Do electric patient beds reduce the risk of lower back disorders in nurses?

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The aim of this study was to compare the probability estimates of lower back disorder (LBD) for a nurse performing a range of simulated patient care activities involving manual and electric patient beds. Studies of simulated patient care involving patient beds were undertaken using electrically powered and manually operated patient beds. The estimated probabilities of back injury, as calculated by the Lumbar Motion Monitor™ (LMM), between the two beds were compared statistically. A statistically significant reduction in LBD probability was observed in those functions that were completely achieved by the electrical mechanism. No significant difference in risk was observed in the patient care activities involving manipulating the patient in and around the bed that are more typical of 'heavy' orthopaedic nursing care in a busy acute ward environment. A potential for increased patient independence was observed during this trial. The LMM recorded no real risk reduction between situations involving electric or manual patient beds in those actions typically required of nurses in an acute orthopaedic ward caring for a disabled patient.

Key words: Electric patient beds; lower back disorder.

Introduction

Replacing Auckland Healthcare patient beds became a priority issue in 1998. The purchase of electric patient beds was proposed as a mechanism for reducing back injuries in nurses and improving patient independence. No specific information could be found in the medical or ergonomic literature to support this assumption and the occupational health unit (OH&S) was instructed to assess this proposal.

Auckland Healthcare has a high compensation cost for back injuries suffered by its nurses, and previous studies commissioned by the Accident Compensation Corporation (NZ) and Auckland Healthcare have identified at-risk wards [1] (orthopaedic, rehabilitation, geriatric, medical and surgical). Accident data and anecdotal comments from the staff have identified the maintenance status of the patient beds as a factor in nurses' back injuries (and strain). Equipment and nursing actions around patient beds have been identified in many studies [2–4] as potent ergonomic factors in recognized back

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incidents. Ergonomic analysis of the actions required in manually raising the head of a patient bed, raising and lowering the bed height and making a bed at the incorrect height suggests that these are substantive additives to an employee's 'back strain'.

The National Institute for Occupational Safety and Health (NIOSH) review of musculoskeletal disorders and workplace factors [5] noted associations between lower back disorder (LBD) and work-related lifting and forceful movements, heavy physical work and work-related postures, supporting in a general sense the specific findings of an excess of LBD amongst nurses [6]. The proposition that reducing these factors in nursing work will improve nursing LBD injury rates is logical, but most studies rely on questionnaires to assess risk [2,5,7]. Few studies have attempted to quantify risk objectively—including those in the nursing industry [2,6]—because of the complex interactions of patient need, privacy and required nursing actions.

Although Auckland employs >5000 nurses on shift-work, the number of nurses suffering back injury is relatively small (25 back claims in 1998–1999, costing NZ$206 000 per annum). Therefore, using incident injury rates as the measure to assess the impact of any

single intervention would be fraught with difficulty. Significant back injury in nurses is a multifactorial problem and Stubbs argues that it should be considered to represent a culmination of minor injuries or 'back strain', rather than as a direct consequence of one specific 'unsafe' incident [8]. It was therefore decided to compare 'unsafe lifts' between the two different pieces of equipment (while carrying out the same nursing functions), rather than attempt to accumulate sufficient back injuries to achieve a statistically significant result.

The Lumbar Motion Monitor™ (LMM; a commercial device marketed by the Chattanooga Group) predicts the probability of tasks causing an occupational LBD. This probability assessment is based on 'recommended' ranges of flexion, sagittal bending and rotation of the back [9]. The LMM is an electrogoniometer, worn as an exoskeleton of the spine, that is capable of assessing the instantaneous position of the thoraco-lumbar spine in three-dimensional space (see Figure 1). The risk estimate, presented as a percentage, is of the probability of membership of the high-risk category of LBD, and has been developed and validated in a number of experiments [10] and trials [11,12]. Marras et al. [11,12] originally proposed that the LMM could be used to assess the LBD

risk of various methods of carrying out a manual handling task in an industrial setting.

This method of measuring 'safe' and 'unsafe' lifts was chosen above other alternatives, such as video filming of nurses carrying out usual activities and scoring the video for lift safety, because of administrative simplicity, uniformity of interpretation, accuracy and lack of intrusion on ward activities. Despite the bulk of the model of LMM used, the nurses quickly adjusted to wearing this device during a pilot trial and did not find it particularly intrusive in their activities.

