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Test of effort needed to move a patient up in bed. Does the carer position around a bed change the force applied when moving a person up a bed

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Does carer position around a bed change the force applied when moving a person up a bed.

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1.0 Introduction

The introduction of friction reduction materials into the tasks of moving people horizontally across a bed has reduced many of the risks related with those transfers (Fray and Hignett, 2015a). Some studies however still show that if these transfers are not completed properly there still remains the opportunity for harm to carers and those being cared for (Fray et al, 2017, Fray and Hignett, 2015b)). One area that to date had not been evaluated are the differences between carer position and the direction of movement to move somebody in lying up the bed. This investigation is a pilot study to evaluate the differences between standing parallel to the side of the bed or taking an oblique offset position at the top of the bed. The study reviews objective measures of the force applied and compares the subjective views of the participants for effort, comfort and likelihood of use.

1.1 Literature Review

Warming et al (2009) defined patient handling as consisting of two tasks '(1) transfer tasks, which is when the nurse assists the patient moving from one position to another and (2) care tasks, which is when the nurse assists the patient in doing daily activities or necessary professional tasks for the well-being of the patient'. The focus of this report will be on patient transfer tasks, in particularly moving patients horizontally towards the head of the bed.

Care staff are frequently exposed to significant load during their daily work. The handling and moving of patients in bed are part of these frequently carried out tasks, with Smith (2005) stating the 'act of pulling a patient up to the head of the bed, is a frequently performed patient handling task' and 'nurses are exposed to high risk patient handling tasks at a high frequency'. It is considered that nursing tasks can be high risk (Owen and Staehler, 2003).

Various studies have highlighted that carer's are at risk of potential injuries when carrying out transfer tasks (Garg et al., 1991, Schibye et al., 2003, Waters 2007). Other supporting studies (Alamgir et al 2007, Jager et al 2013) confirm the fact that carers are vulnerable to sustaining MSI due to 'transferring and repositioning tasks during patient/resident/client care'. The potential risk of injury is accentuated through

not using slide sheets; with Jordan et al. (2011) stating transfer tasks not using slide sheets are responsible for the 'highest lumbar load of various patient-handling tasks'.

In order to reduce the impact of poor/ awkward patient handling and in particularly patient transfer, training and certain patient handling techniques/ aides have been put in place to help aid and inform carers (Smith, 2005, Cohen et al. 2010). Pellino et al (2006) states using transfer aides reduce physical stress on the part of nurses. Information, education and training in proper use of aids/ equipment are essential to promote behavioral and attitude changes among staff (ISO 2012, ANA 2013, Nelson et al, 2003). Several studies reported the combination of both using equipment and education is more effective safer patient handling (Black et al 2011, Lim et al 2011, Garg & Kapellusch, 2012).

2.0 Methods

2.1. Aims

The overall aim of this study is to quantify and compare four different conditions in terms of the force required to transfer a patient up towards the head of the bed, using both novice and expert users.

2.2. Objectives

To quantify the amount of force required in each condition of transfer for both novice and expert users.

To compare and rank the different conditions from best to worst in terms of force needed.

2.3 Conditions

The postures/positions to move someone towards the head of the bed were selected having reviewed current best practices (Brooks & Orchard. 2011, NHS. 2010, Smith et al., 2011). A focus group of professionals within the subject area was used to provide evaluation on the methods. The force required to move the patient up the bed was evaluated in pilot studies. Through testing a final suitable weight ($\approx 68\text{kg}$) was decided. On evaluation a weighted mannequin was used to standardise the trial. Market standard slide sheets were placed under the mannequin and the force devices were attached to standard positions on a non-slip under sheet. The conditions selected for the trial were:

1. Parallel Stepping- Two participants, on either side of the bed with hands at the shoulder and hip of the patient the carer's step up the bed sliding the patient along.
2. Rotation- Two participants, one on either side of the bed with hands at the shoulder and hip of the patient participants turn towards the head of the bed, without moving the feet.
3. 2 Person Oblique Pull Up Bed- Two participants at each top corner with an oblique offset base. To move the carers take a step backwards keeping their arms straight.
4. Single Person Pull Up Bed- This transfer uses one participant, at the head of the bed with hands shoulder width apart. When ready the participant steps backwards, keeping their arms straight.

