# Moving patients safely

## Essential care for pressure ulcer prevention

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# Contents




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# Foreword

Patients who cannot change postures autonomously need to be repositioned to avoid pressure ulcers. This requires significant physical effort from caregivers, which sometimes leads to back pain and even the occurrence of orthopaedic injuries. To maintain the motivation of caregivers and protect them from back pain and injuries, the industry has developed equipment for repositioning, lifting and transfer, which ranges in levels of complexity—from simple sheets placed under a patient to manipulate postures, to hoists. The latter are used mostly to handle bariatric patients, when nurses cannot manually reposition or transfer the patient. Morbidly obese patients were identified in the epidemiological literature as being particularly vulnerable to deep tissue injuries. It has been demonstrated that the excessive body mass of inactive bariatric patients deforms soft tissues in weight-bearing areas to extents that endanger tissue viability. As the myth that obese patients are more protected from pressure ulcers 'because they have more padding' has now been completely discredited, and since repositioning and lifting equipment is mostly used for this population, it is important to carefully consider what the potential consequences of constantly leaving straps or sheets under the patient could be. The primary consideration should be that patients who need repositioning most often have fragile skin and subcutaneous tissues, and, as in the bariatric example, they are sensitive to sustained tissue deformations.

Localised sustained tissue deformations occur internally as a result of the interactions of rigid bony parts with overlying soft tissue structures. At or around the bone–soft tissue interface sites, cells and tissues are distorted so substantially already that any additional extent of localised deformations could push the tissues beyond their biological tolerance and initiate a deformation-inflicted injury cascade. Straps that are too thick and rigid; buckles; or even a strap or sheet that has thick sutures or contains bumpy parts may cause that extra bit of tissue deformation. Sometimes, a fold in a sheet under the patient is all that it takes to inflict serious tissue damage. Accordingly, only equipment that has been carefully designed and tested for the purpose of being left under the patient should be used. Moreover, such equipment should work adequately together with the support surface, that is, without compromising the efficacy of the support, since it is the combined structure of the support and overlying repositioning equipment which interacts with the body. This requires adaptability of the support, a key feature of good support surfaces. Furthermore, if the equipment is misplaced under the patient with the potential to cause localised tissue deformations, the support should be designed to take some of these deformations off and away from the tissues. Repositioning/

lifting equipment and support surfaces work together as one system. Their design should be coupled and tested in conjunction, which should be manifested in the instructions for use (i.e. which equipment should be used on which support surfaces). Moreover, the potential occurrence of accidents where the equipment is misplaced under the patient should be tested on the designated support surface. Finite element modelling is a powerful tool for such testing.

In summary, repositioning/lifting equipment that is left under the patient between repositioning events needs to be designed for that purpose. Equipment specifications must include recommendations of support surfaces that have the necessary adaptability to provide efficacy, while also mitigating the effects of adverse events of misplaced equipment, which has the potential to increase localised tissue deformations. We have developed a methodology for testing the potential effects of such adverse events based on finite element modeling, which can be translated from the current application of paediatric wound prevention into testing the interaction of repositioning/lifting equipment with support surfaces and a patient's body.

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# Movement: the key to pressure ulcer prevention

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## Abstract
Movement, be it spontaneous and independent or physically assisted by others, is the pivotal protective mechanism by which an individual avoids the risk of pressure ulcers. It follows that, if movement is crucial for prevention, then activity-based risk assessment alongside interventional pressure management should be at the heart of the care pathway for preventing pressure ulcers. Time is also crucial, so protective interventions should be triggered immediately if the patient cannot move. This is typically achieved through a strict repositioning regimen, heel floatation and the provision of a pressure-redistributing support surface.



### Key words
Pressure ulcer ■ Immobility ■ Repositioning ■ Musculo-skeletal disorder


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Figure 1: Category IV pressure ulcer

## The case for action

Pressure ulcers (*Figure 1*) are commonly encountered across all clinical settings, from intensive care to home care, and continue to represent a significant clinical and economic challenge for health-care providers (Dealey et al, 2012; National Institute for Health and Care Excellence (NICE), 2014). The NHS Safety Thermometer, which provides a standardised methodology for monitoring safety outcomes, has reported pressure ulcer data for a 13-month period, ending December 2014. During this period, a total of 2 700 397 patients were surveyed across both community and acute care settings (Clinical Audit Support Unit, Health and Social Care Information Centre, 2015). Of these, approximately 4.5% (monthly range 4.3%–4.7%) of patients were found to have one or more pressure ulcers, and just under a quarter of these were considered to be 'new' injuries—these are wounds that develop following admission to hospital or after referral to the primary care team. It can therefore be predicted that, unless the situation improves, some 123 000 patients may suffer this potentially avoidable injury in England each year.

Pressure ulcers are both distressing and painful. These wounds can have a prolonged impact on quality of life, leading to loss of independence, depression and social isolation. Physically, pressure ulcers may require many months of treatment and, at worst, can lead to significant, sometimes life-threatening sepsis and amputation. The financial cost can also be substantial, due to medical complications, increased length of stay and lost 'bed day' productivity (Dealey et al, 2012). The case for action is compelling but, at times, the sheer size and scope of prevention guidelines (National Pressure Ulcer Advisory Panel (NPUAP) et al, 2014) can seem overwhelming. Pressure ulcer risk is managed on the frontline in the daily tasks of moving, inspecting and assessing the patient, but the importance of movement in terms of prevention may be underestimated in clinical practice. The challenge of prioritisation might be simplified by taking a hierarchical approach to pressure ulcers, with movement, or lack of it, considered the principal risk factor. It then follows that pressure management through repositioning, above all else, should be the foundation of prevention (Phillips, 2014).

## Why movement is important in pressure ulcer pathology

Movement is critical for physical and psychosocial life. The very act of moving is not only a means of communication with the surrounding environment. It is, in essence, important for all aspects of tissue health: it is the primary mechanism by which individuals avoid the type of tissue damage associated with exposure to prolonged pressure. After a period of inertia, sensory stimuli triggered by changes within the tissue provoke a subconscious change of position, even during sleep. These changes, which may be as frequent as every 8 minutes, can be subtle, as even small postural adjustments can be sufficient to reperfuse the tissue (Reenalda et al, 2009). The frequency and degree of movement may be influenced by the surface on which we rest: for example, the harder the chair, the more people tend to fidget. When this protective mechanism is inhibited (for example, by illness, infirmity, trauma or medication), the pressure ulcer risk increases.

Movement is also an important consideration for many other bodily functions, but, uniquely, the relationship between pressure ulcers and pressure is absolute and interdependent. By definition, pressure ulcers cannot form without loading or pressure on the tissue (*Box 1*) and this is most typically associated with sitting or lying for an extended period while failing to redistribute pressure across the body (NPUAP et al, 2014). Similarly, a medical device that is in close contact with the skin (such as a cast, splint or cannula) will have a similar effect on the tissue if the pressure applied is of sufficient magnitude and duration.

### Box 1. Understanding pressure ulcers

**A pressure ulcer** is a localised injury to the skin and/or underlying tissue, usually over a bony prominence, resulting from **sustained pressure** (including pressure associated with shear).

A number of contributory or confounding factors are also associated with pressure ulcers, the primary of which is **impaired mobility**.

