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An efficiency evaluation of different hoisting devices to complete three frequent patient transfers.

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Abstract. The aim of this study was to compare the efficiency and staff preferences of three different hoisting devices when completing lying to sitting and sitting to sitting transfers. The study explored time, task steps, physical environments and staff preferences.

The study used 15 experienced participants in manual patient handling. Three basic transfers were completed: Bed to chair, Chair to wheelchair and Wheelchair to bed, with two overhead hoists (fixed single track and H-frame) and one floor-based mobile hoist with a manikin load. Data were collected on time taken to complete the tasks and task stages. The stages needed to perform the tasks were reported through Hierarchical Task Analysis (HTA). Subjective data on ease of use and a comparison of steps/time were collected after each device use.

There were no statistical differences in the time taken between the transfer types ($P > 0.1$). The mobile hoist took significantly longer than the two gantry devices (Post hoc analysis $P < 0.001$). HTA analysis showed added physical and positional tasks were required due the space constraints of the mobile device. Participants reported the H-Frame device to be quicker, required less stages to complete the task and was considered more accurate. Subjectively there was an order of preference of H Frame, Single Track and Mobile device.

The time difference between H-Frame gantry hoist and Mobile hoist was calculated at 90 seconds per transfer which cumulatively over a working week can add up to a significant time saving.

Keywords: Patient Transfers, Efficiency, Assistive Devices.

1 Introduction

There is an increasing emphasis on the frequent mobilisation of patients both in acute and long-term care, which adds physical stress and workload to care workers. The use of hoists has become an essential part of delivering safe health and social care services. Jung & Bridge (2009 [1]) in a systematic review reported evidence to suggest a decrease in musculoskeletal injuries and physical stress when compared to a mobile hoist and manual handling techniques. Though other reviews [2, 3, 4] still cast doubt over the full benefits of the implementation of assistive technology it has become accepted best practice to hoist for full weight patient transfers.

The care environments have many complexities that impinge on hoisting activities and restrict full implementation. Space constraints [5], layout restrictions and the forces to manoeuvre hoists all affect acceptance [6, 7, 8].

There are important differences between the two main types of lift devices; floor lifts (devices that roll on a set of wheels on the floor) and overhead lifts (lifts that are suspended from a track attached to the ceiling). Some research has shown that overhead lifts are preferred to floor lifts [9, 10, 11, 12]. Commonly, in discussion, staff state time as a restriction to utilizing hoists in care work opposed to more hazardous manual transfers. Not since Bell (1984) had time studies been used to support the implementation of hoisting in clinical practice [13].

The aim of this study was to report the length of time and number of steps taken to carry out a number of tasks using ceiling hoists, fixed track and H-frame, and a mobile hoist which was supported by the subjective evaluation by experienced users.

2 Methods

2.1 Study Design

The study was conducted at Loughborough University's Design School. The study was a laboratory based observational trial, to analyse the Hoist-Task combinations to understand the interaction of these two- variables. Ethical approval was granted by Loughborough University. Informed consent was collected with each individual. A pilot study ensured feasibility for the main research [14] to evaluate timing, activities and that instructions were clear and concise. The pilot was also used to review data collection documentation [15].

Purposive sampling was used for recruitment [16] inviting experienced care workers (n=15) from known locations and groups. The latin squared design was used for the order of the hoists used in order to eliminate the bias of learning the Hoist*Task combinations as the session progressed [17].

All participants carried out 3 transfers with each hoist in the following order which represented a series of transfers as they would be used in a ward situation:

- Bed to Chair
- Chair to Wheelchair
- Wheelchair to Bed

Each set of transfers were completed with the 3 types of device (provided by Guldmann ab). All devices had the same handset and motion available to standardize the information.

- A ceiling track free-standing rail system (H-Frame movement)
- A ceiling track system with only X-Y movement (Fixed Track)
- A floor standing Mobile Hoist

All were used in line with company guidance and agreed fittings and slings. Each transfer was controlled to ensure consistency and validity of the data. The following controls were used:

- Standard room dimensions and room boundaries were used for every task
- The sling was fitted to the mannequin and then placed in the same position for each transfer
- The room had a standard position before the next task began.
- All hoists and equipment were placed in standard positions for the start of each transfer

2.2 Protocol

A series of background context questions were asked to gain an understanding of the participant's experience, types of equipment used, and regular hoisting activities carried out.