2.4 Data Collection

In line electronic force meters allowed force data to be collected from each hand for the 3 of 4 conditions. When completing Condition 3 participants chose to place both hands at a single place on the slide sheet resulting in only a single force gauge being used. Ethical approval was achieved through the University systems. The force devices were calibrated daily and between participants. Each condition was completed three times, with an average taken, any large variations in the data caused a repetition of the action. A convenience, non-probability sampling strategy was used, by sending a number of emails to potential participants and using those who replied in the trial.

During the trial participants were given time to familiarise themselves with the transfer. Each transfer would then be carried out three times. Once completed the participants being asked to fill out either a short novice or expert review questionnaire. The transfer was repeated if any errors or significant differences from normal movement or participant body position were observed, to give consistency in the analysis.

2.5 Subjective Data

After the participants carried out each condition they were asked to complete a subjective review depending on their level of experience (novice & expert). These included a Borg rating scale and likert scale questions reporting the effort, security and safety of each condition, with the expert review also including how likely the particular condition was to be used in their regular practice and workplace.

2.6 Forces Assessment

Forces in Newtons were recorded at 20 readings per second in the software. Each transfer was examined with the length of transfer, average force and peak force being calculated and recorded. These data were used to compare the conditions:

- Total load per transfer - all hands all carers
- Individual load per transfer - both hands per carer
- Individual hand load for conditions 1, 2 and 4

2.7 Statistical Analysis

A Shapiro-Wilks test for normality was conducted on all data to evaluate for normal distribution. This implied the use of a repeated measures ANOVA test or a Friedman test. For the total load per transfer and also individual load per transfer, a repeated measures ANOVA was used to test for significance between the average force of each condition. Independent Samples T-tests were conducted to compare the average force exerted between the novice and expert participants. For non-normal distributions Wilcoxon Signed Rank test or Mann-Whitney U test were used. Post hoc analysis used the Bonferroni corrections.

3.0 Results

A total of 21 participants were used. These were split into novices (n=10) and experts (n=11), with each completing each transfer three times.

4.1 Subjective Review- Qualitative Data

The participants rated the transfers on a Borg Biomechanical effort scale. Table 1 shows the comparisons per condition, there was a higher level of effort for the rotation movement for both novices and experts (ANOVA, $p < 0.05$). The oblique positions (1 P and 2P) were considered easiest.

Table 1. Perceived biomechanical effort (High = Effort).

Condition	Novice		Expert	
	Mean	SD	Mean	SD
1. Parallel stepping	2.8	0.75	3.7	0.96
2. Rotation	4.0	0.90	6.1	2.02
3. 2-person oblique pull up bed	1.9	0.75	3.0	1.57
4. Single person pull up bed	2.8	1.16	2.7	0.68

When reporting safety and comfort the novice participants felt condition 3 was the most comfortable (4.3) and safest (4.1), whereas condition 2 was the least comfortable (2.1) and least safe (2.5). The workplace experience for the expert participants allowed further subjective questioning Table 2.

Table 2. Subjective Responses For Expert Participants (High is preferred).

Condition	Comfort		Safety		Individual acceptance		Organisational acceptance	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Parallel stepping	2.8	0.98	3.1	0.83	2.5	1.21	3.2	1.34
2. Rotation	1.7	0.91	1.7	0.91	1.5	0.69	2.9	1.70
3. 2-person oblique pull up bed	3.6	0.93	3.6	0.92	3.2	1.08	2.9	0.94
4. Single person pull up bed	3.8	0.54	4.1	0.54	3.4	0.92	3.4	1.03

The comfort and safety scores for experts aligned with the novice view that the Rotation task was the least preferred. In addition they were asked to rate how likely they were to use the method from their own choice and from their organisation's perspective. Individually the score suggested they would not like to use the Rotation method (2) but it was thought that people would use it in their organisations. To explore the consistency of the responses all Expert data were tested for correlation and there was a clear uniformity across all comparisons (Table 3)