(NPUAP et al, 2014)

## Pressure, shear and time

The pathophysiology of pressure injury has two distinct but interrelated pathways (*Figure 2*). On one side there is the influence of intrinsic and extrinsic factors, which directly affect the physical response of muscle, fat and skin when exposed to external forces. This is commonly referred to as 'tissue tolerance'. Anatomical structure also impacts this pathway, with areas such as the bridge of the nose and back of the heel or head being particularly vulnerable to full-thickness ulceration, because of minimal tissue bulk between the epidermis and the bone. The second component is the physical exposure of the tissue to mechanical forces, which are defined by the duration, magnitude and direction of 'load' or 'pressure' (NPUAP et al, 2014) (*Figure 2*). In practice, applied pressure is typically non-uniform,

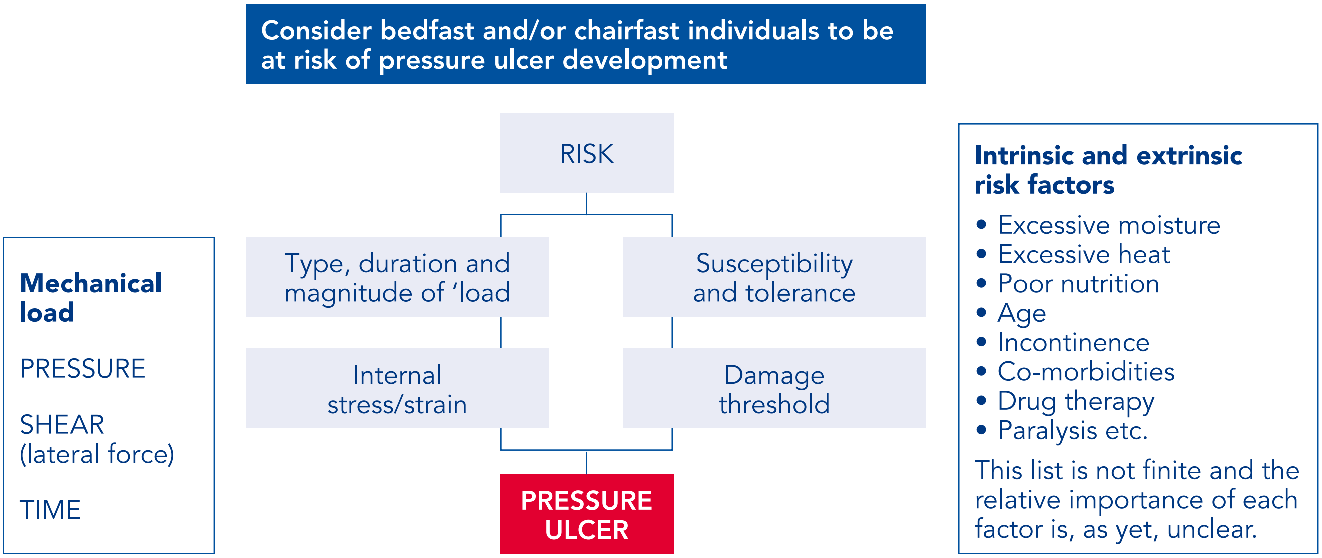


Figure 2: Conceptual model of pressure ulcer pathology (NPUAP et al, 2014)

causing additional deformation and strain (shear) within the skin and deeper tissue. In particular, posture can influence the degree of shear within the tissue, which is why a patient should be correctly supported to avoid sliding or slumping in the bed or chair. Tissue deformation results in distortion, further narrowing of blood vessels and, in extreme cases, disruption of the cytoskeleton (NPUAP et al, 2014). Morphology, mechanical properties and tissue tolerance can all change over time as a result of ageing, lifestyle, chronic injury or disease (NPUAP et al, 2014). For this reason, patients respond very differently to the same environmental conditions (Loerakker et al, 2011).

Time is also important and is inversely related to the amount of pressure applied. Tissue is generally able to tolerate a lower pressure for a longer period, although it is not possible to determine a 'safe' pressure for individual patients, as this will depend not only on the anatomical location but also on the patient's underlying condition. Where pressure is sustained and sufficient to occlude microcirculation, hypoxia and tissue ischaemia with irreversible cell damage can occur in as little as one to two hours (Gefen, 2008). The criticality of time is the main driver behind traditional repositioning protocols and has led to some practitioners considering acute susceptibility to pressure ulcers as a medical emergency (State Government Victoria, 2006).

### Tissue microclimate (environment)

In addition to vessel occlusion, both posture and pressure can provoke a rise in local skin temperature (Angelidis et al, 2009; Källman et al, 2013), increasing metabolic demand at a time when compression has reduced the supply of oxygenated blood (perfusion). A localised temperature increase of just 1°C has been shown to provoke a hyperaemic response similar to that seen with a pressure increment of 12–15 mmHg (Lachenbruch et al, 2013). Increasing temperature, whether local or systemic, is also likely to induce a sweat response, leaving the skin in a continually moist state. This can exacerbate pre-existing tissue vulnerability, particularly in older patients or those with long-standing conditions such as renal failure, diabetes and steroid-induced tissue frailty. In essence, prolonged wetness (maceration) can reduce the tensile strength of the skin, leaving it less able to withstand pressure and particularly prone to friction (Reger et al, 2010). While friction is not considered a cause of pressure ulcers *per se*, any damage to the integument will negatively affect tissue tolerance and increase the risk of infection.

## Movement: a question of screening

A systematic review of risk factors for pressure ulcer development (Coleman et al, 2013) supports the position of NPUAP et al (2014) in suggesting that mobility/activity, skin/pressure ulcer status and perfusion (including diabetes) are the primary predictive factors. All are directly related to exposure to pressure and the first two factors feature across the most common risk assessment tools.

However, in reality, there are times when a full risk assessment might be considered impractical or inappropriate—for example, in the emergency room, pre-admission unit or during the peri-operative period. These may be times when a patient's condition is changing rapidly or when their physical status is, at the time, uncertain. Unfortunately, when clinical priorities necessarily take precedence, risk assessment may be deferred beyond the 1–2 critical hours within which injury can occur in the most susceptible patients. It is, however, usually possible, and indeed prudent, to inspect the skin for early signs of damage during general examination and make a judgment as to whether the patient can move.

Given that mobility and activity limitations are considered a necessary condition for pressure ulcer development, without which a pressure ulcer will not occur (NPUAP et al, 2014), there is relative value in using *movement* as a screening tool. This approach is adopted for the Ramstadius tool (*Box 2*) (Ramstadius, 2000), which simply categorises patients into those who cannot physically reposition themselves (very high risk) and those who can. This method, based on clinical judgment, has been considered to be of similar predictive value to more complex risk assessment tools (Webster et al, 2011).

Once risk is established, a holistic assessment follows, with an individualised plan of care typically triggered by the overall

### Box 2

**Ramstadius tool: pre-screening question**

**Mobility assessment**

Does the person regularly reposition themselves **without assistance** every few minutes (including during sleep, when seated and people with sensation deficits e.g. peripheral neuropathy etc.)?

☐ **YES** Assessment complete, person **NOT** 'at risk'—no interventions required

