Focus on: Aspects of Critical Care

Pressure sore prevention in the critically ill: what you don’t know, what you should know and why it’s important*

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The critically ill are particularly vulnerable to pressure sore development. These expensive and often painful complications have been largely ignored for many years and the entire problem has been managed by nursing staff. Current methods for identifying patients at risk are inadequate and subjective. Scoring systems have been known to over-predict those at risk and this maybe because they frequently originate from elderly care settings. Additionally, their relevance to the critically ill has not yet been established.

The use of pressure-relieving devices has become commonplace; however, there is a paucity of data from controlled clinical studies. No uniform approach in measuring the effectiveness of these devices exists. What is certain, though, is that a voluminous amount of work needs to be conducted in order to verify their continued use.

It is increasingly apparent that the complex nature of pressure sore development means that it is unrealistic to expect a single discipline to manage the problem effectively. A multidisciplinary team approach is the most appropriate way to improve management in this vital area.

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Introduction
Pressure sores are an expensive, common, painful and needless complication of critical illness. They are far from a new concept. Evidence of their existence can be traced back to the days of the Pharaohs when Egyptologists from the British Museum examined the embalmed body of the Priestess of Amen and discovered pressure sores on both the buttocks and shoulder (Thompson, 1961).

In more modern times, however, the problem of pressure sores has been exclusively left to nursing staff to manage with the medical profession maintaining a low profile save for a few pockets of activity in plastic surgery and elderly care. Concerns with this approach become apparent when the extent and severity of the problem is highlighted. For example, it has been estimated that the NHS spends £200 million per year on treating pressure sores alone and that 3 months worth of treatment for a severe pressure sore alone costs £40,000.
Up to 13% of patients develop pressure sores whilst on Intensive Care (Hunt, 1993) and the presence of a pressure sore has been associated with a two- to fourfold increased risk of death in elderly patients in the ICU (Thomas et al., 1996; Clough, 1994). Many authors (Clark, 1997; Young & Dobrzanski, 1992) have highlighted the need for studies to evaluate the effectiveness of pressure-redistributing devices in order to tackle the problem, but at present such studies are rare. These important concerns are but a mere fraction of the plethora of matters that emanate from such a vast subject, each one warranting serious attention from all those who are concerned and involved with patient care.

Risk factors
A pressure sore can be defined as an area of local tissue damage caused by pressure, shear or friction. Unsurprisingly, the primary cause of pressure sore development is pressure; therefore, the aim of pressure sore strategies is to reduce the magnitude and duration of pressure. Several factors have been put forward as to why some people are more at risk of developing them than others and these have been classified as factors that are either ‘extrinsic’ or ‘intrinsic’ in nature.

The main extrinsic factors are the forces of pressure, shear and friction. All have been identified as being great contributors to tissue damage in the critically ill mainly as a result of the varying degrees of immobility intensive care patients encounter. The method of damage caused by pressure seems fairly obvious in that pressure, exerted by the patient’s weight on a support surface, causes body tissue to become compressed against a bony prominence resulting in poor capillary perfusion. But attached to this is a rather odd historical footnote that work from the 1930s suggests the amount of pressure required to achieve capillary occlusion is 32 mmHg. This widely quoted figure originates from measurements taken at the fingertips, held level with the heart, of healthy young students. The problem with this is that the figure is of little relevance to those of critically ill patients who often have multiple pathologies. It is even more absurd when it is remembered that it is the application of pressure over time that is of concern and that the amount of pressure for capillary occlusion varies between individuals. In patients with hemiplegia for example, capillary occlusion has been found to occur at levels as low as 11 mmHg (Ek et al., 1987).

Friction usually occurs when two surfaces move across one another (Bridel, 1993), such as when a patient is lifted up the bed improperly. Friction is not directly thought to play a major part in the development of pressure sores but it does exacerbate the stripping of the epidermis if it is already damaged, or it can be the initial cause of damage when the forces of shear and pressure are present as well. Damp skin or surfaces raise the friction coefficient thereby increasing the effect. A recent addition that attempts to overcome frictional forces is the use of specially designed low-friction materials. These are usually sheets that are laid over a support surface. Due to the reduction in friction, however, they can often cause the patient to slide about unnecessarily resulting in the nursing staff having to frequently reposition the patient.

