Ergonomics: The Development of an Ergonomics Training Program to Identify, Evaluate, and Control Musculoskeletal Disorders Among Nursing Assistants at a State-Run Veterans' Home

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Abstract:

Nursing assistants (NAs) who work in nursing and personal care facilities are twice and five times more likely, respectively, to suffer a musculoskeletal disorder compared to service industries and other health care facilities, respectively. The purpose of this study was to develop an ergonomics training program for selected NAs at a state-run veterans' home to decrease musculoskeletal disorders by 1) developing questionnaires to assess musculoskeletal stress, 2) evaluating the work environment, 3) developing and using a training package, and 4) determining the application of the information from the training package by NAs on the floor. Results show two new risk factors not previously identified for nursing personnel in the peer-reviewed literature. Quizzes given to the nursing personnel before and after training indicated a significant improvement in understanding the principles of ergonomics and patient-handling techniques. Statistical analysis comparing the pre-training and post-training questionnaires indicated no significant decrease in musculoskeletal risk factors and no significant reduction in pain or discomfort or overall mental or physical health.

Article:

INTRODUCTION

Nursing assistants (NAs) are employed in one of the nation's leading occupations at risk for musculoskeletal injuries and illnesses. In 2001, the National Bureau of Labor Statistics (BLS) reported that personnel working at extended care facilities, including NAs, were approximately five times more likely to suffer an occupational injury than those in private or service industries and almost two and a half times more likely than those in other health care services.[1] Also, the BLS reported that nursing and personal care facilities had over twice the incidence of lost work-day cases than private industries, service industries, and health services, including hospitals.

Of the musculoskeletal injuries reported among NAs, injuries to the back are the most frequently observed.[2–4] Recently, the BLS reported that NAs' back injuries occurred at almost twice the frequency as back injuries in all occupations in private or service industries, and that back injuries among NAs were much higher compared to other parts of the body.

The musculoskeletal risk factors have been identified and are associated with patient-handling tasks. Studies from the literature have identified that this high incidence of back pain among NAs and other nursing personnel is associated with patient-handling tasks that involve lifting and carrying patients, causing high levels of biomechanical, physical, and postural stress.[2,5–7]

Studies have shown that effective training helps nurses recognize and change their work environment and/or work practices to help decrease musculoskeletal injuries.[8–12] A study by Hellsing et al.[11] looked at the effect of ergonomics training on two groups of nursing students. Two different nursing schools in the same geographical region participated in the study. One group of nursing students, the control group, received the normal

ergonomics training. The other group of nursing students received extra ergonomics training as well as behavioral training.

The extra training received by the nursing students was integrated into a 2-year program with an average of 2 hours of extra ergonomics training per week. The extra ergonomics training included items such as body awareness, correct body mechanics, patient transferring techniques, pain perception, and psychosocial work environments.

Effectiveness of the extra training was determined by a questionnaire with both objective and subjective sections. The results indicated that the extra training was well received and that the students who received such training were very con-tent with their education. The trained nurses also proved to have better ergonomics techniques while working, positioning themselves in more favorable physical positions.

Because the problem of musculoskeletal injuries and ill-nesses continues to plague nurses and nursing assistants, the Occupational Safety and Health Administration (OSHA) is-sued a national news release on March 13, 2003, entitled "Ergonomics Guidelines Announced for the Nursing Home Industry."[13] These guidelines focus on practical recommendations for employers to reduce the number and severity of workplace injuries by using methods found to be successful in the nursing home environment. Training of nurses and NAs on patient-handling in nursing homes is one of the major components emphasized by OSHA to reduce and prevent occupationally related musculoskeletal disorders.

MATERIALS AND METHODS

Three different units within a state-run veterans' home were chosen to compare the effectiveness of an ergonomic training program to teach NAs good work practices and the use of engineering controls to decrease the incidence of musculoskeletal disorders. The three different units were used as three different experimental training groups (see Figure 1).

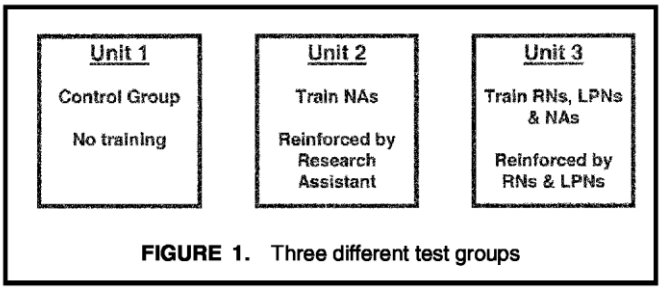

FIGURE 1. Three different test groups

The first unit, the control group, was evaluated before and after training but did not receive the actual training. The second unit was also evaluated before and after training, with the NAs being the only ones trained, in a classroom setting, by the research assistant. After the training, the research assistant reinforced this training on the floor. The third unit was also evaluated before and after training, but first the nursing personnel, including registered nurses (RNs) and licensed practical nurses (LPNs), received training by the graduate research assistant.

