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Reducing back stress through an ergonomic approach: weighing a patient

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Abstract—Back problems are prevalent in nursing personnel. Nursing assistants in a nursing home stated weighing dependent patients was a very stressful task; they manually lifted patients up onto a chair scale. The task was redesigned in two ways: the use of a ramp scale and use of a hoist with a digital scale. With the new methods, perceived physical stress to shoulder, back and body was reduced, compressive force to L5S1 and shear force were reduced (wheelchair scale method), and "patient" feelings of comfort and security were increased.

Introduction

Back problems resulting from over-exertion are prevalent among nursing personnel. Klein *et al.* (1984) found that nursing personnel ranked fifth in occupations claiming worker compensation for back injury; only heavy labor occupations such as garbage collectors, miscellaneous laborers, and warehouse workmen ranked higher than nursing personnel. The lifting and transferring of patients have been perceived by nursing personnel to be the most frequent precipitating factors or triggers of these back problems (Harber *et al.*, 1985; Jensen, 1985; Owen, 1989; Stobbe *et al.*, 1988; Stubbs *et al.*, 1981; Valles-Pankratz, 1989; Venning *et al.*, 1987).

Many approaches to decreasing back problems have been tried in general industry as well as in health care institutions and home care. Emphasis has been primarily on education and training with a definite focus on body mechanics. However, these approaches have had

little impact on the problem. Studies have indicated that an ergonomic approach involving the assessment of stressful tasks and development of alternative methods can reduce the potential for over-exertion problems (Owen and Garg, 1991; Garg *et al.*, 1991).

Ergonomics is the scientific study of human work (Pheasant, 1991). This generally involves the approach of matching the job to the worker rather than trying to fit the worker to the job. The goals are to identify those aspects of the job which are particularly hazardous and to redesign them so they are safer. This may be done through such avenues as redesign of the task, the product, the work station, the environment or the overall work organization.

Therefore, in order to decrease the back stress problem in nursing, nursing personnel must begin to look at the tasks which they feel are stressful to the upper and lower back. This group of health professionals should delineate approaches to decreasing that stress. They must be encouraged to problem-solve and work with management in striving for changes that could impact on the problem which is costly in relation to human suffering, staffing and financial cost.

The following is an example of an ergonomic approach whereby nursing assistants in a nursing home identified a stressful task, the task was evaluated, alternative methods for carrying out this task were tested, recommendations were made, changes were implemented, and the stressfulness felt was reduced.

Nursing assistants from a large county nursing home were invited to identify their most stressful tasks carried out in a typical work day. Thirty-eight of the 57 nursing assistants caring for 140 residents/patients volunteered to identify stressful tasks. Weighing residents was one of the tasks perceived as most stressful by this group.

In many clinical settings the task of weighing a patient is carried out by manually lifting or transferring the patient, yet there is little guidance in the nursing literature about how to complete this task. Most recommendations deal with proper lifting techniques, body mechanics and back care (Christensen and Kockrow, 1991; Craven and Hirnle, 1992; Greenwood, 1986; Kemp *et al.*, 1989; Kozier *et al.*, 1991; Potter and Perry, 1993; Scholey, 1984; Timby and Lewis, 1992) and are generally for tasks of transferring patients in and out of bed, repositioning patients in bed, and lifting patients from the floor. The task of weighing patients is seldom mentioned, yet some patients must be weighed daily while others may be weighed once a month. The objectives of this study were: 1. Evaluate the existing method of weighing patients in the nursing home. 2. Redesign the task so as to decrease the physical stress to the nursing personnel (to be done in the laboratory setting). 3. Apply the results from the laboratory setting to the clinical setting as part of actual patient care.

Method

Present method used for weighing patients

The present method for weighing patients in this nursing home involved transferring patients from a wheelchair or geriatric chair up into a weighing-scale chair and then back to the wheelchair or the geriatric chair. The scale chair was mounted on a weighing platform, which was 21.5 cm high, 50 cm wide and 68.6 cm long. The chair seat height was 53.3 cm from the floor and the arm rests were 71.1 cm from the floor. The front edge of the chair was 22.2 cm behind the front edge of the weighing platform (see Fig. 1).

To weigh the patient, two nursing assistants pushed the wheelchair close to the weighing

Fig. 1. The manual lifting method: grasping the patient under the axillae, lifting the patient out of the wheelchair, carrying/transferring the patient to the chair on the weighing platform.