☐ **NO** Person is identified as **AT VERY HIGH RISK** for pressure injury

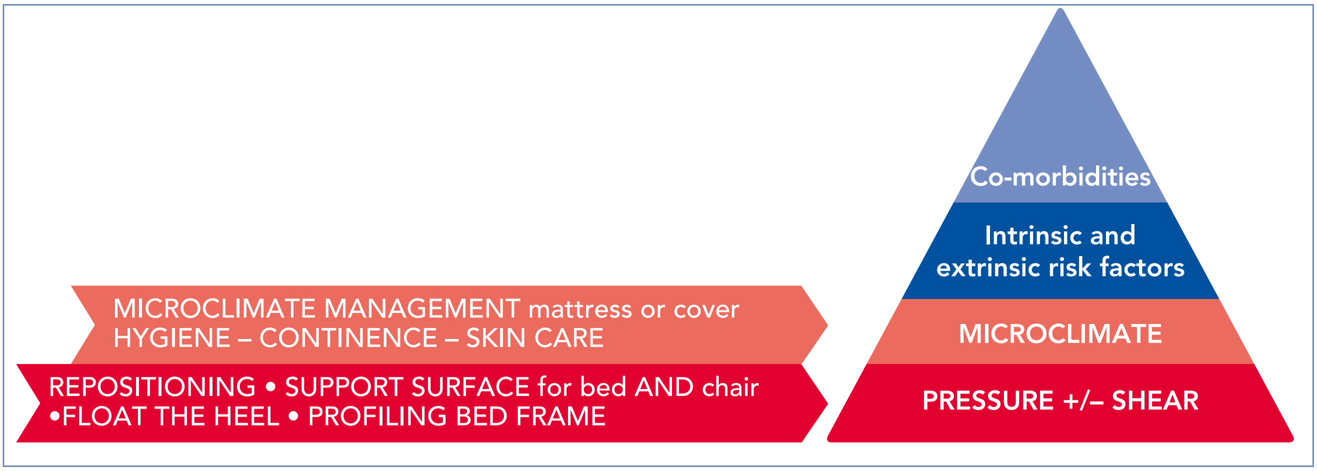


Figure 3: Prioritisation model for prevention

score. Nevertheless, a patient may have a cumulative score that suggests they are not at risk of pressure ulcers, but they may still have some areas of specific vulnerability. An alternative approach would be to target the sub-domains of risk assessment tools, such as the Braden score (Braden and Bergstrom, 1987)—essentially those areas dedicated to sensory perception and activity. This approach can protect patients who might otherwise be considered minimal risk (Gadd, 2014). In practice, if a patient cannot reliably detect discomfort (sensory perception = 3), they may not be stimulated to move. Similarly, they may 'spend the majority of each shift in their bed or chair' (activity = 3) (Braden and Bergstrom, 1987). In both instances, they are exposed to the primary cause of pressure ulcers: prolonged pressure. Scoring 3 or less in either of these categories, irrespective of overall score, is sufficient to warrant a preventative care plan. Although appearing simplistic, this approach provides a rapid assessment of whether the patient is able to detect the stimulus to move and has the strength, confidence and understanding to respond appropriately. To take risk assessment to its simplest conclusion, NPUAP et al (2014) define 'risk' as *any patient confined to a bed or chair*.

While the causal link between pressure and tissue injury is relatively straightforward, the reasons for immobility are much more complex. For example, impaired mobility can be attributed to normal ageing, physical infirmity or conditions and medications that inhibit sensory perception. Likewise, immobility may be caused by pain, anxiety or physical restraint (traction), which discourages or prohibits movement. In some cases, it is the lack of understanding regarding why repositioning is important that affects a patient's motivation to move, or they may simply exercise their right to refuse assistance. Information is key and it is important that both the patient and their family understand why pressure ulcers happen and how to prevent them. Whatever the origin, reduced mobility places the patient at immediate risk of pressure ulcers and addressing immobility represents the foundation of prevention (*Figure 3*).

It is also important to recognise the limitations of risk assessment. A systematic review (Moore and Cowman, 2014) failed to establish a direct correlation between the use of compound risk assessment tools and pressure ulcer prevention. Although there is undoubted value in using a structured risk assessment such as the Braden score (Braden and Bergstrom, 1987), it is the action that is taken after assessment that determines the outcome. Effective care delivery will involve a multidisciplinary team including nurses, therapists, the patient and their family.

## Repositioning for prevention

Fortunately, immobility and altered sensation (for example, sedated, unconscious or paralysed) are two of the easier risk factors to identify and can be mitigated with relative speed. The patient could simply be moved (repositioned) and/or the pressure beneath the patient redistributed by 'floating' the heels, for example. Ideally, both interventions should be adopted, with the frequency of repositioning governed by the patient's overall condition, skin response and type of support surface used (NPUAP et al, 2014). The act of repositioning reduces the duration and magnitude of pressure over bony prominences, enables reperfusion of the tissues before damage becomes irreversible and has the added advantage of allowing heat and moisture to dissipate from previously weight-bearing skin. In addition to repositioning, patients are generally provided with a pressure-redistributing support surface. The choice of surface will be determined by their overall condition, therapy goals and

## KEY POINTS

- Pressure ulcers occur when the tissue is exposed to prolonged pressure (with or without shear)
- Immobility and diminished sensation are principal contributory factors
- Any patient who is bed or chair-bound is at *risk* of pressure ulcers
- Movement is the natural protective mechanism, which protects the skin from pressure-related injury
- Repositioning and mobilisation can prevent negative health outcomes
- Caregivers need to be alert to deterioration in the patient's condition; risk can increase rapidly
- Caregivers must consider their own safety when repositioning patients

pressure ulcer status. McNichol et al (2015) propose using the Braden scale sub-domain of mobility/activity to direct the selection of the most appropriate support surface for both the prevention and treatment of pressure ulcers; other sub-domains, such as the need for moisture control, can narrow the selection further. These principles are not unique to the Braden scale and could be adapted for other risk assessment tools, which share similar assessment criteria.

In reality, some patients—such as those in pain, in traction, undergoing complex treatments or receiving end-of-life care—cannot tolerate frequent repositioning. Others may not have access to caregivers or may simply exercise a personal choice not to move. For patients who cannot be regularly repositioned, guidelines (NPUAP et al, 2014) recommend that they be nursed on a specialist 'active' (alternating) air mattress. These mattresses redistribute pressure beneath the patient several times each hour by inflating and deflating individual air cells (Phillips et al, 2012). However, it is worth noting that, irrespective of the support surface, all patients should be repositioned if possible. Contemporary opinion now supports gentle repositioning in even the sickest patient. Small, frequent posture adjustments can have a positive effect on tissue perfusion (Reenalda et al, 2009) and are recommended for patients in whom full repositioning may be contraindicated (McNichol et al, 2015). Similarly, slow, gentle rotation is now advocated for patients with severe cardiovascular or respiratory disorder. These are patients who might previously have been considered too unstable to move (Brindle et al, 2013).

Some patients, such as those receiving end-of-life care, cannot tolerate frequent repositioning

In addition to pressure ulcer prevention, movement contributes to comfort, hygiene and, importantly, functional ability (NPUAP et al, 2014). Physical deconditioning can occur rapidly during periods of inactivity (Bell, 2012) and limited mobility is an independent predictor of negative health outcomes, particularly in elderly hospitalised patients (Doherty-King et al, 2014). Best practice guidelines recommend that patients should progress to sitting and ambulation as rapidly as they are able to tolerate (NPUAP et al, 2014).

### Technique

It is important to use a good repositioning technique. This both limits the amount of friction to the epidermis, which is easily damaged (particularly where the patient has moist, friable or already damaged skin), while ensuring that the patient is moved in a comfortable, secure and dignified manner. When considering moving and handling equipment, it is important to ensure that any device that remains in situ beneath the patient has been specifically designed for retention (NPUAP et al, 2014) and does not create an adverse environment by interfering with the pressure-redistribution properties of the mattress or by retaining heat and moisture against the skin. The presence of seams, creases and fabric texture should also be taken into account when considering whether or not to leave a device in situ and weighed against the obvious benefit of convenience.

## Movement and the caregiver

It is evident that to protect immobile patients from pressure ulcers, they need to be regularly repositioned, and guidelines advocate an individualised regimen. However, in practice, this is typically ritualised at between six and twelve times per day and frequently requires multiple caregivers. This is labour intensive and costly (NICE, 2014), with 90% of preventative care expenditure being attributed to manpower resources (Dealey et al, 2012). Repositioning is also the single greatest risk factor for musculo-skeletal injuries in health professionals. McCoskey (2007) observed that 60% of risk is related to repositioning in bed, turning in bed, moving the patient to the head of the bed ('boosting') and transferring patients from bed to bed. It is important that members of the clinical team consider their own safety while taking care of their patients and use equipment, tools and training that can ensure safe practice.

## Conclusion

Pressure ulcers do not occur without exposure to sustained pressure and/or shear and the dominant contributory risk factor is immobility, irrespective of cause. Any patient who cannot (or will not) move (including patients with sensory deficit) will require timely pressure management. This can be simple repositioning and strategic use of flotation devices or pillows. When prescribing repositioning protocols, clinicians should be mindful of the speed at which tissue damage can occur and be sure to use safe patient handling techniques to protect themselves and their patients.

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# Using patient handling equipment to manage immobility in and around a bed

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## Abstract

Assisting people with physical limitations is a regular part of many care packages, both in hospitals and in community care. The understanding of safer techniques and a constantly developing range of equipment and environmental solutions has improved the implementation of safer handling solutions. A recent publication by National Pressure Ulcer Advisory Panel et al (2014) for pressure ulcer prevention and treatment has clarified the overlap between wound care and the provision and use of slide sheets. This article explores the process to be used when a slide sheet solution would be suitable for a person that spends a significant time in bed and may also require pressure ulcer prevention or treatment.