The NAs were then trained in the classroom either by the nurse educator from the veterans' home or by the research assistant and then supervised on a daily basis by staff nurses (RNs and LPNs) on the floor to reinforce classroom instruction. The purpose of this arrangement was to determine the difference between (1) no training, (2) training reinforced by the graduate research assistant, and (3) training reinforced by daily supervision from the RNs and LPNs on the floor.

The ergonomic training program consisted of the pre-training data that included questionnaires developed by the research assistant. The pre-training questionnaires were given to the NAs about 3 months before training and included general questions (age, education, etc.) to determine the stress of the top 20 perceived risk factors, to evaluate the pain/discomfort levels evaluating parts of the body, and to respond to a general health survey.

An evaluation of the NAs' work conditions before training was completed to determine what information to include in the training package and presentation. Information pertaining to the NAs work environment was assessed by the entire nursing staff, including RNs, LPNs, administrative nurses, and NAs, in the form of questionnaires. In this manner, the largest amount of information could be gathered from as many nurses and NAs as possible to build an effective training program ad-dressing the issues thought to be problems among the NAs at the veterans' home. The questionnaires used to assess the NAs' work environment were (1) top 20 risk factors, and (2) obstacles. Videotaping was also used to evaluate the work environment of the NAs, the purpose being to analyze the NAs' work environment in the laboratory, develop corrective actions, and then utilize the corrective actions and videotapes during the training sessions.

The training package was constructed based on the most pertinent risk factors identified by the nursing personnel from all three units using the top 20 risk factors questionnaire. A Microsoft® PowerPoint® presentation including data, digital pictures, and mini-videos was developed by the research assistant. The research assistant then used the training package to train the nurses in correct ergonomic work practices, administrative strategies, and the use of engineering controls. In addition, the information gathered from the obstacles questionnaire was used with time and emphasis devoted to each of the engineering controls, administrative strategies, and work practices that the nurses felt were top issues preventing them from performing their tasks.

Before the training presentation started, the nursing personnel were given a pre-training quiz. The final quiz was given after the training was complete. The purpose was to look at each nurse's quiz, both pre- and post-training, and statistically compare them to determine if the information was passed on correctly by the research assistant and if the nursing personnel understood and retained the information.

One month after the training was completed, post-training questionnaires were given to the NAs on all three units. The post-training questionnaires were the same three questionnaires given before training. Each of the three post-training questionnaires was scored in the same manner as the pre-training questionnaires and then compared using statistical analysis. In this manner a quantitative comparison between the pre- and post-training questionnaires determined the efficacy of the ergonomics training, comparing the three different units to determine if the NAs retained the information.

RESULTS

The results of this study include: (1) development of effective questionnaires including top 20 risk factors and obstacles, (2) evaluation of the NAs work environment using the developed questionnaires and videotaping, (3) development and presentation of a training package specific for NAs, and (4) statistical analysis of pre-training questionnaires to post-training questionnaires to determine retention and implementation of the training presentation by NAs on the floor.

Evaluation of the NAs work environment consisted of the top 20 risk factors questionnaire developed by the research assistant, the obstacles questionnaire also developed by the research assistant, and videotaping of the NAs on the floor performing the top risk factors. A total of 68 nurses and NAs re-turned the questionnaires. Table I lists the results of the ranking of the risk factors and their respective categories. The 20 risk factors were rank-ordered and divided into high, medium, and low tasks according to a paired t-test statistical analysis. The high and medium ranks are statistically different from each other and the medium and low ranks are statistically different from each other, meaning that the risk factors above (i.e., 2 vs. 3) are significantly different from each other. Similarly, risk factor 11 is significantly different from 12. However, risk factor 3 is not significantly different from 4, nor is risk factor 12 from 13. The highest risk factor computed was 7.21 and lowest stress computed was 1.60 and are statistically different from each other with a p-value of <0.001.

The high risk factors that were significantly different than the medium risk factors were "lifting fallen client from floor" (7.21) and "client starting to fall" (6.93). The medium risk factors were significantly different than the low risk factors with p-values of 0.004 between "lifting patient up in bed" and "repositioning patient in

wheelchair." The other significant p-value (0.004) was between "bathing patient" and "lifting and carrying soiled laundry."