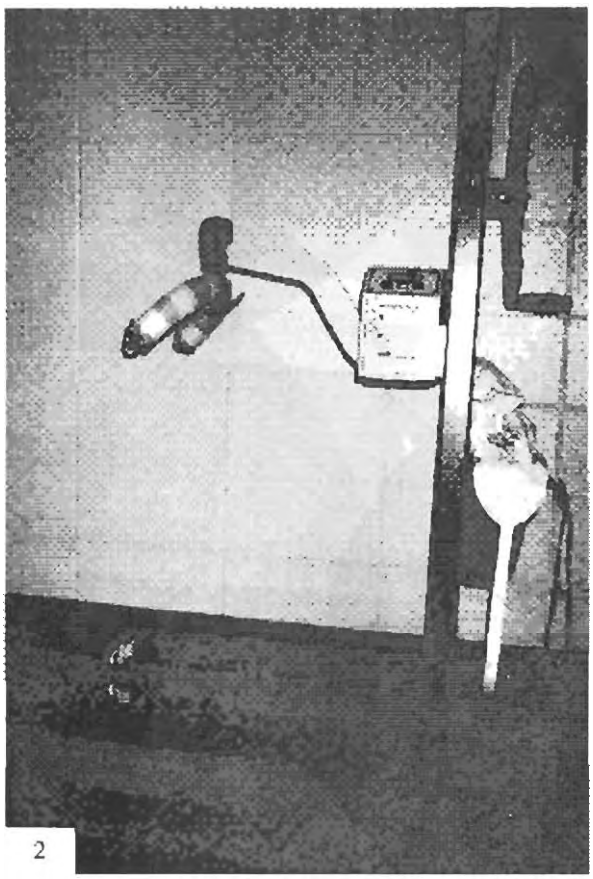

Fig. 2. Hoist and attached scale.

Fig. 3. Wheelchair weighing scale on weight platform.

platform. They stood near the patient and grasped the patient under the axillae with one arm near the elbow. They lifted the full weight of the patient off the wheelchair, carried the patient up onto the chair on the weighing platform, and set the patient down on the weight chair (Fig. 1). This required that the patient be lifted up to the height of the chair (53.3 cm) and then guided between the arm rests before being seated. The same procedure was used in reverse for transferring the patient from the weighing chair to wheelchair. The average weight of the patients in this study was 60 kg (sd = 14.1, range = 37–120 kg); therefore each nursing assistant routinely lifted an average of 30 kg up into the weight chair and then down again from the weight chair.

Alternative methods for weighing patients

Two popular types of devices that were commercially available for weighing dependent patients were explored: (1) scales attached to mechanical hoists and (2) scales with wheelchair ramps. Most mechanical hoists include a digital scale as an optional accessory for weighing patients. A patient can be weighed while being lifted off a bed or chair by simply pressing certain controls on the hoist. Based on nurses' and patients' feedback from a previous study focusing on transfer tasks such as bed to chair and chair to bed (Garg *et al.*, 1991), a hoist with a scale attached was selected for weighing patients (Fig. 2).

The second weighing device selected for study is similar to the type of scale found in most health offices, except that it has a wheelchair ramp and a platform for covering the scale. Based on discussions with nursing home personnel, a wheelchair ramp weighing scale was selected for this study (Fig. 3). The ramp was 75 cm long, 68 cm wide and 9 cm high from the floor.

Subjects

Six female senior nursing students participated as subjects in the laboratory study; all had at least one year of experience with the lifting and transferring of patients. (Four of the six were also working as nursing assistants.) They served both as nursing assistants and as "patients". When serving as patients they were instructed to act as passive patient models and not to assist in supporting their own body weight. In this manner they at least resembled the actual patient by weight to be lifted. A nurse observer was present at all times to monitor these instructions.

Their mean age was 22.5 years (sd = 0.8, range = 21–23); mean height was 165.3 cm (sd = 6.3, range = 157–175); and mean weight was 63.3 kg (sd = 10.8, range = 54–79.5).

Procedure

Experimental procedures and data collection forms were explained to the subjects. The three patient weighing procedures were demonstrated (the present method used for weighing, weighing while being transferred via hoist, and weighing through the use of the wheelchair scale ramp). Before any data were collected, the subjects were asked to try each procedure a few times until they felt comfortable with it. The manual lifting technique was studied first, followed by pushing the wheelchair onto the scale ramp, and then weighing by use of the hoist. After completing a given patient weighing procedure, the nurse subjects were asked to rate their perceived physical stresses for shoulder, upper back, lower back

and whole body on a 10 point scale of 0 = no stress to 9 = very stressed (Webb, 1983; Blache *et al.*, 1987). The patient subjects were asked to rate how comfortable they felt using an eight point Likert scale (0 = extremely comfortable and 7 = extremely uncomfortable); likewise, they rated their feeling of security on a scale of 0 = extremely secure and 7 = extremely insecure. Each patient weighing procedure was timed and videotaped.

After completion of both the manual lifting and pushing methods, the subjects were asked to assume their initial postures and body angles were measured. Pushing forces were measured at the initial pushing movement using a hand force dynamometer. The compressive force on the L_5S_1 disc was estimated using a three-dimensional static biomechanical model (Garg and Chaffin, 1975). Briefly, the model involved simulation of the task, computation of forces and moments (resultant moments) at various body joints, and comparisons of these forces and moments with volitional forces and moments (muscle strength) to estimate the percentage of male and female populations that could be expected to perform the task occasionally without over-exertion. The input to the model consisted of body joint angles (elbow; shoulder—horizontal and vertical angles; foot; humeral and trunk rotation angles; trunk lateral bending angle; and the angles of hip, knee, and ankle) or hand coordinates with reference to the center of the ankle joints, a gross body posture (such as stoop, squat, stand, lean, etc.), and the direction and magnitude of hand forces. The output from the model consisted of the percentage of male and female populations capable of performing a given manual materials handling task, limiting muscle groups, and provided an estimate of compressive force on the L_5S_1 disc.