**Key words**

Patient handling ■ Wound care ■ Pressure ulcer

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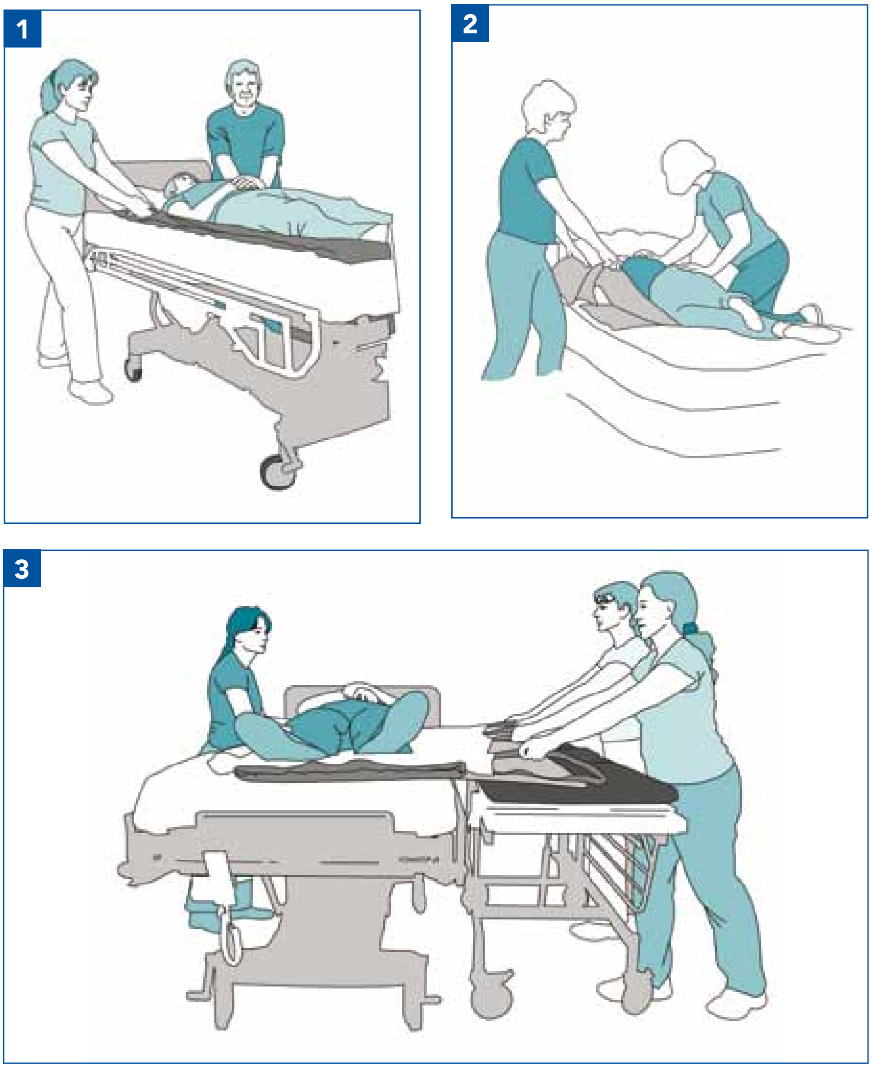
The need to assist people with limited capacity and reduced movement is well recognised in health care. There are few tasks in routine care that do not require some form of physical assistance, such as bathing, dressing, toileting, feeding, mobility support, etc. The level of exposure to these very frequent tasks has consistently been associated with the high prevalence of musculoskeletal disorders (MSD) in care workers (Stobbe et al, 1988; Garg and Owen, 1992; Smedley et al, 1995; Marras et al, 1999; Alamgir et al, 2007; Warming et al, 2009). Several systematic reviews reported evidence to support the introduction of the range of safe patient handling (SPH) intervention strategies (Hignett, 2003; Hignett et al, 2003; Dawson et al, 2007; Tuller et al, 2010; Martimo et al, 2008; Thomas and Thomas, 2014). Concerns about the cost of injuries to care workers and the loss of staff to the service are key drivers for the continuing development of specialised equipment for moving and handling people safely, in addition to maintaining the patient's comfort and dignity. Significant reductions in injuries, and other staff, patient, treatment and organisational benefits following the introduction of safe patient handling (SPH) programmes have been reported in several papers (Collins et al, 2004; Li Wolf and Evanoff, 2004; Nelson et al 2006; Garg and Kappellusch, 2012; Elnitsky et al, 2014; Theis and Finkelstein, 2014). Chhokar et al (2005) showed cost–benefit improvements after a 3-year follow up study primarily focused on provision of hoist equipment. Lim et al (2011) showed the reduction in repeat injury potential when following a suitable multifactorial intervention including training, equipment and organisational changes. Repestro et al (2013) and Fray and Hignett (2013) developed complex methods to evaluate the multifactorial patient handling interventions.

## Supporting mobility in and around a bed

This article focuses on patient handling activities that involve movement in the bed and their relationship with the prevention of pressure damage to the tissue of a patient with limited mobility. SPH activities to support movement across a bed surface, i.e. lateral movement across a bed, moving a person up the bed ('boosting'), moving from one surface to another surface ('lateral transfers'), turning and rolling.These are all common manoeuvres that could contribute to pressure ulcer risk factors with raised interface pressure, friction and shear (National Pressure Ulcer Advisory Panel (NPUAP) et al, 2014). The assistance of activity for patients in bed is necessary to reduce pressure ulcer risks by the alleviation and redistribution of pressure, changes to the circulation and the local microclimate at the point of contact with the bed.

Slide sheets can be used for SPH to reduce friction during horizontal transfer activities. The slide sheet system consists of two layers of low-friction material. As the patient is moved, one layer stays in contact with the supporting surface while the other stays in contact with the patient, allowing the friction interface to occur between the two layers and not at the skin surface. Most slide sheets in use at the time of publication are low friction on all surfaces, which allows for some movement at all interfaces and aims to avoid points of fixation. This may add to the shear component of the horizontal patient movement (e.g. hammocking). Friction-reducing slide sheets support more frequent repositioning movements for dependent patients, without higher risks of musculoskeletal disorders (MSDs) for the carers or increasing pressure ulcer risk.





Correct manual handling technique using slide sheets (Derbyshire Inter-Agency Group, 2011).

The MSD risks to carers from horizontal (lateral transfer) movements have been evaluated biomechanically. Several studies have measured the forces and postures demonstrated when moving a dependent patient without the use of SPH equipment (Skotte et al, 2002; Schibye et al, 2003; Theilmeier et al, 2010; Jordan et al, 2011). These have shown that carers are at significant risk of hazardous postures and high forces and that improvements can be seen by the correct use of slide sheets (McGill and Kavcic, 2005; Baptiste et al, 2006; Fray and Hignett, 2009; Fray and Loughborough Alumni Research Forum (LARF), 2012), though there is little published evidence of any improvements in pressure-care management (Enos, 2013; Kotowski et al, 2013). An alternative consideration for in-bed movement is the use of a hoist, which in some situations may be the preferred solution. Some patients may find the use of a hoist challenging and the successful selection, insertion and transfer with slide sheets may allow better engagement from the patient, with respect to dignity and comfort.

An important secondary consideration for the use of slide sheets is that the insertion and removal of the device is also a SPH activity, which may include further rolling, pulling or pushing of the patient. Methods have been developed for the insertion/removal of slide sheets to minimise patient movement (Derbyshire Inter-Agency Group, 2011; Smith et al, 2011). Two studies (Fray and Hignett, 2009; Fray and LARF, 2012) that evaluated carer actions for inserting or removing slide sheets based on a comprehensive task analysis reported benefits from leaving the slide sheet underneath the patient. Benefits were also suggested for comfort and security of the patient when the device was left in situ.