TABLE I. Ranking of the Top 20 Risk Factors and Their Respective Category Computed from Responses from All Nurses, All Units

Rank	Risk Factor	Category	Average Score n = 68	SD	p-Value[A]
1	Lifting fallen client from floor	High	7.21	2.53	0.37
2	Client starting to fall	High	6.93	2.67	
3	Transferring from toilet to wheelchair	Med	4.97	2.32	<0.01
4	Transferring from wheelchair to shower chair	Med	4.88	2.36	0.65
5	Transferring from wheelchair to toilet	Med	4.82	2.21	0.87
6	Transferring from wheelchair to bed	Med	4.82	2.20	0.88
7	Transferring from shower chair to wheelchair	Med	4.80	2.37	0.72
8	Transferring from bathtub to wheelchair	Med	4.78	2.43	0.94
9	Transferring from wheelchair to bathtub	Med	4.70	2.42	0.93
10	Transferring from bed to wheelchair	Med	4.53	2.14	0.40
11	Lifting patient up in bed	Med	4.34	2.69	0.39
12	Repositioning patient in wheelchair	Low	3.53	3.53	0.004
13	Making bed with patient in it	Low	3.52	2.02	0.86
14	Repositioning patient in bed	Low	3.34	1.97	0.36
15	Dressing or undressing patient	Low	3.01	1.85	0.26
16	Changing absorbent pad	Low	2.84	1.75	0.18
17	Bathing patient	Low	2.56	1.65	0.28
18	Lifting and carrying soiled laundry	Low	1.87	1.20	0.004
19	Making bed without patient in it	Low	1.74	1.80	0.39
20	Lifting and carrying meal trays	Low	1.60	0.97	0.20

[A]p-value < 0.05 is considered significant difference.

Table II lists the obstacles from each of three categories with their respective average, standard deviation, and their computed p-values using paired t-test statistical analysis of the ranking of the obstacles in each category, 2 paired with 3, etc. This was applied for each category: work practices, administrative controls, and engineering controls.

The results from Table II indicate that the "height of bed too low or too high" was considered the most stressful work practice if not executed properly. It is significantly different from "feet too close or too far apart," which is significantly different from "slow transfers versus fast transfers." Nursing personnel perceive the height of the bed and placement of feet very stressful if not executed properly. Under administrative controls, "time frame allowed to care for patients" and "time frame allowed to do the work" were considered by nursing personnel to be the most stressful when trying to perform patient-handling tasks, with the remaining five controls very similar in stress with "not enough time spent on patient-handling training" being significantly different from "lack of pre-work warm-up or exercise." The nurses reported that not enough time spent on training is much more stressful than exercise or the method of reporting pain. Among engineering controls, "use of gait belt when transferring" is the top control thought to give the most stress and is significantly different than "use of chair lift when bathing patient." The gait belt is perceived to be much more stressful to use than any of the other engineering controls listed in the questionnaire.

The information contained in the training package was com-piled from the evaluation completed by the research assistant using the top 20 risk factors questionnaire, the obstacles questionnaire, and videotaping of the NAs performing patient-handling tasks. Table III outlines the nursing personnel trained on Units 2 and 3. Results indicate that very few NAs were trained from Unit 2, 3–11 p.m. shift. Results also show that only 64% of the total NAs on Unit 2 were trained, compared to 84% of the NAs from Unit 3.

TABLE II. Overall Ranking of Obstacles in Each Category from the Questionnaires Given to the Entire Nursing Staff

Obstacle	Average Score n = 68	SD	p-Value[A]
	Work Practices		
Height of bed too low or too high	5.86	2.78	0.003
Feet too close or too far apart	4.82	2.68	
Slow transfers vs. fast transfers	4.15	2.34	0.04
Knee support on bedside when transferring from bed	3.97	2.58	0.87
Moving patients vertically	3.70	2.56	0.13
Moving patients horizontally	3.57	2.26	0.67
	Administrative Controls		
Time frame allowed to care for patients	5.90	3.10	0.32
Time frame allowed to do the work	5.62	3.14	
Not enough workspace to perform tasks	5.30	3.10	0.80
Staff support to accomplish tasks	5.00	3.10	0.54
Not enough time spent on patient-handling training	4.61	3.01	0.29
Lack of pre-work warm-up or exercise	3.52	2.92	0.05
Method of reporting pain at work	3.23	2.60	0.70
	Engineering Controls		
Use of gait belt when transferring	3.33	2.48	0.04
Use of chair lift when bathing patient	2.79	2.24	
Use of two-person walking belt when transferring	2.70	1.88	0.96
Use of lift sheet when repositioning patient in bed	2.68	2.27	0.66
Use of mechanical lift when transferring	2.50	2.21	0.30

[A]p-value < 0.05 is considered significant difference.