Table 3. Result Of The Spearman's Rho Test For Expert Participants (** Sig <0.001)

	Comfort	Safety	Individual	Organisational
Comfort		.950**	.755**	.499**
Safety			.761**	.520**
Individual				.637**

4.2 Force Data

The force data was investigated as; total load per transfer, individual load and individual hands. Although the peak force would be the major cause of injury, it was not used in the analysis as, for all transfers, this force was far away from the 1.8kN limit value set out in ISO 11228-2 (2007) and reported in Jäger et al's (2012) study.

Figure 1 shows the combined force that was required for each transfer. The total force for Parallel Step and Rotation were significantly higher than the two top of the bed transfers. There is an interesting anomaly in the trial that overall the single person up the bed is more efficient with only one pull being applied.

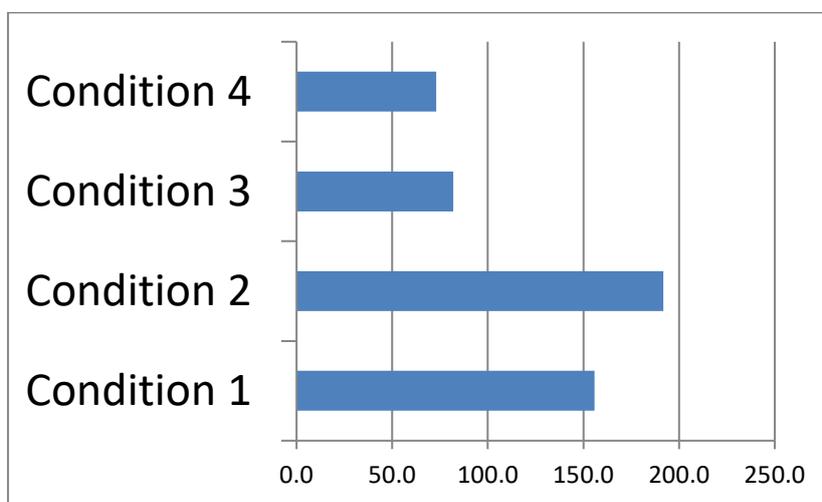


Figure 1 Total Force per Transfer (L and R Hand all carers)

In all conditions the novices applied more force to complete the transfers than the expert group (Fig 2). The relative risk increased with the more hazardous actions Condition 1-45%, Condition 2-37% opposed to 5% and 15% for Conditions 3 and 4.

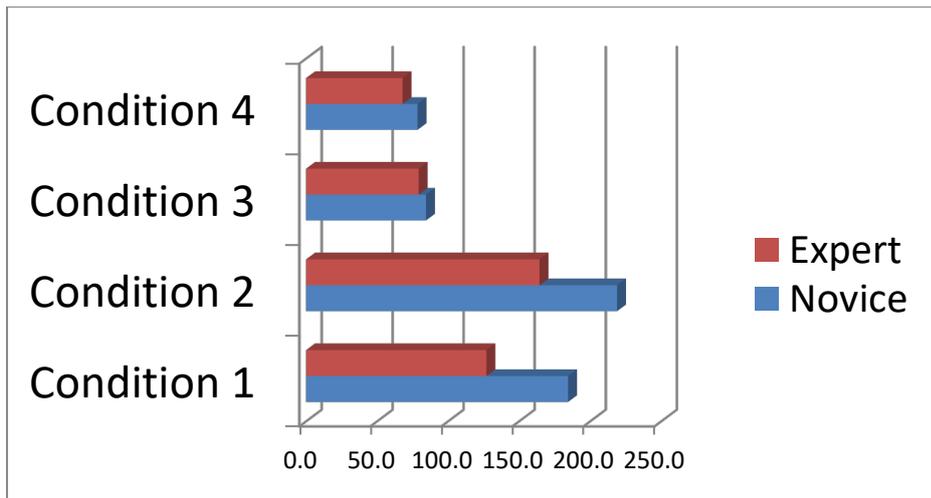


Figure 2 Total Force per Transfer (Expert vs Novice handlers)

Fig 3 shows the mean peak and mean average force applied for individual participants. This data rebalances the effort for the individual delivering the single person transfer. Condition 3, the two person oblique position showed the lowest force (ANOVA $p < 0.000$ against all conditions). The order of effort for each of the tasks was repeated for peak and average forces applied.