Participants were familiarised with the equipment used in the study. They were allowed to use the equipment to get a "feel" of how it worked and to ask any questions they had about the room, equipment or tasks to be carried out. Due to the sampling methods chosen all participants had hoisting knowledge, but all were given instructions so that they were familiar with the equipment and the operation of the chosen hoist.

Participants were introduced to the series of tasks that needed to be carried out, in the following order: Bed to Chair, Chair to Wheelchair, Wheelchair to Bed. The Latin squared method design chose the order of the hoists, participants were told which hoist to use for each transfer.

The sling was fitted to the mannequin before each task, so the participant did not need to do this activity. Instructions were provided on the task that was to be carried out and participants were informed that the task would be completed when the hoist was moved clear of the patient and they needed to stop once they had completed one transfer. The room could be set up and returned to its original position. After the three tasks were completed a questionnaire relating to the hoist was given to the participant. This was repeated until all three hoists had been used.

2.3 Data collection

Data were collected for each transfer task (n=9 per participant).

Video. Each session was recorded on video camera, so the responses could be corroborated retrospectively, and detailed analysis of the activities carried out in case of any follow up or queries on the study.

Interview. The interview responses were recorded on a pre-defined proforma, for all activities and participants.

Time. Measurements of time taken were collected for all activities and noted in the Topic Guide. The time stamps on the video were recorded for future reference.

Questionnaire. Comparative data was gathered, through a questionnaire, on subjective rating on time and steps needed to complete the tasks. This was to ascertain how the Hoist/Task interaction varied in compared to their normal hoisting.

Task based questions. A series of task-based questions were asked to complete the session. An evaluative interview was carried out and the participants had the opportunity to discuss what they thought of the hoists and discuss any areas of concern when carrying out the activity.

2.4 Data analysis

The interview data was coded and tabulated for comparison across the transfer types and hoist types. The Task-based question responses were used to provide a narrative for the discussion.

Time data was recorded using time stamps from the video and the actual time taken to complete the task in seconds. The following analysis was completed.

- Mean times, with standard deviation, of all Task*Hoist combinations
- Test for normality – Shapiro-Wilks
- Two-way Repeated Anova with Mauchly's Test for Sphericity and Post Hoc Tukey Tests where required.

Tabular Hierarchical Task Analyses (THTA's) were created for all Hoist-Task combinations. The data recorded included time taken for each sub-activity of the main activities completed [18]. Comments were recorded where appropriate providing an insight into the actions of the participant with any mistakes or errors noted.

Questionnaire data recorded the frequency of all responses and used to show comparative ease of use, perceived time and steps to complete task.

3 Results

Fifteen participants completed all transfers in the trial (n=9 each). Two video recordings were partially incomplete (P4 & P7) and one participant omitted some subjective responses, P10. The participants all reported a long history of patient handling and had positions of patient handling responsibility in health or social care.

3.1 Time Taken for Tasks

The data in figure 1 shows the Wheelchair to Bed is the slowest task overall, taking 186s and the quickest transfer is Bed to Chair taking 176s. There is a 10s difference between

Figure 1. Mean times for all tasks with all hoists

the slowest and quickest task. The Bed to Chair had the largest standard deviation at ± 53.661 and the lowest was Wheelchair to Bed at ± 49.636 , a difference of 4.025. Statistical analysis confirmed that across the transfer types there was no notable difference in times ($P > 0.1$)

3.2 Time Taken for Different Hoist Types

Figure 2 below shows the mean time for each transfer with each hoist. All mobile transfers took longer than any of the ceiling track ones. The H-frame system was the quickest marginally than the fixed track system. The overall difference between the mobile and the H-frame was 90 seconds per transfer activity from loops on to loops off.

Figure 2. Mean times for each transfer all tasks with all hoists

When comparing the transfer type data and the hoist type the two-way repeated measures ANOVA showed that there was significant effect from the hoist type but not from the transfer type, Table 1.

Table 1 Results of the Two-way repeated ANOVA

	Sig	df	f
Hoist Type	0.000	2	113.62
Transfer Type	0.111	2	2.41
Hoist*Transfer	0.250	4	1.39

The post-hoc analysis (Tukey HSD) showed Significant difference between the mobile and both ceiling track systems ($p < 0.001$) but not between the two track systems ($p = .492$) even though the H frame was quicker for all tasks.

