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Does the use of friction reducing devices actually reduce the exposure to high force horizontal transfers?

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Abstract:

Transferring a person from lying to lying frequently occurs in healthcare, e.g. bed to trolley, treatment tables, theatre departments and ambulance services. Transferring patients has long been identified as a contributory cause of MSD in healthcare processes. The provision of friction removing material is accepted as a sensible solution to reduce the biomechanical load for horizontal transfers. Little evidence has reported the consequences of not following best practice guidelines when using friction removing devices.

This study explored routes to error in an NHS Trust for a range of horizontal transfers and investigated the level of knowledge within the workforce to complete these transfers. A questionnaire survey (n=170) showed that a high percentage of staff reported that horizontal transfers using slide sheet devices were not being performed optimally. A laboratory study quantified the force differences between a best practice transfer and the various erroneous methods. The additional forces showed up to 100% increase in the amount of effort for healthcare workers for each transfer not performed correctly.

Based on the reported error an intervention was implemented that simplified the slide sheet protocol across the trust. Only one single slide sheet was provided in all areas to ensure full coverage of the bed and allowed all transfer types with a single tube sheet. Secondary data showed significant improvements in the ability of staff to follow the new protocol and reduce routes to error.

Keywords: Patient handling, biomechanics, healthcare workers, load movement, assistive devices

1. Introduction

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. Transferring patients has long been identified as a contributory cause of MSD in healthcare processes (Smith, 2011). 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, 2011, Hall, 2005).

Several studies have identified the benefits of using friction reducing equipment to reduce the manual handling risks of a lateral transfer (Zelenka et al, 1996, Bohannon, 1999; McGill and Kavcic, 2005; Lloyd and Baptiste, 2006, Fragala and Fragala, 2014) 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 operator's posture (Derbyshire Interagency Group, 2011, Baptiste et al, 2006, Fray and Hignett, 2009); inflatable devices (Hall, 2005, Baptiste et al, 2006). Some mechanical solutions have been evaluated, including: hoisting solutions (Silvia et al, 2002; Dolan et al, 1998) and mechanically assisted rolling (Silvia et al, 2002). All of the studies and best practice guides indicate that the benefits are most effective when there are two layers of friction reduction material under the load being moved.

Recent studies show that the compliance with safer handling methods are not developing as organisations would like (Koppelaar et al., 2013, D’Arcy, Sasai, and Stearns, 2012). Safe patient handling practitioners see one of their roles as the improvement of both competence and compliance within their staff groups (Smith, 2011, Fray and Hignett, 2013). It can be observed that in order to be able to respond to the wide variety of handling scenarios that may occur some systems of work have a wide variety of possible equipment and method combinations. This study investigates one multi-site NHS Trust with a complex range of options for managing horizontal transfers including flat sheets, tube sheets, different sizes, different numbers per transfer and different directions of movement. In the challenging world of modern health and community care high quality requires an ergonomics based solution that not only reduces the biomechanical risks to staff but needs to be easy to adopt, remember and be efficient for carer and patient.

2. Study Outline

This study explored the knowledge and applied skills of the workforce within the participating NHS Trust. The data from the first survey informed a laboratory investigation that utilized previously defined research methods (Fray and LARF, 2012) to measure the forces to move a patient in a variety of ways. The study group then adopted a novel product, which aimed to improve the relative number of errors in the transfer set up, as the only equipment available to assist with all horizontal transfers. A secondary survey reviewed the ability to follow the new protocol to explore the possible reductions for errors.

This study explored several objectives:

- To identify the level of understanding of healthcare workers regarding the multiple sizes and positions used in various horizontal transfers
- To measure the difference in force required to complete horizontal transfers with different combinations of slide sheet, transfer type and surface.
- To quantify the level of force that can be apportioned to erroneous use of this standard piece of patient handling equipment.
- Evaluate a simplified intervention strategy to assist with the error reduction.

3. Methods

1. Questionnaire Survey

A simple questionnaire survey evaluated the knowledge and practical selection of methods for the use of friction reduction devices for the staff in a UK healthcare provider. A convenience sample was used as participants were invited as they attended their various patient handling updates or when the team was required to visit an area. The questionnaire required the individual to select the position and format of the friction reducing device for a number of activities e.g. horizontal lateral transfer, moving up a bed, turning from supine to side lying. Various options (n=12 combinations) were listed and the participants selected the ones they used. The options varied for number of sheets, type of sheets, and the position of sheets under the patient and the direction of movement. The responses were categorized as correct, possibly correct or incorrect depending upon the response and the best practice guidance given in the local protocols. These patterns of movement and alignment defined the correct and incorrect conditions for the laboratory study.