## Safe systems of work

Many years of evaluation of SPH techniques has developed detailed information and international consensus on best practice (ISO/TR12296, 2012). Clear guidance is available for using slide sheets

### Box 1. Important considerations for selection and use of a slide sheet

The evidence for improvements in care is mostly supported by the implementation of comprehensive multifactorial SPH programmes. These programmes suggest that solutions must include organisational commitment, management procedures and systems, a comprehensive risk assessment process, the provision of suitable physical environments with the correct level of equipment and training in both methods and equipment use.

(Smith, 2011; Derbyshire Inter-Agency Group, 2011; ISO/TR12296, 2012; American Nurses' Association, 2013; Gallagher, 2013; Hignett et al, 2014).

in line with current best practice for rolling, turning, lateral transfers and horizontal movements in bed (Derbyshire Inter-Agency Group, 2011; Smith et al, 2011). The key issues for consideration are in *Box 1*.

- Use a high-quality product with proven friction reduction properties
- Ensure the slide sheet remains flat underneath the patient, without creases
- Avoid leaving the thicker edges/ handles of the slide sheet under the patient
- Follow single-patient-use equipment (slide sheet) protocols to avoid cross-infection issues
- Use the correct size of slide sheet to facilitate a successful SPH transfer
- Ensure no part of the patient is in contact with the bed surface
- Conduct the sliding manoeuvre in a smooth co-ordinated manner
- Regularly check the slide sheet as laundering may reduce effectiveness (friction properties)
- Use slide sheets in conjunction with electric profiling beds to minimise repositioning activities.

As with all complex systems, staff and carers may not follow the processes as defined in best practice (Swain et al, 2003; Cornish and Jones, 2010). Therefore, training, instruction and supervision in the workplace are required to improve compliance. The barriers to 'best practice' have been investigated (Koppelaar et al, 2009; Koppelaar et al, 2013) and possible solutions (Schoenfisch et al, 2011) have been suggested. Some of the key barriers to best practice are linked to the resources, e.g. in complex cases with larger (plus size) patients there is a requirement for higher numbers of carers; equipment to assist the transfer needs to be available in the proximity of the transfer; and slide sheets should be provided for individual patients and laundered between patients.

Though there may have been some previous conflicts between the SPH and pressure care management, both are component parts in the drive towards high-quality care in hospital and community care provision. Both have a clear focus on the individual patient, ensuring that they come to no harm and have the best opportunity for improvement. The delivery of safe and effective care can only be supported if the staff are comfortable, safe and confident when they are caring for their patients (*Box 2*).

## Collaborative approach

The opportunities for collaborative solutions to manage both patient mobility and longer-term maintenance of pressure ulcer management are indicated by: the growing requirement for pressure ulcer patients to be managed in the community (Eurostat, 2013) owing to the ageing population, the additional requirements to protect informal carers (Hiel et al, 2015) and the trend for retaining older nurses (Fitzgerald, 2007).

The recent changes to the pressure care guidance (NPUAP et al, 2014) have reinforced the need for more collaboration between SPH practitioners and tissue viability nurses. There is a balance between selecting the correct pressure-relieving surface, and the management of a person on that surface. Additional improvements can be offered by the correct use of equipment for assistance in everyday care tasks to give a further opportunity to improve care delivery. The development of a combined solution with pressure care and SPH is seen every day in hospital and community care. The alignment of the guidance should develop a clear signpost for research to evaluate the combination of these alternative approaches to better understand the collaborative effects.

None of the individual issues reported in this article remove the requirement for a comprehensive risk assessment that includes the physical condition, health status, associated risk factors, the environmental considerations and the mobility level of the patient. The professional judgment of both the SPH practitioner and the pressure-care nurse can enhance the co-delivery of a single suitable

### Box 2. Key relevant guidance from a safe patient handling perspective

The risks of moving the full body weight of a dependent patient are well recognised. For horizontal transfers and many in-bed movements, the provision of a friction-reducing slide sheet may be a sound solution for reducing physical effort and improving patient comfort. The risk assessment for patient handling and the risk assessments for the prevention and management of pressure ulcers need to work in combination to deliver the best outcome for the patient.

care package that allows best return on investment for pressure relief management and treatment, comfort and dignity by safe and comfortable carers.

The recent changes to pressure care guidance have reinforced the need for more collaboration between SPH practitioners and tissue viability nurses

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## KEY POINTS

- A more co-ordinated, collaborative approach between safe patient handling and pressure care management is required
- If there is easy access to slide sheets carers are more likely to use them and less likely to take unnecessary risks
- If carers understand the risks and benefits of using slide sheets they are more likely to seek a safe solution
- Using slide sheet devices for in bed movements has benefits not only for safety, but also for the patients' comfort, security and dignity
- The recognised benefits of improved patient movement have to be compatible with pressure reducing therapies and treatment goals

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# Selecting an 'in situ' lifting device: what do we need to know?

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## Abstract

For many years it has been generally accepted that the introduction of bed linen and other devices such as transfer sheets is likely to degrade the ability of a support surface to manage mechanical loading upon the body and to prevent maceration and local heating of the skin. Recent guidance removed a prohibition on the use of transfer sheets left under the patient while in bed to allow specifically designed sheets to be left in situ. This article reviews the evidence that bed linen and transfer sheets may be detrimental to support surface performance and reports on laboratory tests of microclimate control and load management to illustrate the safe use of a new transfer sheet, the Maxi Transfer Sheet MTS (ArjoHuntleigh, Sweden).

**Key words**

Transfer devices ■ Horizontal transfers ■ Microclimate ■ Load management ■ Pressure ulcers

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The use of support surfaces (in bed and while seated) to redistribute both pressure and shear from anatomical landmarks prone to pressure injury is a key element of pressure ulcer prevention (National Pressure Ulcer Advisory Panel (NPUAP) et al, 2014). In recent years the impact of support surfaces upon the microclimate (temperature and moisture) at the skin surface has also been recognised as a factor implicated in helping to prevent pressure injuries (Wounds International, 2010). However, the management of pressure, shear and microclimate can be diminished where other materials are introduced between the skin and the support surface. These 'foreign' materials include the support surface cover itself, bed sheets to provide warmth and comfort, under-pads to cope with incontinence and transfer devices used to assist patient repositioning. In addition to 'foreign' material wrinkles, creases and seams in bed linen can also pose challenges for tissue viability, creating local points of high tissue loading.

## A brief history of best practice

Around 30 years ago, the prime concern in managing support-surface use with bed sheets was the disconnection of connectors between active therapy surfaces and their pumps through the tight tucking of sheets under the support surface (Hibbs, 1988). By the early 1990s, awareness had grown of the harmful effects of using tight mattress covers applied to the skin. Clark and Andrews (1991) reported the change in interface pressure at the sacrum of six healthy volunteers when resting upon a foam mattress with a loose or tight cover. Where the mattress cover was loose, interface pressures averaged 18.3 mmHg (standard deviation (SD) 5.1 mmHg), whereas a tight mattress cover increased interface pressure to a mean of 24.8 mmHg (SD 2.9 mmHg). The effect of tight support surface covers has become known as the 'hammock' effect, with the effect intensified both as the tension in the cover increases and the degree of curvature of the bony prominences becomes greater (Iizaka et al, 2009). Ever since the hammock effect was first described (Denne, 1981), there has been considerable debate over the clinical significance of the hammock effect (Denne, 1981; Crawford et al, 2006; Morita et al, 2012), with investigators unable to show increased interface pressures when seated upon seat cushions with and without covers, although skin changes indicative of early pressure damage were observed where cover materials were changed to a less elastic cover (Morita et al, 2012). An *in vitro* model (Iizaka et al, 2009) of artificial buttocks and the limited clinical data (Morita er al, 2012) indicate that the hammock effect changes the performance of a support surface. However, this change may be challenging to define using interface pressure measurements given that the pressure sensors may give rise to a hammock effect themselves, confounding the data the sensors report (Iizaka et al, 2009).