Marras calculated that this method is twice as accurate as video analysis techniques, such as the Ovako working posture analysing system (OWAS) [13], for the assessment of back movement and LBD risk.

Method

Two identical acute orthopaedic wards were outfitted with new beds. One ward received electric beds (M5 Electric Ward Bed, Howard Wright Ltd, New Plymouth, New Zealand) and the other received new manual patient beds (Howard Wright M5 Ward Bed, an identical bed without the electric mechanism).

Figure 1. The Lumbar Motion Monitor.
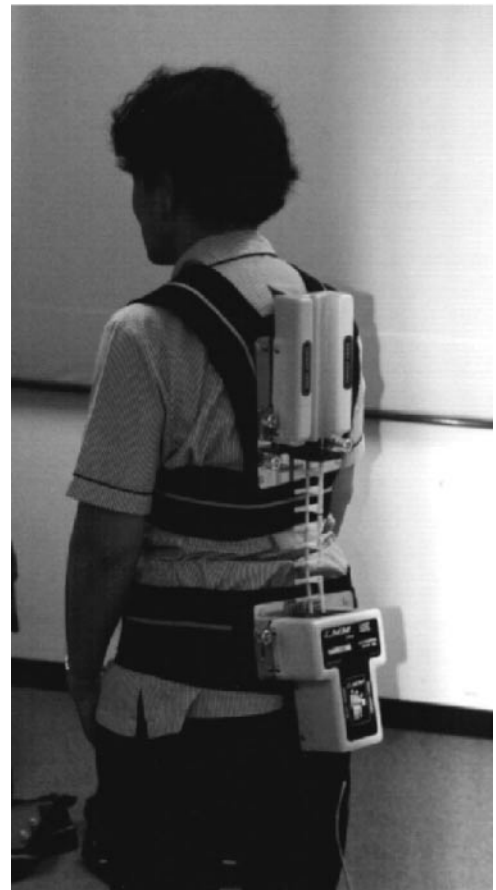
Initially, it was intended to use nurses from each ward carrying out actual patient care in the evaluation. However, the heavy acute patient load throughout the time of the trial made the use of ward nurses too difficult in the daily functioning of the ward, so that OH&S staff carried out the comparison.

The following nursing activities were simulated for each type of bed. One staff member (a female nurse of 169 cm height and weighing 85 kg) acted as the nurse, one staff member (a male of 190 cm height and weighing 88 kg) acted as the patient and a third staff member operated the LMM. Each action was repeated until 20 measurements of <3% variance of risk estimate were obtained (i.e. each repetition was accepted or rejected manually before proceeding to the next repetition).

The actions simulated were as follows.

1. Lifting the head of the bed with a patient in the bed.
2. Raising and lowering the bed with a patient in the bed.
3. Changing the patient's position in the bed. This consisted of:
   (a) lowering the head of the bed from the semi-recumbent to the prone position;
   (b) shifting the patient up the bed;
   (c) raising the head of the bed again to the semi-recumbent position.
4. Transferring the patient from the bed to a chair alongside the bed. This consisted of:
   (a) lowering the bed and flattening the head of the bed;
   (b) raising the patient from the lying position to sitting on the edge of the bed;

(c) transferring the patient to a chair alongside the bed.

Estimations of nursing satisfaction, patient independence and ongoing operating costs are the subject of reports by other departments.

Results

The results are presented in Table 1 as the risk assessment of each task, calculated by the LMM. All tasks were undertaken a total of 20 times to within 3% variance. The LMM provided an averaged result from the 20 repetitions. Using the percentage risk probability developed by the LMM, the relative risk for the same actions between the electric and manual beds was calculated, together with confidence intervals using Epi Info. Significant relative risks are marked with an asterisk.

Specific tasks (e.g. shifting a patient from the bed to a chair) were broken down into the component actions. The LMM provided a risk assessment of individual components and an average overall risk probability of the complete action.