2. Laboratory Trials

A repeated measures design was used with three different sized patient loads (58-98kgs) for different combinations of sliding devices (n=12, Table 1).

	Equipment	Size(cm)
1	Single layer Theatre Sheet A	70x190
2	Single layer Theatre Sheet B	70x190

3	Pair of Flat Sheets (Coated Polyester, no handles)	70x200
4	Pair of Flat Sheets (Green Plastic)	70x200
5	Pair of Flat Sheets (Coated paper)	70x200
6	Tubular Double bed size (Coated Polyester)	140x200
7	Tubular Slide Sheets (Coated Polyester, 3 of, full body length)	70x145
8	Pair of Flat Sheets (Coated Polyester Handles)	70x200
9	Extended Tubular Slide Sheet (Coated Polyester, Novel design)	90x220
10	Tubular Slide Sheets (Coated Polyester 2 of, Shoulder to hips and calf)	70x145
11	Tubular Slide Sheets (Coated Polyester 1 of, Shoulder to hips)	70x145
12	Pair of Flat Sheets Double bed size (Coated Polyester Handles)	140x200

Table 1. Equipment and position combinations

Data was collected by the same experimental team for all the physical trials. The patients completed a series of lateral transfers starting a) on the bed, b) half on a transfer board and c) fully on a transfer board. Additionally a series of movements up the bed were also recorded with the patients only lying on the bed (as in a) above). The combinations were created to replicate both the evidence based best practice, and incorrect positions of the slide sheets for different transfers.

2. a Experimental Scenario.

Patient actors were formally introduced to the trial and consent in line with Loughborough University ethical approval system. During the transfers the patient was completely passive and adopted a fixed position, hands across chest, legs straight and not crossed. The range of conditions was defined by the experimental group based on the results from the survey. The correct/incorrect classification, the positioning of patient, sheet and slide sheet was based on current best practice and supported by the training and protocols agreed in the healthcare organization. The ‘patient’ started on a hospital bed with the chosen equipment in place. The forces to move the patient were measured as the minimum repeatable force to initiate movement (Fray and Hignett, 2015). To record the force at the start of horizontal movement, markers were placed on the patient and bed. The patient and observer had to agree that horizontal movement had occurred. The forces for the physical tasks were recorded using a Mecmesin AFG2500N force gauge for all pulling actions. The activity was repeated until a sample of 5 values within 5% variation around the median was achieved. The quality of the movement was noted as there were different interactions between boards, sheets, position and loads. The adhesion between some board and sheet combinations caused a build-up of force and excessive movement to occur and measures had to be excluded.

3. Intervention and evaluation

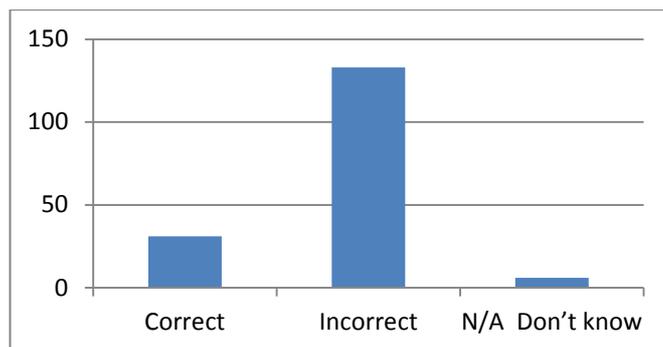
The study informed a change in the provision of equipment and training support in the study site. A single multidirectional slide sheet system was adopted as the single solution for all horizontal transfers. All other slide sheet combinations were removed and training supported the new device. An evaluation was conducted as part of the regular internal performance review.

