomenon in orthopaedic surgery (Lawrentschuk *et al.*, 2002; Ravenscroft *et al.*, 2006; Koval *et al.*, 2007; Tustanowski, 2009; Burke *et al.*, 2012). This is because wound dressings are applied over joints that move and cause dressing skin interactions that lead to shear and/or friction episodes and thus blister formation.(Tustanowski, 2009). To a lesser extent, blisters have also been identified in patients undergoing gynaecological surgery (Sanusi, 2011; Ousey *et al.*, 2011). Additionally, severe wound traction-blisters after inadequate dressing application following laparoscopic cholecystectomy have been identified (Sanusi, 2011).

What is the impact of blisters?

Post-surgical blisters are a considerable cause of morbidity following surgery. For example, blisters caused by tapes that are used to retain wound dressings have been identified as the causes of postoperative complications, including wound infection and prolonged length of hospital stay (Gupta *et al.*, 2002; Tustanowski, 2009; Ousey *et al.*, 2011; Sanusi, 2011). Blisters at dressing margins can also increase the risk of wound infection. Blisters are effectively a disruption to the integrity of the skin and, as such, may allow ingress of bacteria and cause infection. This is especially the case if the blister membrane (epidermis) is ruptured (Leal and Kirby, 2008). Thoughts are divided as to whether blisters should be maintained intact or burst (Dearden *et al.*, 2001; Murphy and Amblum, 2014), but blisters associated with wounds have been identified as the main cause for topical wound and skin

infections in patients undergoing amputation (Harker, 2006). Some research has identified that the main problems with surgical wounds following hip and knee surgery are blistering and infection, specifically if dressings are applied for a long period (Ravenscroft *et al.*, 2006).

Wound infection is a common surgical complication leading to significant mortality and morbidity (Al-Dabbagh and Dobson, 2013). Surgical site infections (SSIs) are the most common type of hospital-acquired infection for surgical patients in both the United Kingdom and United States (Wilson *et al.*, 2004; Lamagni *et al.*, 2015), occurring in about 10% and 38% of patients respectively. SSIs impair wound healing, prolong hospital stay, and cause unnecessary pain (Emmerson *et al.*, 1996). Importantly, they have been associated with increased use of medical resources and consequent increases in the cost of patient care, specifically hospitalisation and bed-usage (Herwaldt *et al.*, 2006). Despite this, most SSIs are caused by contamination of an incision with microorganisms from the patient's own body during surgery. Infection caused by microorganisms from an outside source following surgery is less common (Leaper *et al.*, 2008). The site of surgery, the incision depth, age of the patient, nutritional status and the presence of co-morbidities all influence whether patients might acquire an SSI (Olivier *et al.*, 2013). However, the presence of blisters around the incision site have also been identified as a potential site of entry for infectious agents (Jester *et al.*, 2000). In a recent review of the literature the post-operative dressing regimes after hip/knee arthroplasty were evaluated. Although no single treatment emerged as the ideal postoperative dressing regime for hip and knee arthroplasty wounds, it was identified that a selection of dressings could be recommended on the basis of reducing the incidence of postoperative blistering and wound infection (Collins, 2011).

Blister impact on patient rehabilitation and quality of life

Blisters are painful, whatever the cause (Ousey *et al.*, 2011; Gonzalez de la Guerra and González, 2013; Milne *et al.*, 2012). Research on friction blisters has identified that they can cause a range of unwanted complications ranging from minor pain to severe infections (Guerra and Schwartz, 2012). Pain from blisters is elicited via the normal inflammatory pathways with various mediators (e.g. prostaglandin E2, (PGE2), leukotriene B4 (LTB4), interleukin-1a (IL-1a), interleukin-6 (IL-6) and tumour necrosis factor-a (TNF-a) being released into the blister fluid (Reilly *et al.*, 2000). It is the view of the authors that additional complications occur in patients with post-surgical wounds who develop blisters when pain might be exacerbated by repeated application and removal of dressings. Also, there is a high risk of blister de-roofing and subsequent infection (Ravenscroft *et al.*, 2006). As a consequence of this pain, there might be a detrimental effect on postoperative physiotherapy and rehabilitation. This is mainly because the pain associated with the blisters reduces mobility (MacDonald, 1984) and, as a result, prevents or lessens the opportunity for rehabilitation and physiotherapy.

Early mobilisation of a patient after surgery is now an accepted part of physiotherapy and rehabilitation. This is because:

1. Patients who have had surgery on or around joints (e.g. knees, shoulders, ankles, fingers, hips) should be mobilised as soon as possible post-surgery in order to achieve the best outcomes in terms of joint ROM (Range of Motion), healing and patient well-being (Pearse *et al.*, 2007; Chandrasekaran *et al.*, 2009; Guerra *et al.*, 2014).

