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 musculo-skeletal 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, 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 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.

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.

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

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'.

forces. Although most nurses were 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—THE EFFECTIVE USE OF SUPPORT SURFACES IN 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 for pressure ulcer prevention and treatment has clarified that specifically designed support surfaces may be left *in situ* under the patient for a limited time
- Slide sheet solutions may be suitable for people that spend a significant time in bed and may also require pressure ulcer prevention or treatment
- Slide sheet 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
- In specific tests performed on the Maxi Transfer Sheet (MTS) (ArjoHuntleigh, Sweden) in comparison with conventional bed sheets, the MTS did not reduce favourable 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
- Pressure ulcer risk for patients appears to be reduced because friction and possible shear occurring during removal and application of slings and or sliding sheets is eliminated by leaving the MTS in place