4. Results & Discussion

4.1 Questionnaire Results

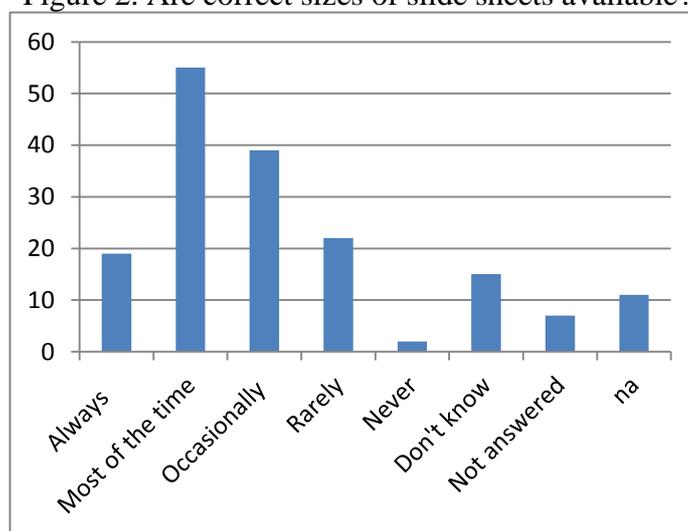
The questionnaire response (n=170) showed that there were numerous routes to error for the use of friction reducing devices in the organisation. Figure 1 shows that 78.2% of the respondents gave an incorrect description of the position and use of the slide sheets.

Figure 1 Correct/Incorrect responses (n=170).



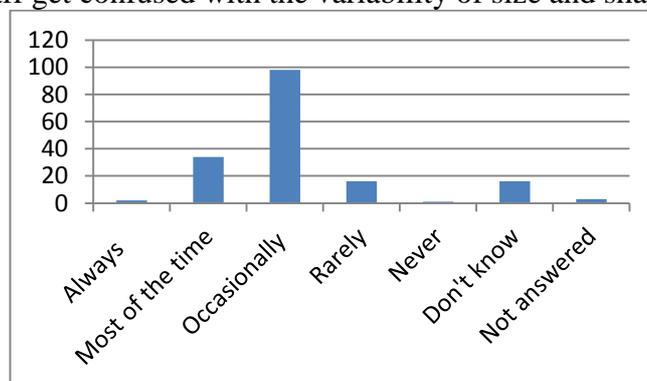
The errors were shown to include incorrect selection of device including wrong number of layers, wrong type, wrong shape and wrong positioning of sheets during the transfer e.g. vertical to horizontal alignment. The survey investigated if the lack of suitable slide sheets may have contributed to the poor understanding and develop poor practice. Figure 2 shows the frequency that there was insufficient choice or equipment in the various areas.

Figure 2. Are correct sizes of slide sheets available?



The level of confidence that staff were able to make the correct choice of size, shape and position for the three transfers was also questionable. Figure 3 reports that the 21.2% of staff were confused most of the time and a further 57.6% reported occasional confusion.

Figure 3. Do staff get confused with the variability of size and shape of slide sheets.



Further investigation explored the relationship between the different transfer types and the descriptions of safe practice (Table 2). Moving a person up in bed showed the highest knowledge

of the set up at 64.1%, Lateral transfers next with 55.9% and turning to side-lying showed the worst understanding with only 44.7% being correct. Of the 830 responses 31.6% were incorrect and a further 13.0% may have been incorrect with combinations of position and movement.

Transfer	Correct	Possible solution	Incorrect
Move up Bed	209		117
Turn in Bed	113	92	48
Lateral Transfer	138	16	97
Total	460	108	262

Table 2. Quality of knowledge across transfer types

The evidence from this survey shows that the staff would regularly complete transfers for these three movements with the slide sheet combinations in either incorrect or less than optimum positions (44%). The errors reported included insufficient numbers of sheets, incorrect alignment, insufficient coverage of body areas, inappropriate combinations of movement and alignment. These errors all lead to increased effort for the healthcare worker. The patterns described were used to define the force measures and the analysis for the laboratory study.

4.2 Laboratory Study

The force data was collected for 12 slide sheet combinations (Table 1), correctly and incorrectly used with two different slide board combinations for the 3 patient loads. Each combination was measured under 5 positional variations (directly on bed, ½ on solid transfer board, fully on solid transfer board, ½ on flexible transfer board and fully on flexible transfer board) with three different sizes of patient (58, 72 and 98kgs). The agreed reliability for the consistency of force was achieved across the range of activities (n=180 slide sheet and patient combinations and n=1123 force measures).

The forces to laterally move the patient were proportional to the body weight of the patient being moved. The single layer theatre devices showed higher forces than the two layer versions. Some transfer board and sheet combinations showed different qualities of movement. The flexible board showed an element of adhesion so there was a higher force and staggered jerky movement.

One of the problems identified with the incorrect methods was where two layers become one during the transfer. The forces, Table 3, showed a significant increases for large and medium sized patients

	Single Layer	Double Layer
Heavy	214.7	104.7
Med	172.6	98.3
Small	71.5	65.2

Table 3. One layer to two layers for lateral transfer on bed (p<0.05)

The second error identified was the lack of coverage between the patient and the bed. This can occur when narrow sheets are used under full body, trunk and legs or just trunk. Figure 4 shows the force to move the patients when on a solid transfer board similarly to the previous example more than double the force was required between best and worst scenarios.