Discussion

The specific factors identified as being related to the onset of back pain include obesity [1], a history of a previous back injury, age, shorter duration of employment, recent job change, overtime, being female [14], psychosocial stressors [15] and heavy manual work [16]. NIOSH, in its metanalysis of the work relatedness of some musculoskeletal disorders, summarizes the evidence as follows:

Table 1. A comparison of overall risk assessment of LBD between manual and electric patient beds for nurses carrying out nursing functions

Average overall probability (LMM)	Manual (%)	Electric (%)	Relative risk (RR)	95% confidence interval of RR
Tilting bed				
Tilting bed head up	61.00	5.00	12.2*	5.12–29.08
Tilting bed head down	57.00	7.00	8.14*	3.91–16.97
Altering height of bed				
Releasing and lowering bed	44.00	7.00	6.29*	2.98–13.28
Raising bed	48.00	24.00	2.00*	1.34–3.00
Shifting patient in bed				
Lowering head of bed	64.00	26.00	2.46*	1.71–3.53
Raising bed to ergonomic lift height	55.00	23.00	2.39*	1.60–3.57
Shifting patient position in bed	51.00	51.00	1.00	0.76–1.31
Lowering bed to patient safe level	66.00			
Re-raising head of bed	62.00	28.00	2.21*	1.56–3.14
Average overall risk probability	66.00	53.00	1.25	0.99–1.57
Transferring patient from bed to chair				
Lowering bed	41.00	24.00	1.71*	1.12–2.60
Raising patient from lying to sitting	43.00	45.00	0.96	0.70–1.31
Transferring patient from bed to chair	54.00	57.00	0.95	0.74–1.21
Average overall risk probability	59.00	57.00	1.04	0.82–1.31

*Significant relative risk.

a   there is evidence for a positive relationship between back disorder and heavy physical work.

b   there is strong evidence that lower back disorders are associated with work related lifting and forceful movements.

c   there is evidence that work related awkward postures are associated with lower back disorders.

d   there is strong evidence of an association between the exposure to whole body vibration and low back disorder.

Manipulation of patients in and around patient beds fulfils all these criteria, apart from the association with whole body vibration. Electric patient beds seem to reduce some 'heavy physical work', some of the 'work related lifting and forceful movements' and some 'work related awkward postures', but this reduction was overshadowed when more complex patient/nurse interactions occurred around the patient bed.

The trial had to substitute simulation of nursing tasks rather than use nurses working in real situations. Although unsatisfactory, this compromise was forced on the trial due to a mixture of staffing and workload issues (it was the middle of the New Zealand rugby season), and complicating factors such as patient consent and privacy issues. The simulated nature of the activities would tend to lead to an underestimation of the risk (in comparison with actual nursing duties), but should not affect the comparison of similar actions between two pieces of equipment fulfilling the same patient function.

Marras *et al.* [11] do not claim that the LMM proves a causal link between the action and LBD, but they do suggest that it has a role in providing 'a quantitative, objective measure to design the workplace so that the risk of occupationally related LBD is minimized'.

Using this equipment and risk calculation proved the common-sense proposition that the electric bed would reduce the number of unsafe lifts where it removed the need for nurses' manual participation in that activity. There was a reduction in calculated risk for these somewhat artificial circumstances of between 2- and 5-fold.

When more real nursing functions were simulated, the reduction in overall calculated relative risk was unchanged, or reduced in a non-significant manner. This is logical in that the parameters of the more complex actions undertaken (patient weight, distance to move patient) are far more momentous than the rather limited parameters of those actions superseded by the electric bed (leaning forward, lifting the weight of the head of the bed, etc.).

This study (using only one nurse) did not allow for the assistance of another nurse during the at-risk procedures (shifting the patient up the bed, transferring the patient into a chair). However, this probably reflects the unfortunate reality of nursing in many hospitals, and the issue at question (do electric beds reduce risk in comparison with manual beds?) would not be altered by increasing the number of nurses on both manual and electric bed actions.

Conclusion

Using the method of estimating risk probability, the use of electric patient beds appears to reduce the number of unsafe lifts and, hence, could contribute to reducing back injuries amongst nurses. Because of the multifactorial nature of back injuries, any such reduction from a single, independent intervention will be hard to quantify. Unaccompanied by other significant back-sparing interventions (buddy lifts, ceiling track cranes, hoists, adequate staff numbers, etc.), it does not appear that electric patient beds will, by themselves, significantly reduce the overall risk to nurses of LBD and, hence, the overall cumulative injury rate. From observation, these beds have considerable potential to reduce the patient 'housekeeping' burden in the alert, well-orientated patient. However, it appears from this study that any reduction in back injury costs would not justify the purchase of this equipment.

Acknowledgements

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