RESEARCH

The Evaluation of a Prototype Handling Device to assist with Horizontal Lateral Transfers

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A novel combination of existing technologies were used to design a prototype handling device to assist with the horizontal lateral transfer of patients. The development of the device suggested that there would be savings for both time and effort. A detailed ergonomics evaluation was conducted to evaluate the expected benefits. Experienced patient handling advisors carried out a comparison trial using three other frequently used lateral transfer devices. Data were collected on the handling methods used; the patient experience; the user experience; and the forces required to complete the transfers. The prototype device performed better than the comparators in terms of time, force, ease of use by the users. It also scored well for the patient outcomes of comfort and security. The statistical analysis showed that the data tended to significance and the post-hoc tests showed that the variation was consistent with the novel design.

INTRODUCTION

Patients who require assistance to move and are in bed for long periods of time can develop problems with tissue breakdown (pressure ulcers). In healthcare, tissue breakdown (viability) risks are commonly managed with inflatable overlay mattresses. The use of inflatable or soft padded overlays can impair the process of assisting with patient movement.

A collaborative project between the Healthcare Ergonomics and Patient Safety Research Unit and Frontier Medical Ltd used a novel combination of existing technologies to design a prototype transfer device to assist the horizontal transfer of patients in a lying position, The Repose® Companion. The prototype inflatable lateral transfer device has been developed from a previous piece of equipment primarily used as a pressure relieving mattress overlay (The Repose®Mattress). Frontier Medical Ltd developed The Repose® Companion as a transfer device that can stay with the patient when the transfer is complete.

The Repose® Mattress has been in use for many years and is the product of choice in some hospitals and longer term and home care settings. Many studies have shown that it performs well in terms of reduction of pressure ulcers (Price et al, 1999, Osterbrink et al, 2005; Macfarlane and Sayer, 2006) and improves sleep and pain control (Price et al 2003).

The activity of transferring a person from lying to lying frequently occurs in healthcare, e.g. bed to trolley, treatment tables, theatre departments and ambulance services. Early studies reported that methods of transfer include staff reaching over one flat surface to hold a draw sheet and pulling the patient across the surface to the destination point (Zelenka et al, 1996; Bohannon, 1999; Lloyd et al, 1998). As patient handling methods have developed, interventions and equipment options have become increasingly available to improve lateral transfer methods (Derbyshire Interagency Group, 2001).

Several studies have identified the benefits of using friction reducing equipment to reduce the manual handling risks of a laterals transfer (Zelenka et al, 1996, Bohannon, 1999; McGill and Kavcic, 2005; Lloyd and Baptiste, 2006) and suggest that forces will be reduced with the use of equipment.

Other mechanical or assistive technologies have been evaluated to improve the methods for lateral transfers, for example: long handled transfer sheets to improve operators posture (Derbyshire Interagency Group, 2001, Baptiste et al, 2006); inflatable devices (Hall, 2005, Baptiste et al, 2006). Some mechanical solutions have been evaluated, including: hoisting solutions (Silvia et al, 2002; Dolan and Adams, 1998) and mechanically assisted rolling (Silvia et al, 2002).

All of the studies and best practice guidelines identified that the exerted forces are the critical factor but all the suggested solutions include the location, introduction or fitting, and skills to use an assistive aid.

Early design discussions about The Repose® Companion suggested that task analyses and work evaluations could show clear savings for staff time and effort if the two problems of tissue viability and manual handling risks could be solved by a single piece of equipment that remained in situ and travelled with the patient. This is an approach which has seldom been seen in the field of manual handling interventions and equipment design. There is evidence to suggest that many equipment options, especially hoisting, add complexity to the task and increase the time required to complete the process. By taking a design approach to reduce the time and simplify the process this prototype could be an influential design not only for the tissue viability management but also as a design concept for many patient handling systems.

AIM

To evaluate the use of The Repose® Companion against three other lateral transfer devices and to make recommendations for design improvements, and manufacturing and marketing information.

METHOD

This project evaluated the ergonomic issues related to the use of The Repose® Companion. Patient handling intervention studies have found that mixed methodologies evaluating user and patient outcomes give strong evidence, (Fray and Hignett, 2008; Baptiste et al, 2006). The evaluation process concentrated on four areas:

1. Observation of the user actions
2. Patient experience
3. User experience
4. Forces used to complete the lateral transfers.