Figure 4. Force (N) for 1, 2 and 3 sheets under a heavy and medium patient.



The trials explored the differences between solid and flexible transfer boards. The evidence was not clear as different boards interacted with different slide sheets to confuse the effects. It was clear in most transfers that the solid boards reduced the force required for horizontal movement. Comparisons between like styles of slide sheet were also made Table 5 shows sheets of different material for the different lateral movements. The innovative product (9) compared favorably with the selection and the disposable products (4, 5) were less effective.

Lateral Transfer	9	8	5	4	3
On Bed top	63	105	167	154	109
1/2 On Solid Board	101	102	149	182	140
Fully on Solid Board	79	107	97	134	80
1/2 on Flexible Board	93	118	151	195	102
Fully on Flexible Board	65	100	101	184	101

Table 5. Force (N) for different materials of slide sheets

4.3 Intervention and Evaluation

The Trust adopted a single device (9) to allow the simplification of equipment selection for all horizontal transfers. Similar data was collected at the annual update training to compare with the pre-data information. In the follow up survey staff were again provided with all possible positions for the slide sheets and asked to select their preferred set up. Figure 5 shows that almost all staff responded correctly for the range of transfers.

Figure 5. % correct answers in the follow up survey (n=40)

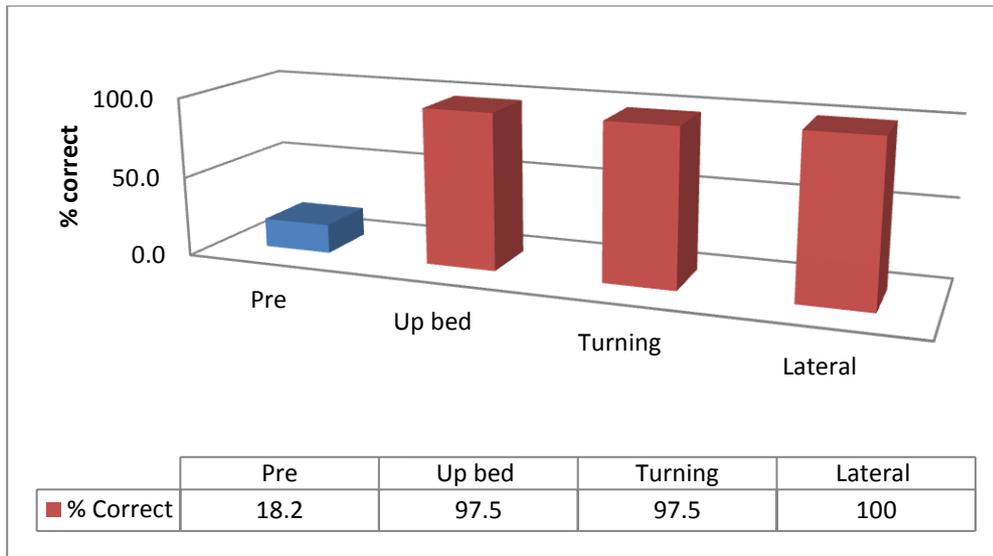
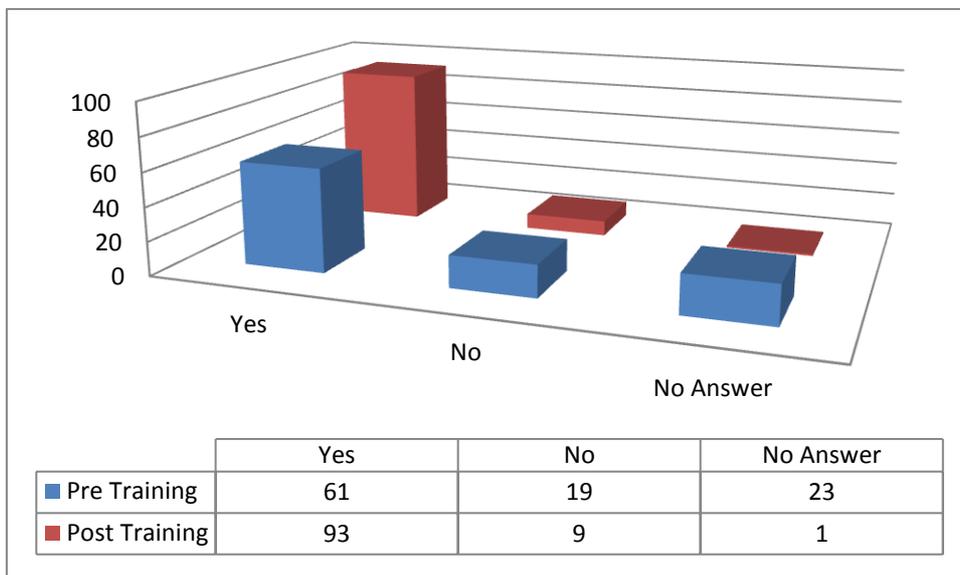