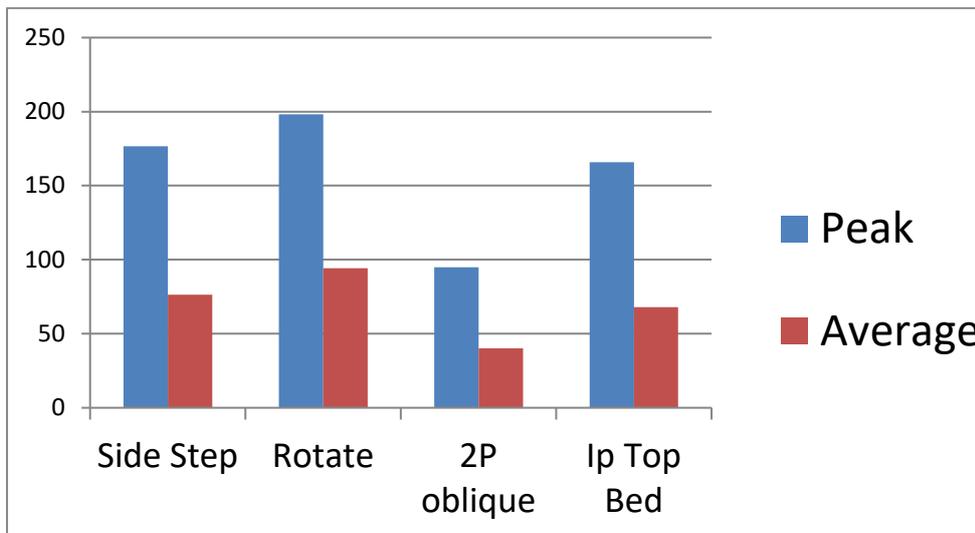


Figure 3 Force per Individual (L and R hand)

As this trial collected individual hand data it was possible to compare hands and position relative to the bed (e.g. shoulder vs hip hold). Figures 4 and 5 show limited differences between left and right and up and down. Some participants reported differences in the load especially between medial and lateral rotation in Condition 2 Rotation. The Anova Analysis showed no differences between the conditions

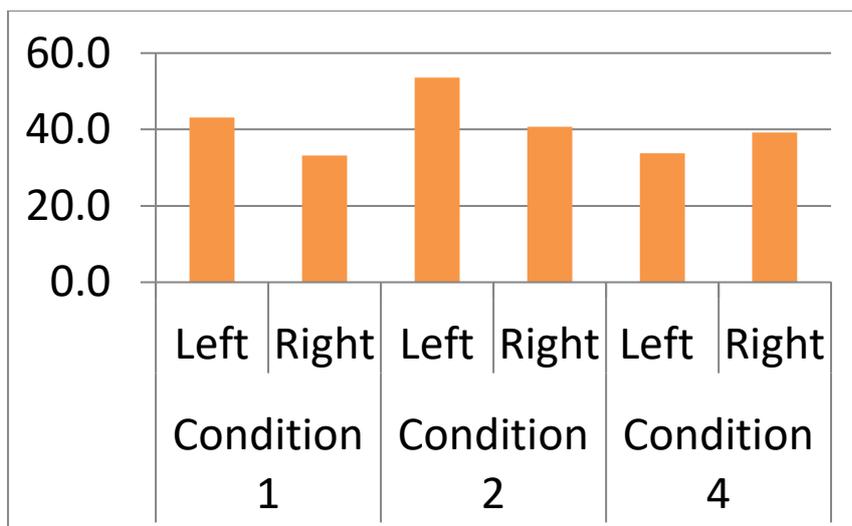


Figure 4 Left vs Right Hand for Two Person Transfers.