Data were collected using observational user trials (task analysis, compliance, time elapsed) and force measures.

Observational User Trials

A repeated measures design was used with four experimental conditions. The participants completed a series of transfers from bed to trolley and trolley to bed using four lateral transfer devices.

1. Tube flat slide sheet
2. Pair of single flat slide sheets
3. Quilted tube slide sheet
4. Repose® Companion Transfer device.

A large bridging board was provided to assist each transfer together with other small manual handling aids. All participants were familiar with all the lateral transfer devices though they might not have been using each on a regular basis. After each task the participants were asked to evaluate the equipment and a comparison was collected at the end of the session.

Participants. Clinical staff (nurses, physiotherapists and back care advisors) with a high level of knowledge of patient handling were invited to attend. Group attendance was requested but in certain circumstances groups were made up from different sources. 21 participants were recruited (7 groups). Each group consisted of enough people to complete the lateral transfer methods plus an additional participant to act as the 'patient'.

Experimental Scenario. The 'patient' started on a hospital bed and was transferred to a hospital trolley using the four lateral transfer devices. The trolley was pushed around a fixed course and the 'patient' then transferred back to the hospital bed. The 'patient' and participants were informed that the patient had recently undergone abdominal surgery and had severe and long term arthritis that prevented them from sitting or transferring independently.

Experimental Procedure. Participants were formally introduced to the trial and consent in line with Loughborough University ethical approval system. Prior to the trial each group discussed their preferred method for completing the transfer. The observer (MF) recorded the chosen method. The order of presentation of the lateral transfer devices was randomised. The trials were video recorded.

After each transfer task a series of questionnaires were completed. After all the lateral transfer devices had been used a further set of comparative questionnaires were completed. The users evaluated the lateral transfer devices for usability, force and time characteristics and the 'patient' evaluated the lateral transfer devices for comfort and security. The user evaluations were augmented with comparative discussions in de-brief forum. The intervention of the research team was kept to a minimum to avoid directed guidance in the evaluation.

Task Analysis. The video footage was analysed to create a list of physical actions completed by the individual members of the group. 164 task analyses were completed to review the movements, actions and the time taken for each stage. These data were used to identify which of the tasks involved exposure to force, these were then used for the force measures.

Compliance. Each group of participants agreed their preferred method for completing the lateral transfer task from devices 1-3 and followed the protocol for The Repose® Companion (device 4). The video data were examined to check compliance with the selected method and for errors in performance against best practice guidance, manufacturers instructions and the researcher's (MF) experience.

Time Elapsed. The time taken for the completion of the transfers from bed to trolley and vice versa were calculated from the video data. The time elapsed per individual action was also recorded and for the calculation of exposure to loading and MSD risk.

Force Measures

The force data and detailed analyses of the tasks and methods were conducted separately to minimise user feedback and potential bias. As a comparison for the strength evaluations the forces required to transfer a patient was measured using an electronic force gauge (Mecmesin AFG2500N). Each task was replicated by the researcher and expert handlers (n=5) and repeated measures of the task were completed under the same conditions as the user trials. Due to the short duration of some of the tasks only maximum applied forces were recorded.

Time multipliers were used for the longer tasks to calculate the exposure to loading during the task. A musculoskeletal risk exposure score was to be calculated as the cumulative total of the products of force and time for each individual transfer (168 exposure scores were calculated, this will be presented in a future publication).

Statistical Analysis

ANOVA with repeated measures calculation was used for data sets that were evaluated across the four different experimental conditions (e.g. time, force). If significant variation was detected post hoc analyses was conducted using Paired T-tests. The Freidman's test was used to identify differences between the conditions where individual subjective scores were recorded and for the comparison ranked data sets. Paired T-tests were again used post-hoc to identify the root of any significant variation. The significance value was initially identified as $p<0.05$ for all tests, but due to the small sample sizes and numbers of conditions required that for the post hoc tests the Bonferoni correction was used and significance was set at $p<0.008$.

RESULTS

For the evaluations collected after using each lateral transfer device, The Repose® Companion scored consistently better across all sections (table 1). The variations in order were not seen in the comparative evaluations at the end of the trial below. Almost all participants ranked the four pieces of equipment in the same order across all sections. The picture for force evaluation was the weakest (table 2).