Shear is a horizontal force perpendicular to pressure and is usually the end result of a combination of friction and movement. A common example of this occurs when a patient is sitting upright in bed. At such a time, the shearing forces are greater on the sacral tissues then if the patient is lying flat, the skin is gripped by the sheet or support surface and if the patient, sheet or support surface is moved then this will cause the bony prominence to be wrenched across internal tissue. Shear increases pressure thereby causing a reduction in capillary blood flow. In the critically ill, the effects of shear demonstrate themselves most notably as a non-blanchable area of skin on the heel.

Intrinsic factors are those factors that can exacerbate the effects of pressure and are unique as they increase the individuals response to pressure sore formation. Unsurprisingly, there are a plethora of factors that fall into this category but amongst the most common are: general health, mobility, consciousness, bodyweight, nutrition and incontinence. An in-depth analysis of these and other similar factors is beyond the scope of this article but in relation to the critically ill,
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The intrinsic factors of anaemia, faecal incontinence, length of stay, APACHE II score and noradrenaline infusion have been found to be significant in a group of 286 critically ill adults (Theaker et al., 2000).

Pressure sore prevention involves identifying patients at risk, when they are at risk and the measures needed to reduce risk. Nursing staff often use scoring systems to predict risk, amongst the most common of which are the Braden (Bergstrom et al., 1987), Waterlow (1985) and Norton scoring systems (Norton et al., 1962). However, there are inherent problems with such scoring systems in that they are often adapted from other clinical areas, use supposed rather than proven risk factors and doubts have been expressed as to their usefulness to direct care as they have seldom been found to have high rates of reliability and validity (Edwards, 1996). Not only does this have cost implications, it also raises serious concerns about their continued usage. Although scoring systems must be used in conjunction with clinical judgement, this subjective approach assumes that all nurses possess the fundamental skills to determine and assess risk in a uniform manner. Therefore, assessment of risk is often made by nothing more than an educated guess and it is difficult to justify this current approach in such a vulnerable population. Reducing the risk of pressure sore development is both complex and multifactorial and it is therefore most effective when managed by the multidisciplinary team rather than one discipline alone.

Prevention

One method of pressure sore prevention within the intensive care unit worthy of mention, as it is one with the largest financial implications, is the use of pressure-relieving support surfaces. Currently, there are over 200 of these devices commercially available all claiming to relieve or reduce the forces that contribute towards pressure sore formation. A voluminous amount of data relating to support surfaces has therefore been generated over the years which practitioners have the thorny task of deciphering in order to assess the effectiveness and suitability of the support surface to be used. The function of a support surface is twofold, namely to redistribute pressure and provide a comfortable surface for the patient. Effectively, support surfaces that redistribute pressure fall into two categories, pressure-reducing and pressure-relieving.

Within the hospital setting, the most common pressure-reducing support surface is the humble foam mattress; it is made of lightweight polyurethane and has a honeycombed structure made up of polymeric struts and air. It works by maximising the skin’s contact area and reducing peak interface pressures; this is the result of the weight of the patient causing the mattress to deform around the patient’s body. Although designed to accommodate the full spectrum of patient shapes and sizes, such mattresses can lead to inadequate pressure relief in heavier patients as too much weight depresses the mattress to the extent that it rests on the bed frame beneath. This is commonly termed ‘bottoming out’. Foam mattresses are covered with materials that need to be both waterproof and fire retardant, but the presence of a cover prompts a phenomenon known as ‘hammocking’. This largely unreported effect is where the cover generates surface tension by acting like a bed sheet that is pulled tightly. This problem is, however, recognised within the industry and manufacturers attempt to address the problem by incorporating textiles into the cover that have elastic properties. One other form of pressure-reducing device is the low air-loss mattress, most of which are a series of cells beneath the patient that are inflated by an air pump. Most are portable and are either placed on an existing bed frame or, in some cases, placed on top of a standard foam mattress. Some low air-loss systems seek to maximize pressure reduction in the body’s more susceptible regions, such as the sacrum, by making the relevant area of cells have an even lower pressure. Others allow the operator to adjust the configuration of static pressure thereby keeping the interface pressure against the patient’s skin at a level below capillary occlusion. It must always be remembered that a completely deflated mattress with zero air pressure leads to a high tissue interface pressure.