To determine whether the nursing personnel understood and retained the information contained in the training session, statistical analysis was completed analyzing the pre-training quiz with the post-training quiz by inputting each of the 35 scores, both pre- and post-training, into a Microsoft® Excel® spreadsheet and then calculating a two-paired student's t-test. Table IV lists the total scores of the pre-quiz versus the post-quiz. Results from the pre-training and post-training quizzes indicate that the training was effective and understood by all 35 NAs and nurses, RNs, and LPNs.

To determine overall effectiveness of the training presentation and reinforcement of the training on the floor, statistical analysis of the pre-training and post-training questionnaires was completed using analysis of variance (ANOVA). Table V lists the p-value associated with each of the three pre-training and post-training questionnaires. There is no significance between the pre-training and post-training questionnaires with regard to the level of stress for the risk factors, pain or discomfort, and in the general health perceived by the NAs.

TABLE III. Outline of Training Sessions and Who Attended

	Unit 2	Unit 3		
Shift	NAs (n = 14)	RNs (n = 5)	LPNs (n = 3)	NAs (n = 17)
7 a.m.–3 p.m.	6/7	2	2	9/9
3 p.m.–11 p.m.	1/4	2	0	4/5
11 p.m.–7 a.m.	2/3	0	0	3/3
Total	9 ÷ 14 = 64%	4 ÷ 5 = 80%	2 ÷ 3 = 75%	16 ÷ 17 = 84%

DISCUSSION

Evaluation of the NAs' work environment using the 20 risk factors questionnaire identified the top risk factors exposing NAs. The risk factors were rank-ordered according to their average score. The high-stress risk factors were identified on a scale of 1–10, 10 being the most stressful, (i.e., lifting fallen client from floor [7.21] and client starting to fall [6.93]). This is new information that has not been previously identified in the literature.

Research conducted and reported by Garg et al.[7] identified "toilet to wheelchair" as the most stressful patient-handling task perceived by NAs. Other articles look at interventions for other patient-handling tasks such as weighing a patient[10] or transferring patients from the wheelchair to a shower chair using assistive devices, but not one mentions intervention strategies for reducing stress when lifting a client from the floor or client starting to fall.

The ranking of the 20 risk factors from 1 to 20 gives a wide spread of the amount of musculoskeletal stress on NAs when transferring patients. The most stressful risk factor being "lifting fallen client from the floor" (7.21) and the least stressful being "lifting and carrying meal trays" (1.60). This large spread is different from other studies that have identified a range of stressful activities such as the study conducted by Garg et al.[7] In that study, 16 tasks were identified and ranked by NAs. The range went from 14.3–9.6. This is unlike the findings identified in this study, which identified a much broader range of stress-levels from high to low.

The evaluation of the NAs' work environment was also accomplished with the obstacles questionnaire. Obstacles were rank-ordered in each category: engineering controls, administrative controls, and work practices. Among the work practices, the highest stress obstacle identified by the nursing personnel was the "height of the bed too low or too high" (5.86).

The identification of this obstacle as being the most stressful is understood when visiting the floors of the veterans' home. Many beds utilized in the facility are special beds for those patients who tend to fall out while lying in the bed. To avoid using restraints on the patients, the veterans' home has chosen to use special beds that lay on the floor. The bed cannot be raised much higher than one foot so the patient has less risk of injury when falling out of bed. The NAs identified both "lifting fallen client from floor" and "height of the bed too low or too high" as top risk factors and obstacles. It can therefore be assumed that the nursing personnel identified height of bed as high risk for themselves and associated that obstacle with the risk factor of "lifting fallen client from floor," which is the task performed by NAs when a patient is in the bed described above.

The high-stress obstacles identified under administrative controls included (1) time frame allowed to care for patients (5.90), (2) time frame allowed to do the work (5.62), (3) not enough work space to perform tasks (5.30), and (4) staff sup-port to perform tasks (5.00). Many articles from the peer-reviewed literature have identified time as a problem among those who handle patients, especially when using assistive devices.[4,7,14] Not enough work space to perform tasks, identified by the nursing personnel at the veterans' home, has also been identified in the literature as a problem. It has been stated in the literature that working in small spaces, such as when transferring from toilet to wheelchair or wheelchair to toilet, can be very stressful on the NA because of such a small working space.(7)

TABLE IV. Pre-Training and Post-Training Scores from Nursing Personnel

Pre-Training Quiz n = 35		Post-Training Quiz n = 35		p-Value[A]
Ave	SD	Ave	SD	
12.20	1.98	13.88	1.43	7.18×10^{-6}

[A]p-value < 0.05 is considered significant difference.