3.3 HTA Analysis

THTA's were completed for all video recorded transfers in the trial ($n=125$). The core phases identified were attaching the sling, raising the patient, moving from A to B, lowering the patient and removing sling. The speed of actions was uniformly ranked

with the H frame the quickest, followed by the Fixed Track and the Mobile was slowest in all phases. In addition the mobile hoist required the longest time for moving the hoist and had the most time allocated to the re-arrangement of the room and or furniture. The breaking down of the transfers with a simple HTA method clearly identifies the time differences and explained the significant time savings with the H-Frame system.

3.4 Subjective Responses

The subjective responses showed that most experienced carer's preferred the H-Frame device, rating it best for time taken, ease of use and steps taken. The feedback also gave a more noticeable difference between the two ceiling track systems. Ratings showed a clear preference for the H frame over the ceiling track and the participants showed some clear judgements as to their logic of choice.

- Mobile Hoist
 - Space was an issue
 - Time consuming with a single carer, and was seen as a 2-person transfer
 - Postural comprise
 - Thought needed to complete the activities
- The Ceiling Track (Fixed)
 - Difficulty in positioning the hoist and extra manoeuvring of equipment was needed
More steps required than the H-frame
 - Very Easy to operate and move the hoist
 - Less effort required to hoist the patient
- The Ceiling Track (H-frame)
 - Easy to position the hoist as there was minimal preparation
 - There was no restriction to the access of the hoist

Figure 3. Subjective reasoning from participants

4 Discussion

There is a significantly greater difference between the Mobile Hoist and the Ceiling Track (H-frame) hoist. This difference of 90s for all tasks between the two hoists is an important finding, as nurses currently have a heavy workload and a cutback on staff time is an important factor in their job [19]. A heavy workload often means stress is placed on the nurses, and with a link between stress and Musculoskeletal disorder (MSD) in the workplace, these issues are the most common in work related ill health. The Health and Safety Executive Report found “that there is high exposure to both physical and psychosocial work risk factors resulted in the greatest likelihood of reporting musculoskeletal complaints” [20]. Therefore, with more time to complete other tasks this could potentially reduce the workload and stress levels for the nurses, resulting in fewer reported cases of illness due to MSD’s.

The HTA review identified that the extra bedside space occupied by the floor standing mobile hoist caused many adaptations to the workers behavior. They were required to bend and reach increasing postural risk, make more physical moves to complete the transfer. Move heavy furniture and create space to access the destination surface. Accuracy and ease of use judgements were also affected by the use of the mobile hoist.

The implications on time saved through using a Ceiling Track (H-frame) over the Mobile Hoist can provide significant benefits for the carer and health care organisation. Considering a ward that requires 30 transfers a day, the analysis from this study identifies a potential saving of 45.5 minutes using the Ceiling Track (H-frame) and 8.5 minutes over the Ceiling track (Fixed). This is therefore a more efficient use of the carer’s time enabling them to concentrate on other aspects of their job. The time saved could potentially present a cost benefit, even through the Ceiling Hoists are more expensive than the Mobile Hoist initially [21]. This type of study that identifies cost and time efficiency should assist care organisations to support the implementation of safer patient handling and mobilization as sound business sense not just for carer safety.

The aim of this study was to confirm the time and quality differences between the different hoist types. This was best delivered in a laboratory study. But this is the studies main limitation as it does not reflect the complexity of real healthcare situations. A timing and efficiency study in a real setting should support these findings. The design of the tasks to not include the application of the sling and locating and moving the equipment may indicate further time savings in the real world. Providing sufficient numbers of hoists and slings, especially the overhead systems over each bed should enhance the time saved against shared hoists and slings.

5 Conclusion

This study restricted the analysis to the actual transfer from surface to surface but showed a significant time saving. Product designers, ergonomists and those involved in the design of effective care need to closely inspect these findings and consider where future efficiencies may be identified. Hoist and sling design to allow rapid application and removal. Possible consideration of the removal of the sling with

hoistable clothing or another innovation. The exploration for opportunities to make environments more task friendly, possible removal of repetitive or un-necessary actions. Rightly quality of care delivery has been a focus in many healthcare ergonomics projects but efficiency in core care activities will release time to allow carers to deliver other aspect of care with less time pressure.

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