It is not only the hammock effect of support surface covers and tightly tucked bed sheets that can reduce the performance of a


Figure 1. The Maxi Transfer™ Sheet: a replacement bed sheet with integrated lift facility.

support surface. Williamson et al (2013) reported reductions in the ability of a low-air-loss support surface to dissipate heat and remove moisture when a variety of bed linens were introduced between a heated test object and the support surface. Where plastic-backed under-pads were used, the dissipation of heat and evaporation of moisture were reduced. In the most challenging scenario—nine layers of material between the test object and the mattress—the ability of the low-air-loss surface to manage microclimate factors was effectively removed.

The observation that sheets, covers (and other devices left upon the support surface) could reduce the effectiveness of a support surface was reinforced in the 2014 international pressure ulcer guidelines (NPUAP et al, 2014) recommendation that clinicians should 'limit the amount of linen and pads placed on the bed'. However between the first (NPUAP and European Pressure Ulcer Advisory Panel (EPUAP), 2009) and second (NPUAP et al, 2014) editions of the international pressure ulcer guidelines, one change occurred that was contrary to the opinion that bed linen left under the patient could affect the ability of a support surface both to redistribute pressure and shear and manage microclimate factors. In 2009, the first edition stated that transfer devices should never be left under patients, whereas, 5 years later, the recommendation was changed to read 'do not leave moving and handling equipment under the individual after use, unless the equipment is specifically designed for this purpose'. This article considers why such a change in recommendations could arise, and how a specifically designed transfer sheet could be demonstrated to have no deleterious effects on support surface performance.

## What makes a transfer sheet safe to leave under a patient?

There are no specific criteria that have become generally accepted to determine whether a transfer sheet is safe to leave under a patient. However, general recommendations can be taken from the literature regarding the effects of bed linen and other devices that are left between the patient and the support surface. The transfer sheet should be conformable with both the mattress surface and patient body to prevent any reductions in immersion and envelopment while reducing any hammock effect. A suitable transfer sheet should not have a plastic backing (Williamson et al, 2013), prominent seams over its surface, nor should it be of a thickness likely to reduce immersion and envelopment or reduce the timed application and removal of loading by active therapy surfaces. A suitable transfer sheet should not block the removal of heat and evaporation of moisture from the skin while being strong enough to be used to help reposition patients. In essence, a suitable transfer sheet should behave in a similar manner to a simple cotton bed sheet, with the additional attribute of being stronger to allow it to be used within the repositioning of patients.

## Evaluating a transfer sheet to demonstrate safety when left under a patient

There are three main approaches that can be followed to investigate whether a specific transfer sheet is safe to leave under a patient. The first approach, in vitro, is to characterise the likely impact of the sheet upon microclimate factors such as heat and moisture. To illustrate these processes, data generated through the use of one transfer device will be used. This device is the Maxi Transfer Sheet (MTS) (ArjoHuntleigh, Sweden)—a single layer consisting of 99% woven polyester with a 1% carbon core. The MTS is intended to replace conventional bed sheets remaining beneath the patient while not in use. The MTS provides both comfort to the patient and the strength required when used as a lifting sling to assist horizontal transfers and repositioning (*Figure 1*).

In 2013 three parameters—water vapour resistance, thermal resistance and liquid wicking

## Table 1. Comparison of heat dissipation and reduction of moisture retention upon both a cotton sheet and an advanced transfer device.

| | **Water vapour resistance $m^2Pa/W$** SS-EN 31 092:1994/ ISO 11 092: 1993 | **Thermal resistance $m^2$ K/W** SS-EN 31 092:1994/ ISO 11 092: 1993 | **Liquid wicking rate Capillary rise in 60 seconds (warp)** ISO 9073-6: 2003 |
|---|---|---|---|
| Cotton sheet | 3.45 | 0.0200 | 36mm |
| Maxi Transfer Sheet (*polyester 99%/carbon core 1%*) | 2.38 | 0.0096 | 53mm |

Reproduced from Clark et al (unpublished)

## Table 2. Proportion of the time the interface pressures measured at the 'sacrum' of the loaded mannequin, while resting upon an active (alternating) mattress, were below 30mmHg: mattress uncovered or covered with different bed sheet materials.

| **Proportion (%) of time interface pressure was below selected pressure thresholds** | **No sheet** | | | **Cotton sheet** | | | **MTS** | | |
|---|---|---|---|---|---|---|---|---|---|
| Test run | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| ≤30mmHg | 54.2 | 91.1* | 53.7 | 53.3 | 49.4 | 55.3 | 100 | 100 | 74.2 |
| 20 to 30 mmHg | 7.3 | 42.0 | 20.8 | 15.5 | 12.7 | 14.2 | 48.6 | 41.8 | 38.5 |
| 10–19 mmHg | 13.9 | 15.7 | 14.2 | 29.5 | 18.3 | 11.5 | 26.4 | 41.2 | 29.2 |
| <10mmHg | 33.0 | 33.4 | 18.7 | 8.3 | 18.3 | 29.6 | 25.0 | 17.0 | 6.5 |

* Pressure sensor may have been slightly displaced from the apex of the inflatable cell under the 'sacrum' of the loaded mannequin

Reproduced from Clark et al (unpublished)

## Table 3. Mean and standard deviation Pindex measurements performed with different sheet materials positioned between the mannequin and a powered and non-powered reactive bed surface.

| | **Foam mattress** | | | **Low-air-loss bed** | | |
|---|---|---|---|---|---|---|
| | **Fitted sheet** | **Loose sheet** | **MTS** | **Fitted sheet** | **Loose sheet** | **MTS** |
| Mean | 32.25 | 31.08 | 29.69 | 30.26 | 29.26 | 27.30 |
| Standard deviation | 0.78 | 0.99 | 1.34 | 1.11 | 1.03 | 1.58 |

Reproduced from Clark et al (unpublished)

rate, each related to microclimate control—were measured (Swerea IVF AB) on the MTS and compared with similar data generated using a 100% cotton bed sheet (Clark et al, unpublished). *Table 1* provides details of the specific tests performed with the results, suggesting that the MTS would provide better microclimate control than the cotton sheet given that it has greater breathability, reduced retention of heat and quicker movement of fluid through the MTS compared with the cotton sheet.

The full impact of leaving a transfer sheet between the patient and their support surface would best be explored within well-designed clinical studies with pressure ulcer incidence as the primary objective. However, the great heterogeneity between patients vulnerable to pressure damage would require large numbers of subjects to be recruited to ensure confidence in the data generated and its interpretation. Accordingly, interface pressure measurements performed with and without the transfer sheet being positioned between a test object and the support surface are one set of surrogate outcomes that could be used to assess whether a transfer sheet degrades the load management performance of a support surface. A full-size anatomical mannequin that provides interface pressure data comparable with those recorded from human subjects resting upon the same support surface has been described and used to assess the impact of placing the MTS transfer sheet between active and reactive support surfaces (Clark et al, unpublished). *Tables 2 and 3* illustrate the changes in interface pressure that occurred with and without the MTS sheet between the mannequin and support surfaces.

Considering first active support surfaces, the introduction of either a cotton sheet or the MTS did not appear to reduce the ability of the support surface to allow periods of low mechanical loading upon the sacral area of the mannequin. In fact, considerably more of the measurement period (30 minutes) saw pressures below 30 mmHg applied to the mannequin's sacrum where the MTS was placed between the mannequin and active support surface. Superficially, this result appears to indicate that the performance of the support surface was enhanced through use of the MTS transfer sheet. Interestingly, other authors (Mellson and Richardson, 2012) have also shown improvements in the interface pressures exerted by chairs and cushions where transfer devices were left between subjects and their seats. Upon the reactive surface, the mean interface pressure across all measurement sensors that registered at least 10 mmHg was lower where the MTS sheet was placed between the mannequin and support surface, suggesting improved envelopment and immersion where the transfer device was used instead of loose or fitted bed sheets.