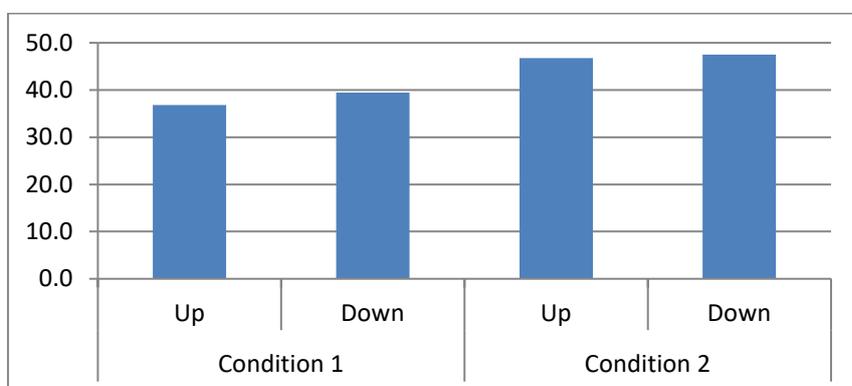


Figure 5 Upper Hand vs Lower Hand in Transfers at Side of Bed

5.0 Discussion

Direct force measures for individual hand loads have rarely been reported in safe patient handling studies. This study, though small, compared the forces and the carers appraisal of a simple transfer using 4 different locations around a bed. It was shown that individual loads for all these transfers including the single person (4) did not exceed the recommended load per individual but there were significant force differences between the conditions. The force to complete the rotation condition (2) was significantly higher than the comparisons. Novices applied more force than experts in all conditions and the relative risk grew the higher the original force which indicates a multiplication of error for less skilled carers.

Though the physical evidence is clear, that the two bedside actions deliver higher forces to the carers, this exploration only measured the total force application. One reason why these two actions may be higher is the use of combination movements. When standing in parallel to the bedside participants had a tendency to take up slack

in the side sheet before the lateral movement up the bed. This adds a vertical component to the horizontal force collected by the conditions from top of the bed, hence increased total force. This observation confirmed the views from an expert discussion group and can be seen in both novice and expert practitioner movements. Electronic goniometry, or directional force recording could be used to explore this in a future study.

Subjectively the participants recorded a significant preference for the oblique position with two carers (condition 3) for comfort and safety. The expert group also rated condition 3 as the one they individually would like to use. They did however consider that the two more hazardous methods Parallel Step (1) and Rotation (2) would be chosen by staff in their organisations. Overall the top of the bed positions scored better for comfort, safety and individual acceptance. The perception of hazard and the comments from the participants suggested that the use of lateral and medial rotation to complete the movement was regarded as harder. This would match with the relative biomechanical capacity at each muscle/joint. Shoulder flexion/extension and abduction/adduction provides a much greater capacity than rotation movements with the smaller muscles of the rotator cuff.

In the analysis of individual hand use there was no specific a pattern of note though some individual comments suggested that the alignment with the bed may have affected their perception of the relative effort e.g. left shoulder lateral rotation was harder than right shoulder medial rotation in a given transfer.

Table 4 Combined Mean Force for Each Individual (n).

Condition	Combined Mean
1. Parallel stepping	76.3
2. Rotation	94.3
3. 2-person oblique pull up bed	40.2
4. Single person pull up bed	73.0

In summary, this is the first study to evaluate the effect that position around a bed has on the forces to move a load up a bed. If the aim of Patient Handling Practitioners (PHP) is to reduce the effort on staff for all transfers then this study raises a question about the transfers stood at the side of the bed using Parallel Stepping (1) and Fixed Feet Rotation (2). Though they did not exceed the individual load per transfer there was a significant increase in the force to complete the transfer. The 2 person oblique transfer recorded approximately 50% of the force to the bed side actions. Most importantly (Table 4) both the mean peak force and the mean average force for the one person pull from the top of the bed (4) was lower than both the two bed side actions (1 and 2).

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