Average Scores/Rank	Flat Tube	Pair Flat Sheets	Quilted Tube	Repose® Companion
1 Compared to usual method	2.14/2	2.29/3	2.67/4	1.24/1
2 Time taken	3.48/3	3.48/3	3.43/2	1.71/1
3 Force used	2.81/2	2.90/3	3.00/4	1.52/1
4 Complexity	2.33/3	2.43/2	2.33/3	4.24/1

Table 1 Individual scores and ranks for user data

Average Scores/Rank	Flat Tube	Pair Flat Sheets	Quilted Tube	Repose® Companion
1. Forces	2.24/2	2.79/3	3.36/4	1.62/1
2. Time taken	2.55/2	2.93/3	3.38/4	1.14/1
3. Complexity	2.52/2	3.05/3	3.26/4	1.17/1
4. Overall preference	2.31/2	2.81/3	3.64/4	1.24/1

Table 2 Comparison score and ranks for user data

The patient feedback relating to the security and comfort of the tasks was positive for the Repose® Companion. Only seven 'patients' completed the trial, one per group, which reduces the effects in the statistical evaluation. However it can be seen from the proximity to 1 in all columns (tables 3 and 4) that the Repose® Companion was the preferred option with the trial participants.

Average Scores/Rank	Flat Tube	Pair Flat Sheets	Quilted Tube	Repose® Companion
Comfort Insertion	2.14/2	2.14/2	2.14/2	1.00/1
Comfort Transfer	2.29/4	2.00/2	2.00/2	1.14/1
Security Insertion	2.29/2	2.29/2	2.43/4	1.43/1
Comfort Removal	1.86/2	1.86/2	2.00/4	1.00/1
Comfort Transport	1.43/2	1.43/2	1.57/4	1.14/1
Security Transport	1.29/2	1.29/2	1.57/4	1.00/1

Table 3 Individual scores and ranks for patient data

Average Scores/Rank	Flat Tube	Pair Flat Sheets	Quilted Tube	Repose® Companion
Comfort Insertion	3.07/3	2.64/2	3.29/4	1.00/1
Comfort Transfer	3.14/3	2.71/2	3.14/3	1.00/1
Time Taken	2.79/3	2.64/2	3.43/4	1.00/1
Security Transport	2.79/3	2.64/2	3.36/4	1.21/1
Overall Preference	2.79/2	2.79/2	3.29/4	1.00/1

Table 4 Comparison score and ranks for patient data

Physical Results and Further Analysis

For the two physical parameters there was conflict with the subjective appraisal. The time elapsed showed little variation between the lateral transfer device options 1-3 but the Repose® Companion was faster due to the reduced number of tasks. The force data showed that the friction reducing characteristics of Repose® Companion were not as efficient as either the flat tube or the quilted tube.

Average/Rank	Flat Tube	Pair Flat Sheets	Quilted Tube	Repose® Companion
Bed to Trolley	260.9/4	252.4/2	256.4/3	201.9/1
Trolley to Bed	211.0/2	225.1/4	216.7/3	153.3/1

Table 5 Time elapsed for transfers and forces

Patient Weight	Flat tube	Flat sheets	Quilted tube	Repose® Companion	Average
55kg	133.4	184.9	173.4	182.2	168.5
78kg	205.1	271.9	231.6	258.6	241.8
					205.1

Table 6 **Forces to transfer with range of equipment**

Statistical Analysis

The individual data and the comparison data from both staff and patients were analysed statistically. For the staff data both the individual data sets and the comparison rankings were significant at the 0.05 level and the post hoc tests showed clear variance from the Repose® Companion (sig at 0.008). For the individual patient assessment data (n=7) there was only significance for the comfort assessment for insertion and removal of the equipment. For the patient comparison ranked data there was significance across all questions but no significance was found in the post hoc tests.

The time taken to complete the activities was assessed with a repeated measures ANOVA. The analysis showed significance for the trolley tobed transfer (p=0.031) and near significant for the bed to trolley (p=0.060). The post hoc tests identified the relationships between the Repose® Companion and the other lateral transfer devices as being the powerful sources of variance (Sig p< 0.008) vs flat tube significant p=0.006, vs flat sheet NS p=0.034, vs quilt NS p=0.089, but all indicated levels of importance.