Figure 3 (previous) shows the level of confusion in the staff regarding the use of slide sheets, 78.8% of the cohort reported Always, Mostly, Occasionally confused with the setting up of horizontal transfers. After the introduction of the new standard protocol and equipment a group were surveyed at their first annual update since the implementation. Figure 6 showed that even before update training 59.2% responded that the new single sheet system was easier to follow. This rose to 90.3% after the additional guidance.

Figure 6. Improvement in confidence with new system



5. Discussion

There have been many studies that identify the biomechanical benefits of using friction reducing devices for horizontal transfers (Zelenka et al., 1996, Bohannon, 1999, McGill and Kavcic, 2005, Lloyd and Baptiste, 2006, Fragala and Fragala, 2014). No studies reported on the inefficiency of not using the equipment with an optimum method. One of the difficulties facing patient handling practitioners is the adoption and sustaining of best practice. The survey clearly showed that the complexity of the range of options for use confused the workers. The requirement to keep two layers of friction reducing material under the patient during the transfer was challenged by the complexity of choices. Reported errors included:

- Not using correct number of slide sheets
- Using tube sheets against their direction of movement
- Not ensuring that slide sheets covered the correct surface area
- Only using a single layer of sheet
- Not placing the patient fully on a transfer board

The staff were comfortable with reporting their selected methods and had low understanding that the choices were erroneous. All transfers that are completed without full coverage of the bed to patient area will increase the amount of force required.

The laboratory study quantified the increase in force required between the efficient and non-optimum use patterns for the full range of transfers (Table 6). Inappropriate use accounted for a doubling of the force required for all movements. The highest forces are approaching the recommended limits for pulling force for a single user. As an individual two person action these would not be raised as a high risk activities but the repeated use would add to the workload of the staff. If activities were completed as an individual worker then this may raise concerns about single force application.

	Best Force	Worst/Error Force	% Increase
Up bed	90.8	175.1	92.8
Turning	61.9	174.8	182.4
Lateral Transfer	63.5	167	163.0
Single vs Double	104.7	214.7	105.1
Surface Area	62.5	132.8	112.5

Table 6. Error ranges for various tasks (N).

One area for further consideration and quantification is how much these extra force requirements may place on a worker over a shift or working week. Real world counts of the volume of work are rarely seen in current patient handling literature but could be used to support the drive to reduce work demands. E.g. If the worker on a busy day conducted 20 transfers erroneously:

- 10 transfers where part of the task used only a single layer adds 10 x 110N
- 10 transfers where a surface area error was seen adds 10 x 70.3N

This would add 1803N to the daily workload which is equivalent to lifting a single load of 180Kgs. The cumulative effect of this type of handling is not reported in patient handling studies and requires further investigation.

The additional forces recorded when not using the optimum operating procedures show that providers of assistive devices and safe procedures still have improvements to make. Equipment solutions need to be intuitive so as to make the correct use the only possible use. In addition these raised forces will add to the physical demand in an area where high load tasks are still prevalent e.g. fitting hoist slings, high risk mobility situations and plus-size care delivery. This trial adopted a slightly over-sized tubular sheet of novel shape and format (9). The aim of this slide sheet was to simplify the process and learning and be the only size and shape in the Trust. The information collected at the first refresher training opportunity after the introduction showed very good knowledge regarding the use and increased confidence in the work system. This study shows that a device that improves compliance with best practice could make significant reductions in the work required across the care setting.

6. Conclusion

This investigation reported that the complexity of possible solutions for slide sheet assisted horizontal transfers caused staff to report non-optimum practice. A laboratory study quantified those errors and showed that the forces could be doubled depending upon the type of use. Patient handling advisors and equipment manufacturers need to consider an ergonomics approach to design a solution that is easy to learn, remember and which is effective for staff and patient.

Acknowledgements

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