2. Surgical stress is the systemic response to surgical injury and is characterised by activation of the sympathetic nervous system, endocrine responses, as well as immunological and haematological changes (Desborough, 2000; Giannoudis *et al.*, 2006). The physiological impact of surgical stress is wide, and includes muscle atrophy (Bautmans *et al.*, 2014). Early mobilisation as part of a multimodal response of patient has also been claimed to prevent such atrophy of muscles (Lipshutz and Gropper, 2013).
3. It has been identified that a major complication arising from lack of mobility due to post-surgical trauma is an increased risk of DVT - for example, risk of DVT has been reported as ranging from 30 – 60% in patients undergoing total knee replacement (TKR) surgery (Pearse *et al.*, 2007). Indeed, Pearse *et al* suggest that the presence of painful and/or infected blisters might delay mobilisation of a patient after a surgical procedure (Pearse *et al.*, 2007).

As an example, NICE Guidelines (National Institute for Health Care and Excellence, 2014) for patients who have undergone surgery for hip fractures state that the hospital should:

1.7.1 Offer patients a physiotherapy assessment and, unless medically or surgically contraindicated, mobilisation on the day after surgery.

1.7.2 Offer patients mobilisation at least once a day and ensure regular physiotherapy review.

The effects of delayed mobilisation – or ambulation – on a post-surgical patient can have more profound effects than those limited to the musculoskeletal system in terms of ROM and muscle atrophy, and the vascular compromise of a DVT. The American Association for Respiratory Care (AARC) adds to accepted evidence that early ambulation is effective in reducing post-operative pulmonary complications (Strickland *et al.*, 2013). Silva *et al.*, (2013) state that high-risk patients, such as those undergoing high abdominal surgery, present with a greater need for more traditional pulmonary physiotherapy as a result of delayed mobility, augmenting the work of Haines *et al.*, (2013), who suggest that patients who do *not* mobilise early following abdominal surgery are three times more likely to develop pulmonary complications for each day that mobilisation is delayed.

These complications are more profound in the older population, who are already disadvantaged as a result of the normal ageing process. In addition to often being comparatively less mobile and with a reduced exercise tolerance compared to a younger counterpart, they frequently present with co-morbidities which themselves may impact on general functioning and activities of daily living. The lungs become less compliant with increasing age, and thus elderly patients present with a higher lung closing volume, physiologically. A higher lung closing volume, combined with imposed recumbency and general anaesthesia to facilitate a surgical procedure, predisposes such patients to small airway collapse (atelectasis), which can present as a significant complication postoperatively (Agostini and Singh, 2009). The likely impact of a pulmonary complication for the patient is an increase in hospital length of stay and poor quality of life, for the immediate post-operative period at least. At the same time, the associated costs for the hospital can be significant when bed occupancy, physiotherapy input and pharmacology alone are considered.

Thus anything that might interfere with early mobilisation of these patients (such as blisters at the incision site caused by dressings) could significantly affect health-related outcomes.

Treatment of blisters / preventative strategies

Discussions surrounding whether to burst blisters have not yet resulted in clear guidance for the practitioner. However, blisters that remain intact *do* still provide a barrier to bacterial ingress and so it would be reasonable to assume that, if at all possible, they should be unbroken. This is particularly important with blisters in close proximity to wounds. As such, they might be at higher risk of infection due to the presence of a higher level of bacterial bioburden within/adjacent to the wound margins (Ousey *et al.*, 2011).

Therefore, it is imperative that the choice of wound dressing addresses the clinical challenge of:

1. preventing formation of blisters in the first place
and
2. preventing damage to blisters should they be present.

Ousey *et al* (2011), in a review, identifies such dressings that meet these challenges. Some of the criteria for such dressings are outlined below:

- Level of adhesion – too much adhesion and damage will be caused; too little, and the dressing will not be retained.
- Isometric elasticity of the dressing, associated with flexibility, that allows the dressing to conform to wound/body contours.
- Dressing thickness – too thick and the dressing will not be in intimate contact with the wound nor adhere properly to the skin.
- Shape of wound site – wounds rarely come in regular sizes or shapes. Therefore, a range of dressing sizes must be provided in order to accommodate the variations seen.
- Quantity of exudate held within the dressing – generally, wound exudate is stratified into low, moderate and high. Dressings (or a range thereof) should be able to manage this across the board.
- Low friction – dressings are a barrier between the skin and external environment, and they may be in contact with surfaces (e.g. clothes, bed linen etc.) that cause friction. This might cause dressings to roll at edges, become dislodged or chafe flesh. Therefore, dressings with a low co-efficient of friction on the external components will ultimately cause less damage.

Conclusion

Blisters are prevalent in patients who have had surgical procedures. This is in part due to the pathology of the patient; and in part due to using inappropriate dressings that, if applied incorrectly, cause blister formation. Blisters impact heavily on the patient in a number of ways - but primarily by causing pain and discomfort, especially if they become infected, which would most probably delay discharge. The presence of blisters may also affect patient mobilisation, an important part of post-operative rehabilitation, which has been shown in some cases to reduce the incidence of DVT thirty-fold and lessen the likelihood of postoperative pulmonary complications in high-risk patients. The use of wound dressings that are proven to prevent blister formation is therefore highly recommended to avoid more serious and costly adverse event sequelae.

It is important that physiotherapists work closely with clinicians attending to post-operative wound care. This is so that not only are the optimum dressings used to enable healing and prevent further damage such as skin stripping and blistering, but also so that the challenges of postoperative rehabilitation and physiotherapy are taken into consideration.

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