Pressure-relieving devices on the other hand aim to remove pressure from specific
body areas and this is done by either one of two methods. Firstly, by suspending or raising vulnerable areas of the body by deflating mattress cells or by using sheepskins, which, much to the relief of many sheep, have largely been found to be ineffective (Defloor & Grypdonck, 2000). Secondly, the more common method is that of removing pressure periodically by the timed inflation and deflation of air-filled cells. Such devices are termed alternating pressure supports as they aim to prevent prolonged tissue ischaemia and any subsequent necrosis. Most of these are mattresses consisting of cells that are connected to a pump that periodically inflates and deflates the cells over a 5- to 10-minute cycle. In bygone days such appliances were relatively unreliable but this has largely been overcome by better pump design and improved materials (McLeod, 1987). Curiously though, one issue that has not been addressed, and one in which no national consensus exists, is the optimal time cycle. Although it has been suggested that an optimal time cycle in sleeping healthy volunteers should be at 5-minute intervals (Rithalia, 1991), no data exists that suggest that this is of any benefit to the critically ill. The time cycle and inflation pressures of the cells are of extreme importance as it can have tremendous impact on tissue interface pressures. Some mattresses have a pre-set programme of time cycle and inflation whereas others that are more sophisticated have special sensors that vary pressure according to the patient’s position, size and shape.

**Evidence**

In 1998, our ICU alone spent an impressive £66,358 on renting and buying pressure-relieving devices. Other areas of healthcare too have voiced unease about the costs of such devices (Bliss & Thomas, 1992), especially in relation to the evidence that justifies such expenditure. In intensive care, the lack of conclusive evidence is of particular concern. Questions remain about any potential problems they may cause either directly or indirectly as all too often nursing staff feel a false sense of security when placing a patient on a special mattress. It is possible to overlook other equally important procedures such as regular repositioning. Manufacturers often use sophisticated marketing strategies to sell these products and substantiate claims with poor quality evidence such as case reports on interface pressures (Krouskop & Garber, 1989) that may not be applicable. Moreover, data from studies conducted in other healthcare environments such as elderly care are often used as justification for the use in critical care environment. Controlled clinical trials are a useful way of assessing the value of pressure-relieving devices but in an interesting study by Young and Cotter (1990), it was concluded that some manufacturers are unaware that their products have been involved in controlled clinical trials. It has often been claimed that controlled clinical trials are difficult to undertake largely due to expense, measurement techniques and interpretation of results. If this reasoning is applied to pharmaceutical research, it soon becomes apparent that such statements are superficial. Modern pharmaceutical studies undergo a formidable amount of testing which includes postmarketing surveillance to monitor adverse effects. It is, of course, arguable that when it comes to pressure-relieving devices there is no need to be so stringent, but manufacturers increasingly describe and market their products as having therapeutic properties. If this is so then they must be examined with the same depth and rigour associated with the pharmaceutical industry. Not to do so is to confound the modern doctrine of evidence-based practice.

That there is a lack of controlled clinical trials in the intensive care environment is an issue by itself. Similar concerns are raised, however, when trying to measure a mattress’s ability to reduce tissue interface pressures. Tissue interface pressure has been defined as the force per unit area that acts perpendicularly between the body and the support surface (Panel for Prediction and Prevention of Pressure Ulcers in Adults, 1992). Most manufacturers, in their literature, support the use of their products by presenting results of studies that measure tissue interface pressure. Many of these tests are conducted using young, healthy volunteers able to tolerate test conditions, the relevance of this to the critically ill has yet to be established. What is interesting
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is to compare the literature of different manufacturers and note the remarkable differences in interface pressures reported. What, then, are the ways that tissue pressure can be measured, and what are the common pitfalls that surround them? The pressure applied on an area of skin from a patient’s body weight is called the contact pressure or interface pressure. This is distinct from the air pressure that is used to measure the pressure inside the air sacs of some mattresses. Some researchers have found that measuring tissue interface pressure can be done consistently and accurately whereas others have reported wide variations in results obtained using different measuring equipments. There are at present five ways in which tissue interface pressure can be measured.