DISCUSSION

There was a clear preference for the prototype Repose® Companion when compared to three other commercially available lateral transfer devices. The task analyses found that many tasks were made redundant by the Repose® Companion as the sliding component remains under the patient. This eliminates many manual handling tasks from the process, e.g. rolling the patient insert the slide. It was possible to insert the large slide board without using any rolling for the Repose® Companion as the inflation allows mattress compression rather than the pressure being felt by the patient.

The strength of response from the users indicated that the speed and reduction in handling tasks reduced their assessment of force needed to complete the transfer. The users rated the Repose® Companion best for speed and force (minimum exertion). The Repose® Companion was the fastest but only third in terms of transfer force. The task analyses found that the longest recorded transfer phase was group 4 with 20 seconds, but many transfer tasks lasted less than 5 seconds. All transfer tasks utilised all members of the group to reduce the effect of this part of the process.

Both these factors indicate thathe physical control systems and the risk management strategies have focussed on the transfer phase and may well have removed the subjective assessment of hazard to the point where other phases of the work now have a more powerful effect .

Other contributing factors were noted in the analysis of the process:

- Lack of focus on efficiency in the transfer actions was evident in many of the groups. Group 3 rolled the patient 6 times before getting the transfer completed. Many of the groups had in excess of 4 rolls for each of the different equipment options.
- Users were observed holding the patient in side lying for excessively long periods. Group 4 held a patient in side lying for 99 seconds in a single roll, Group 6, 85 and 84 seconds in different tasks, and Group 7 for 72 seconds. As some patients are unable to support themselves in side lying without assistance there is increased exertion for the users.
- Potential errors and variance from the preferred protocol was also observed for the more complex methods. None of the participants had experienced the Repose® Companion prior to the trial yet errors and variance from protocol were recorded with the other lateral transfer devices. It is possible that the focus on the new equipment enhanced the user compliance, but the performance with the simple process was very good.

The statistical analysis of this data could not show the full significance due to the limited numbers in the trials. However, there is evidenceto indicate that the Repose® Companion was the preferred lateral transfer device and the post hoc analysis indicated that the variance between the groups was only due to the changes in equipment.

CONCLUSION

The conclusion of this study shows that the prototype Repose® Companion was very successful in reducing time, effort and potential error for the users whilst giving high scores for comfort and security for the 'patients'. It can also be seen that the combination of different assistive technologies and the appropriate work evaluation methods can result in a benefit to users and patients in a health care setting. This combination approach may lead to other opportunities in future patient handling solutions e.g. wearable hoist attachments, interchangeable combinations of bed and trolley.

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New Repose Companion®

An effective aid in the prevention and treatment of pressure ulcers throughout a patient's journey

Key features & benefits include:

Clinically effective

- The patient is always protected by an effective pressure redistributing surface
- Reduces shear and friction forces associated with lateral transfer
- Repose Companion is radiolucent

Safe

- An in-vitro comparative study demonstrated that Repose Companion "was very successful in reducing time, effort and potential error for the users whilst giving high scores for comfort and security for the 'patients'" [1]
- Corner retaining straps fit securely to any support surface
- The zip has an integral cover flap for added protection against fluid ingress

Cost effective

- Saves time and effort during the lateral transfer process
- Avoids expenditure on transfer products such as slide sheets

Lightweight

- A simple non-powered pump, lightweight mattress overlay and cover ensure that Repose Companion is easy to store and safe to use during transfer and transportation

Comfortable

- The top cotton-backed water resistant cover is vapour-permeable maintaining an optimal microclimate between the patients skin and the contact surface
- Companion utilises the NHS's most popular Repose Mattress Overlay with demonstrable improvements in comfort level [2]
- All combined to improve a patient's sense of comfort and security throughout their journey

Durable and maintenance free

- The slide sheet base material is manufactured from polyurethane infused with nylon and is welded to the multi-stretch cover
- Welded seams and zips provide for added security and durability

Easy to use

- Quick 'fool proof' inflation ensures that Repose Companion is easy to set-up ready for use
- Patented 'smart valve' technology inside the pump ensures the device is set to effective pressure levels