TABLE V. Results Comparing the Pre-Training Versus Post-Training Questionnaires

	Statistical Analysis	p-Value[A]	
Top 20 risk factors	ANOVA	0.10–0.94	No significance
Pain/discomfort survey	ANOVA	0.20–0.70	No significance
General health survey	ANOVA	0.17–0.55	No significance

[A]p-value < 0.05 is considered significant difference.

The training package consisting of a PowerPoint presentation and hands-on training was considered highly significant ($p < 0.001$). The pre-training and post-training quiz scores from the 34 training participants only showed a slight in-crease of a few points, but all nursing personnel except three improved their quiz score from pre-training to post-training. Although this is a small increase, it is highly significant; there-fore, we can assume the NAs were listening and retaining the information.

No statistical significance was seen when comparing pre-training questionnaires to post-training questionnaires. After statistical analysis, it was identified that the training did not significantly decrease the stress level of the 20 risk factors decrease the pain or discomfort, or increase the overall physical or mental health of the NAs. Unit 1 and Unit 2 showed no real difference between the questionnaires. Unit 3 showed a slight decrease in the post-training questionnaires compared to the pre-training, but it proved to be an insignificant difference. The pain/discomfort assessment showed a slight decrease in back pain compared to an increase in upper and lower body pain. The small decrease, not significantly different, might be accounted for because the training focused on biomechanical techniques protecting the back when transferring patients.

TABLE VI. List of the NAs Who Participated in the Three Separate Parts of the Study

	Unit 1	Unit 2	Unit 3
Pre-training questionnaire	14	12	12
Training presentation	0	9	10
Post-training questionnaire	5	9	7

Limitations of the study include low participation among the NAs in the three different units. Only five participated from Unit 1, nine from Unit 2, and seven from Unit 3. Some possible reasons for the lack of participation might be the attitude of the NAs, not wanting to participate in the study because of other priorities, or because of the high turnover rate. Table VI outlines how many NAs completed the pre-training questionnaire, how many continued with the training, and then how many ended with the post-training questionnaire. The lack of participation might be attributed to the NAs leaving or moving to another floor.

Another limitation might have been the lack of time to perform the study and reinforce the training on the floor. The pre-training questionnaires were given to the NAs on January 31, training was conducted April 17–28, and the post-training questionnaires were gathered by July 1. The entire study lasted 5 months. This might not have been enough time to perform all aspects of the study to show any change.

CONCLUSIONS

The purposes of this research were to (1) develop effective questionnaires from the most recent peer-reviewed literature to evaluate and analyze the NAs' work environment, (2) evaluate the work environment using the developed questionnaires and videotaping to determine the top risk factors and possible obstacles or barriers that would hinder their performance, (3) develop an effective training package to present to NAs and nurses to train them in how to control the top risk factors determined from the evaluation, and (4) determine if the NAs understood and implemented the training program on the floor by statistical comparison of the pre-training questionnaires with the post-training questionnaires.

The results indicate that the developed questionnaires were effective. The information from the peer-reviewed literature was accurate in determining the most common risk factors exposing NAs. The nursing personnel did not add or reject any of the risk factors or obstacles from the questionnaires.

A thorough evaluation of the NAs' work environment was completed using the questionnaires and videotaping. Identification of the high, medium, and low risk factors associated with the tasks performed by the NAs at the veterans' home were identified, as well as obstacles that increase that risk. The high-risk tasks were identified as "lifting fallen client from floor" and "client starting to fall." The medium-ranked tasks included nine risk factors that involved transferring a patient from one chair to another. The remaining nine risk factors were categorized as low stress. Videotaping analyzed the work environment by taping NAs on the floor while they were performing the high- and medium-ranked risk factors. This analysis was used to develop corrective actions to teach personnel during the training and to use as case studies during the training to have the NAs analyze their own tasks.

A training package was developed that included data, mini-videos, quizzes, hands-on demonstrations, and case studies to teach NAs and nurses how to control the risk factors identified in the evaluation of the NAs' work environment. The training package and presentation were proven effective by the statistical analysis of the pre-training and post-training quizzes identifying that the nursing personnel understood the training.

Pre-training questionnaires were given to the NAs three months before training and post-training questionnaires were given one month after training. Statistical analysis comparing the pre-training questionnaires to the post-training questionnaires indicated that there was no significant difference of decreased stress, pain/discomfort, or overall mental or physical health because of the training package.

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