1. **Pressure relief index**. This technique involves many hundreds of interface pressure measurements on vulnerable body sites such as the sacrum taken over time which are then entered into a computer. This procedure is only of benefit in analysing alternating systems and requires expensive computer equipment.

2. **Maximum and minimum pressure**. This technique is of little use in assessing alternating systems largely because it cannot take into account the time cycles of pressure. Frequently, it is only the maximum pressure that is reported.

3. **Tissue deformation index**. This approach is arguably a better way of assessing a support surface. It stems from the concept that rather than pressure sores being caused by high interface pressures, they develop as a result of unevenly distributed weight. It requires a large number of measurements, however, and complex calculations. Suitable transducers are not readily available.

4. **Pressure impulse**. This method is effectively the ‘area under the curve approach’. Again, it involves a complex calculation with the end result being measured in the rather unusual units of millimetres of mercury per hour. The relevance of this is difficult to interpret.

5. **Average pressure**. This technique has been used to compare different types of mattresses in the past but is unable to gauge the degree of pressure relief.

The mere existence of these processes highlights the fact that there is a lack of a uniform approach to measuring tissue interface pressure. They also clearly demonstrate the vast quantity of unresolved issues in assessing and comparing different types of support surface. Couple this with the lack of clinical trials and one might question why such a state of affairs exists.

**Conclusion**

If pressure sores are ever to be managed effectively, it is clear that a problem of such magnitude and complexity cannot be effectively addressed by any one discipline alone. The resources and influence of other disciplines are both necessary and mandatory. Therefore, medical practitioners involved in the management of the critically ill must ask themselves why it is that this extremely serious problem has been so underestimated. Critically ill patients are especially vulnerable to developing a whole host of complications and none should be ignored.

It is easy to see why support surfaces are both relied on and heavily utilised in intensive care. The major premise is that they reduce pressure. The minor premise is that pressure causes damage and it follows therefore that support surfaces reduce damage. The evidence that supports this conjecture has yet to be confirmed from controlled clinical studies. Quality data does exist but only in environments external to intensive care, the notion that such data are automatically applicable to the critically ill is difficult to substantiate in such a fragile population. It has been argued that controlled clinical studies of pressure-reducing devices are complex and difficult primarily because of the diverse amount of variables. Such arguments carry little weight as if the same were used to excuse pharmaceutical studies, the effect on patients would be catastrophic.

**MCQ’s**

1. Pressure sore scoring systems:
   (a) Use proven risk factors to identify risk—False. Available scoring systems...
all use supposed rather than proven risk factors.  
(b) Must be used in conjunction with clinical judgement—True. Such systems have been found to over-predict and clinical judgement is therefore mandatory.  
(c) Originate from the critical care environment—False. The systems are usually developed from elderly care environments and then adapted.  
(d) Have poor levels of reliability and validity—True. The reasons for this are primarily because people assess risk in different ways.  
(e) Are a useful tool to direct care—False. They must not be used to direct care solely, instead they need to be part of a decision that encompasses all factors.

2. A pressure-relieving mattress:  
(a) Is affected by hammocking—False. This usually affects pressure-reducing mattresses when a sheet is pulled tightly over the support surface.  
(b) Inflate and deflate cells to provide pressure relief of air—True. The cells periodically inflate and deflate to provide pressure relief.  
(c) Use time cycles that affect tissue interface pressures—True. But the optimal time cycle between inflation and deflation is unknown.  
(d) Aims to prevent prolonged tissue ischaemia—True. The deflation period aims to allow the skin area to be relieved of pressure and improve blood flow through the capillaries.  
(e) Is best assessed by the pressure relief index—True. This method assesses pressure over time and therefore does not solely focus on peak pressure.

References


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