## Conclusion

Clinicians have been concerned for many years that the introduction of multiple layers of bed linen may reduce the ability of a support surface to manage both mechanical loading and microclimate factors. Such concerns appear well founded in specific studies such as Williamson et al (2013), where microclimate control was reduced and effectively eliminated where up to nine layers of bed linen were interposed between a heated test object designed to mimic human sweating and a low-air-loss bed. Impairments in a support surface's ability to manage mechanical loading is considered to occur as a 'hammock' effect dependent on the tension in the material upon the support surface and the geometry of the skeleton at specific anatomical landmarks. This effect has been challenging to quantify using interface pressure measurements, with limited clinical data available to show skin changes with tighter fitting seat cushions. While it would appear prudent to limit the amount of extra bed linen where pressure ulcer prevention involves the use of pressure-redistributing surfaces, there is perhaps no requirement to absolutely forbid the leaving of transfer sheets between the patient and the support. Such guidance would only hold true where transfer devices do not reduce the impact of the support surface on microclimate or load management. The MTS considered in this report did not reduce favourable microclimate management and appeared to improve the performance of both active and reactive support surfaces. This last point deserves further investigation in order to explore why improvements may arise, or whether these artefacts arose through interface pressure measurement with specific sensor technologies. Regardless of this interesting observation, it would appear that the MTS could be left safely between patients and their support surfaces. This conclusion needs to be validated through clinical study of any changes in skin condition where the MTS is left in place.

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# Evaluation of a novel bed sheet used to reposition and transfer patients in an intensive care unit

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## Abstract

The Maxi Transfer Sheet (MTS) (ArjoHuntleigh, Sweden) is intended to reduce pressure ulcer risk for patients and musculoskeletal disorders for nurses. The MTS can be used to undertake a range of transfers and repositioning activities. Forces during these activities were measured and the frequency registered for 24 hours during use on an intensive care unit. A significant reduction in physical load for nurses was found in favour of the device in comparison with slings, sliding sheets and manual transfers. This was partly due to lower biomechanical forces and partly due to the fact that some activities were eliminated as the sheet can stay under the patient. The implications for patient pressure ulcer risk are discussed but more research is needed to assess this in detail.

**Key words**

Ergonomics ■ Occupational back pain ■ Transfer aids ■ Nurses

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One of the primary risk factors associated with pressure ulcers is immobility (National Pressure Ulcer Advisory Panel (NPUAP) et al, 2014). In spite of the evidence supporting this, it is a daily challenge to maintain and increase patient mobility and reduce the risk of physical decline. Where patients are fully dependent, such as in intensive care, the challenge is to reposition them frequently. This typically requires several clinical staff at two- to four-hourly intervals; it is labour-intensive and physically strenuous for nursing staff.

The process of repositioning, although of general benefit to the patient, exposes the caregiver to an increased risk of musculoskeletal disorders (MSD). These patient transfers rank among the top 10 of most strenuous transfers, with a high risk of developing occupational back, neck and shoulder pain (Knibbe and Friele, 1999; Hignett et al, 2003; Jansen et al, 2004; Koppelaar et al, 2011; Knibbe et al, 2015).

Repositioning can also cause pain and distress to the patient if not conducted with skill, care and dignity and may provoke adverse cardiovascular events in critically ill patients, especially when movements are rapid or extreme (Brindle et al, 2013). Although repositioning can protect the skin from the detrimental effects of prolonged pressure, a poor technique to reposition the patient can further damage the skin. For example, when the skin is moist, as in the case of incontinence, sweating, burn injuries or the use of certain types of medication, it is prone to friction damage (Reger et al, 2010), particularly if the patient is dragged rather than lifted. A less optimal technique may also increase the risk of shear occurring in the deeper tissue as deeper tissue layers and the bony skeleton move parallel to the skin. Gefen et al (2013) state that these shearing forces are believed to contribute substantially to the risk of deep tissue injury (DTI) and may result in complicated pressure ulcers, while this 'deformation change' can occur very quickly and possibly within minutes (Oomens et al, 2014). These factors contribute to the occurrence of pressure ulcers and have direct relevance to repositioning and transfer techniques.

## Using repositioning aids

To reduce the risk of injury to both patients and staff, clinicians may use a combination of aids to implement frequent repositioning. This may include: using the postural functions of the bed itself, dynamic or static mattresses to provide optimal supporting surface, redistribute pressure and increase support areas and using transfer aids beneath the patient such as lifter (hoist) slings and sliding sheets. From the pressure ulcer perspective, the objective is to lift the patient free of the mattress and avoid sliding the patient. However, this is physically demanding, is usually performed with several nurses (three is not uncommon) and, even where a sling or slide sheet is used, it still has to be inserted and removed from beneath the patient, which requires time and effort in itself and may cause extra shear and friction in and under the skin of the patient (Knibbe et al, 2012; 2014a;b). Indeed the latest pressure ulcer guidelines (NPUAP et al, 2014) explicitly recommend that the sling be removed from beneath the patient, 'unless the equipment is specifically designed for this purpose', which is not always the case.

## A clinical dilemma

On the one hand, therefore, lifting is recommended over sliding, to reduce the risk of tissue damage; on the other hand, from an ergonomic point of view, lifting should be avoided and sliding is recommended, to prevent occupational back pain in nurses. This can be seen as a very undesirable contradiction, especially for nurses in daily practice: do you choose to care for your patient or do you choose to look after your own health? Most nurses tend to give priority to the wellbeing of the patient, but there is also a responsibility and obligation to protect our clinical staff in order for them to be able to provide care in the future. So there is an urgent need to look into techniques and equipment that balance pressure ulcer prevention and occupational health for nurses.

In the Netherlands, this has led to a fundamental redesign of some common techniques for the use of profiling bed, slides, slings and lifters (hoists) and as much care is taken to protect staff from ergonomic risk (Hignett et al, 2014) as is taken to protect the patient (Knibbe, 2013).

## A novel repositioning device

To try to reconcile pressure ulcer prevention and ergonomic safety, a new repositioning device, Maxi Transfer Sheet (ArjoHuntleigh, Sweden), was developed with the high-dependency patient in mind. This soft, flexible manual-handling sheet consists of a breathable woven polyester fabric (99%) for comfort and a carbon thread (1%) for strength. The Maxi Transfer Sheet (MTS) is designed to replace the standard hospital bed sheet and so remain in situ beneath the patient; the full specification of this device is reported elsewhere (Clark, 2015).



The manual handling sheet consists of a breathable woven polyester fabric with a carbon thread for strength

The MTS can be used with a ceiling or floor-lifter (hoist) to undertake a wide range of transfers, such as from stretcher to bed or wheelchair, repositioning on the bed, placing X-ray cassettes under a patient, weighing a patient etc. The expectation is that this permanently accessible sheet eliminates the effort of placing and removing the repositioning device, thereby saving time and reducing the ergonomic risk to the staff and at the same time reducing undesired friction and shear forces for the patient.

## Aim

To evaluate the clinical utility of a new patient-handling device.

## Objectives

- To measure the biomechanical load for the nurses when conducting the following transfers with and without the MTS: horizontal transfers from bed to stretcher; repositioning in bed; inserting and removing an X-ray cassette
- To assess differences in the overall physical exposure of nurses to strenuous repositioning and transfer activities.

## Method

The study was a prospective single-centre case study with a pre-post design of the introduction of the MTS in the clinical setting of an intensive care unit (ICU) (Knibbe et al, 2014a;b).

No funding was received by the authors for this study. The medical ethical committee of the hospital provided a waiver for the study.

The physical workload for the nurses was calculated in two ways.