Results

Biomechanical evaluations, ratings of perceived stresses from nurse subjects, comfort and security ratings from "patient" subjects, and the amount of time it took to weigh the patient are summarized in Table 1. As anticipated, pushing the wheelchair on the ramp

Table 1. Summary of biochemical evaluation, physical stress ratings, patient comfort and security ratings, and transfer times for three different methods of weighing patients

Variable	Manual lifting		Pushing wheelchair on scale		Using hoist	
	Mean	SD	Mean	SD	Mean	SD
Hand force (N)	312	54	78	8	—	-
Compressive force (N)	4960	160	1258	29	—	—
Shear force (N)	890	47	125	6	—	—
Stress ratings*						
Shoulder	7.0	1.2	1.5	1.0	3.0	1.15
Upper back	6.8	0.9	1.2	0.8	2.0	1.1
Lower back	6.2	2.0	1.3	1.1	1.5	1.2
Whole body	6.6	0.8	1.2	0.8	1.9	1.0
Patient comfort rating**	5.8	0.3	0.7	1.0	1.8	1.6
Patient security rating***	5.3	1.6	0.3	0.6	0.7	0.9
Transfer time (seconds)	15.7	2.0	8.2	0.8	150.0	26.2

Scales:
*0 = No stress, 9 = Very stressed
**0 = Extremely comfortable, 7 = Extremely uncomfortable
***0 = Extremely secure, 7 = Extremely insecure

required a substantially lower force than lifting the patient to the weighing-scale chair. The estimated compressive and shear forces at the L_5S_1 disc were significantly reduced. The average initial pushing force of 78 N is well within the pushing strength needed for the average female worker (Snook and Ciriello, 1991). The estimated mean compressive force at L_5S_1 of 1258 N for pushing a wheelchair is well below the 3430 N limit (for action limit) recommended by the U.S. Department of Health and Human Services (1981). In general, the shoulder was the body part most stressed. Manually lifting the patient was perceived to be the most stressful technique while pushing the wheelchair was perceived to be the least stressful (Table 1). The manual lifting technique was perceived as being between "definitely stressed" and "very stressed", the hoist between "just noticeable" and "noticeable stress", and pushing the wheelchair onto the weighing platform slightly less than "just noticeable" stress.

Being allowed to remain in the wheelchair was perceived as being the most comfortable and secure by the patient subjects, followed by the hoist, and then by manual lifting. The techniques of being pushed in the wheelchair and in the hoist were rated as highly comfortable and secure, but being manually lifted was rated as highly uncomfortable and insecure by the patients.

Pushing the wheelchair onto the weighing ramp required the least amount of time; using the hoist to weigh the patient required the largest amount of time.

Discussion

Based on the results of this laboratory study, two different methods were recommended for weighing patients in the nursing home: (1) a method using a weighing scale with a built-in ramp for pushing a wheelchair onto it, and (2) a method using a hoist with a built-in scale. Therefore, the stressfulness of the weighing task was reduced through the redesign of that task and a change in work organization. The method of manually lifting the patient was eliminated from the recommendations. In addition, through the use of the hoist scale, the task could actually be eliminated because the patient could now be weighed at a time concurrent with another on-going task, such as transfer from bed to wheelchair; hence, there was redesign of work organization.

The hoist and a weighing scale with a ramp were then made available to the nursing assistants on the two floors of the nursing home. The new procedures were taught to the nursing assistants and explained to the patients. A nurse observer then made random observations over an eight-month period and found that these recommended alternative methods were consistently used.

As mentioned above, in the clinical setting weighing through use of the hoist method was generally done in conjunction with another task such as transferring the patient from bed to chair; therefore, only scant additional time was needed for carrying out the weighing task. Time was also conserved when weighing those patients who did not require the use of a hoist; it took only an average of 8 s to complete the task using the wheelchair ramp scale. Time has consistently been discussed in the literature as an important variable for nursing staff to avoid the use of a mechanical hoist (Bell, 1984; Jensen, 1989; Owen, 1988). Time was actually saved in this study when nursing assistants took the time to incorporate weighing with other patient handling tasks.

In the study the nurse subjects experienced less stress to the shoulders and back while using the recommended alternative methods. In the clinical setting the nursing assistants

consistently informed the nurse observer that the stress to the shoulders and back was greatly reduced since they no longer weighed patients using the manual lift method.

Conclusions

The findings of this study indicated that nursing staff can indeed delineate stressful tasks and become involved in reducing that stress. They can look at their practice and test out interventions that increase the potential for safety in their workload. Should nurses be expected to lift and carry patients weighing an average of 68 kg? To be considered in addition to the weight of the patient and the distance in carrying the patient are other frequently occurring patient variables such as frailty, combativeness, pain, fractures, and unpredictability. All of these can have an impact on the safety of nursing personnel as well as the safety and comfort of the patient. Involving the staff in identifying, exploring, and testing alternatives should have an impact on the back stress in nursing personnel.

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