1) Biomechanical forces were measured using a calibrated MecMesin force gauge. These forces were used as input for the calculations in the 3D SSPP biomechanical model, version 6.05. Measurements were performed during the transfer and repositioning activities mentioned above (with and without the MTS), using a subject of 70 kg and 1.70 tall.
2) A validated 24-hour log (Knibbe et al, 1999; 2008a;b; 2012; 2014a;b), on which

**Table 1. Biomechanical load (max pull / push / lift forces measured in N and range (min-max)) for three transfers and/or repositioning activities (for 5 repetitions measured with a standardised patient, 70 kg, 1.70 m)**

| | Maxi Transfer Sheet (MTS) | Lifter without MTS | Sliding sheets | Manual |
|---|---|---|---|---|
| **Horizontal transfer bed to stretcher** | | | | |
| Applying slings/sheet | 0* | 146 N (80–390) | 112 N (60–340) | 0 |
| Transfer itself | 0 | 0 | 270 N (140–360) | 658 N (340–934) |
| Removing slings/sheets | 0 | 111 (45–129) | 78 (19-120) | 0 |
| **Repositioning in bed** | | | | |
| Applying slings/sheet | 0 | 146 N (80–390) | 112 N (60–340) | 0 |
| Transfer itself | 0 | 0 | 230 N (110–430) | 441 N (365–822) |
| Removing slings/sheets | 0 | 111 N (45–129) | 78 N (19–120) | 0 |
| **Inserting and removing X-ray cassette** | | | | |
| Applying slings/sheets | 0 | 146 N (80–390) | 112 N (60–340) | 0 |
| Transfer itself | 0 | 0 | 199 N (80–246) | 388 N (266–712) |
| Removing slings/sheets | 0 | 111 N (45–129) | 78 N (19–120) | 0 |

* The Maxi Transfer Sheet (MTS) remains under the patient and therefore the load for applying and removing is zero. But of course the MTS must be changed every once in a while. As a rule, this is done when clean sheets are required: at least once every 24 hours. In that case, the load is similar to applying a sling.

the participating nurses registered all the repositioning and transfer activities they performed during a full 24-hour period before and after the introduction of the MTS.

## Results

All nurses invited to participate (N = 47) actually participated by filling out the logforms.

For the three transfers studied in detail (horizontal transfer from bed to stretcher; repositioning in bed (sideways, turning, up in bed); and placing an X-ray cassette under the patient), we found a significant and substantial reduction of the biomechanical exposure for the nurses when using the MTS compared to manual transfers, transfers with a sliding sheet and when compared to a transfer with a non-permanent sling. *Table 1* contains the overall biomechanical results.

It is remarkable that the range in forces when using sliding sheets and when applying and removing sliding sheets and slings is considerable. Maximum forces above a limit of 230–250 N are not recommended from an ergonomic point of view and under Dutch guidelines need to be avoided (Knibbe et al, 2008a;b). It can be seen in *Table 1* that the MTS, lifter and most of the sliding sheet data remain below that threshold. It is also obvious that all manual transfers exceed that limit and need to be avoided from an ergonomic point of view.

In addition to these effects, the elimination of the need to place and remove the sling prior to and after the transfer or repositioning when using the MTS reduces the total exposure level of the nurses significantly. This elimination effect is further increased, when the total exposure on ward level per 24 hours is calculated as usually one and a maximum of two nurses being required, whereas beforehand more nurses (up to 4) might occasionally be required to perform a transfer safely. *Table 2* presents the effects of this elimination on the total exposure level for a 24-hour period. The total number of transfer and/or repositioning activities was reduced from 634 to 323 for the period of 24 hours.

## Discussion

The results show a substantial difference in physical load for the nurses in favour of the use of the MTS, as opposed to the use of normal slings, sliding sheets and especially the manual transfers. It is also obvious the range in forces is quite large. This is consistent with the findings of Maertens (2011; in Dutch), who also found considerable differences in forces, especially when using sliding sheets. He also found that in some cases these forces would be in excess of the ergonomic guidelines for these kinds of forces. Although most nurses were

**Table 2. Frequency of transfers and repositioning activities registered per cycle of 24 hours before and after the introduction of the Maxi Transfer Sheet (MTS) aggregated for the nurse population (N=47 nurses)**

| | Before Maxi Transfer Sheet (MTS) introduction | After MTS introduction |
|---|---|---|
| **Horizontal transfers** | | |
| Applying sling/sheet/MTS etc. | 16 | 0 |
| Transfer itself | 33 | 17 |
| Removing sling/sheet/MTS | 16 | 0 |
| **Subtotal** | **65** | **17** |
| **Repositioning in bed*** | | |
| Applying sling/sheet/MTS etc. | 122 | 56 |
| Transfer itself | 289 | 179 |
| Removing sling/sheet/MTS | 109 | 55 |
| **Subtotal** | **520** | **290** |
| **Placing X-ray cassettes** | | |
| Applying sling/sheet/MTS etc. | 14 | 0 |
| Transfer itself | 21 | 16 |
| Removing sling/sheet /MTS etc. | 14 | 0 |
| **Subtotal** | **49** | **16** |
| **TOTAL** | **634** | **323** |

* The Maxi Transfer Sheet (MTS) remains under the patient, but must be changed every once in a while when clean sheets are required. This was done on average a little more than once per 24 hours and this frequency is mentioned in the table under 'repositioning'.

not aware of this, especially during the start of the repositioning a slight peak load was often measured. More gradual and slower movements led to lower peak loads. Although our findings are similar, our results remain more on the safe side than the findings of Maertens. Nevertheless, this apparent range—with the undesired possibility of loads in excess of safe limits—underlines the need to find solutions where these larger forces will not occur, or to use techniques that will prevent these forces from occurring. In our study, we found that the likelihood of these forces occurring was lower when using the MTS, for the simple reason that some activities were no longer required, thereby eliminating the risk altogether.

Our study was limited in the sense that more variations need to be measured: different nurses, different patient sizes and weights, different types of material and equipment and different types of mattresses. Maertens (2011) included some of these variations in his study and concluded that especially the type of mattress is of influence especially when using sliding sheets. The softer and or dynamic types, often in use for pressure ulcer prevention, tend to result in higher pulling and pushing forces for the nurse. As we did not vary the type of mattress in our study, this is a limitation of our study and will be a topic for future research. On the other hand, for the MTS, the type of mattress will most likely not matter, which can be seen as an argument in favour of using the MTS.

When it comes to the consequences of our findings for pressure ulcer risks in patients, it is obvious that more clinical research needs to be done. Having said that, we could argue that the risk is reduced because of the following reasons: the friction and possible shear occurring during removal and application of slings and or sliding sheets was eliminated when using the MTS, as this was not necessary anymore with the MTS. Furthermore it was commented by the nurses that the perceived threshold for offering and performing frequent repositioning was lower, as no more than one staff member was required with the MTS, which might encourage timely pressure ulcer prevention. Special clinical activities, such as the use of X-ray plates, were also facilitated without additional friction or shear, adding to the comfort for the patient and reducing their risk profile. Finally, the use of the MTS, especially when attached to the more fluent overhead system, allowed for slow and gradual movements, which lowers the maximum forces exerted on the patient's tissues.

## Conclusions and recommendations

It is apparent from this study of the MTS that devices such as this are promising developments, both from a nurse and from a patient perspective. This study is a small-scale one into these biomechanical effects. Further research, more specifically into the pressure ulcer risks, the clinical effects in a complex population such as ICU-patients and with a control group is required and relevant. Devices such as this may enable the combination of the best care for the patient at risk for pressure ulcers and the optimum protection of nurses' health.

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### SUMMARY: MOVING PATIENTS SAFELY— ESSENTIAL CARE FOR PRESSURE ULCER PREVENTION

- Pressure ulcers occur as a result of exposure to sustained pressure and/or shear, and the dominant contributory risk factor is immobility, irrespective of cause
- When prescribing repositioning protocols, clinicians should be mindful of the speed at which tissue damage can occur and be sure to use safe patient handling techniques to protect themselves and their patients
- A recent publication by National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance has clarified that lift devices may remain in situ beneath the patient, **but** only if they have been specifically designed for this purpose
- Slide sheets and replacement bed sheets are ideal for patients who spend a significant time in bed and require regular repositioning
- The use of safe patient handling equipment must include organisational commitment, management procedures and systems, a comprehensive risk assessment process, the provision of suitable physical environments with the correct level of equipment and training in both methods and equipment use
- In specific tests performed on the Maxi Transfer Sheet (MTS) (ArjoHuntleigh, Sweden) in comparison with conventional bed sheets, the MTS exhibited properties beneficial for microclimate management and appeared to improve the performance of both active and reactive support surfaces, although further research is required
- Other research conducted using the MTS found a significant reduction in physical load for nurses in favour of the device in comparison with slings, other sliding sheets and manual transfers
- If the device can be safely left in situ, it is more likely to be used

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