The Use of Assistance While Lifting

Michael A. Vojtecky, Philip Harber, James W. Sayre
Elizabeth Billet, and Steven Shimozaki

Using assistance during lifting is a desirable behavior. Assistance can elim-
inate or reduce the amount of biomechanical stress associated with a lift,
significantly reducing the risk of low back injury. This paper describes lifting
activities engaged in by nursing care workers. Only 15% of all lifts per-
formed by the hospital nursing personnel in this study were assisted lifts. The
analysis suggests that the use of assistance can be associated with specific
factors such as type of object lifted, work stress associated with the lift,
number of preparations that must be made before the lift can be attempted,
years of experience of the lifter, and the idiosyncratic behavior patterns of
lifters with respect to using assistance. It is recommended that attention be
given to psychological and social, as well as biomechanical, factors in the
control of low back injury.

According to the National Institute for Occupational Safety and Health (NIOSH), musculoskeletal injuries, the commonest of which are disorders of the back, rank second

Michael A. Vojtecky, PhD, is with the Division of Behavioral Sciences and Health Education, School of Public Health, and the Southern Occupational Health Center, University of California, Los Angeles (UCLA) 90024. Philip Harber, MD, is with the Occupational Medicine Branch, Department of Medicine, and the Southern Occupational Health Center, UCLA; James W. Sayre, PhD, is with the Division of Biostatistics, School of Public Health, UCLA; Elizabeth Billet, RN, is with the Nursing Service, UCLA Medical Center; and Steven Shimozaki, is a staff research associate, De-
partment of Medicine, UCLA.

among the 10 leading work-related diseases and injuries in the United States (Centers for Disease Control [CDC], 1983). The Bu-
reau of Labor Statistics (BLS) reported that approximately one million workers sus-
tained back injuries in 1980 and that back injuries account for one of every five injuries and illnesses in the workplace (BLS, 1982a, 1982b). According to Rowe (1983), well over half and perhaps as many as three quarters of all workers have low back pain at some time in their working careers. If so, a con-
servative estimate of the number of people who experience low back pain at some time in their lives would be between 50 million and 75 million people.

Low back pain is a condition that is diffi-
cult to treat, and disability resulting from low back pain is industry's most expensive medical problem. Worker's Compensation statistics and federal labor statistics both

suggest a relationship between exertion activities, especially lifting, and low back injuries (BLS, 1982a, 1982b; Klein, Jensen, & Sanderson, 1984; Liles & Mahajan, 1985; Rowe, 1983). It is estimated that 37% to 49% of all compensable backache is associated with lifting and that 68% of overexertion incidents involve lifting (Chaffin, 1979; Liles & Mahajan, 1985; Rowe, 1983).

Chaffin (1979) and Chaffin and Park (1973) have shown that biomechanical stresses during lifting present significant risks for the development of low back injury. This fact has given rise to the premise that occupationally induced low back disorders and injuries are largely preventable if sufficient attention is given to ergonomic considerations in lifting. One method that is often recommended for effectively eliminating or reducing the biomechanical stress associated with lifting is to use assistance during the lift (Cal-OSHA, 1984; CDC, 1983).

Among particular groups of workers, nursing personnel, who perform a significant number of lifting tasks in their jobs, are known to be at high risk for the development of low back pain (Chaffin, 1979; Cust, Pearson, & Mair, 1972; Harber et al., 1985; Kelsey, 1982; Klein et al., 1984; Stubbs, Buckle, Hudson, Rivers, & Worringham, 1983). This paper describes on-the-job lifting activities engaged in by nursing care workers and discusses factors that relate to their use of assistance while lifting. Understanding such behavior and the factors that affect it is important to the development of practical strategies for the prevention of low back pain and disability.

METHOD

After consulting with the nursing service administration at a large metropolitan hospital, we asked nursing personnel from several units of the hospital to participate in an observational study of lifting activities. It was made clear during the recruitment of participants that the goal of the research was to investigate lifting behavior as a source of biomechanical stress.

Subjects

The hospital units selected for study were chosen because the lifts performed in them were thought to be broadly representative of the kinds of lifts required of nursing personnel. Sixty-three individuals volunteered to participate in the research.

The 63 volunteer participants worked in the following hospital departments: 7 (11%) in the Respiratory Critical Care Unit, 19 (30%) in Vascular-Surgical, 14 (22%) in the Post-Anaesthesia Recovery Room, 16 (25%) in Orthopedics, and 7 (11%) in the Delivery Room. The subjects represented the following job classifications: 47 (75%) were Registered Nurses (RN), 9 (14%) were Licensed Vocational Nurses (LVN), 7 (11%) were orderlies. There were 12 males and 51 females. Five of the males were RNs and the rest were orderlies. Orderlies worked in the Post-Anaesthesia Recovery Room only, and LVNs in the Vascular-Surgical and Orthopedics units only.

Subjects ranged in age from 21 to 50 years with a mean of 30, although none of the orderlies was over 35 years of age. Years of experience in present occupation ranged from 1 to 27 with a mean of 8.

Procedure

A trained observer, instructed to remain as unobtrusive as possible, accompanied each volunteer throughout a single workshift and recorded the complete lifting behavior of that individual. A coding system was used to describe each action involved in a lift. The system provided a record of the type of lifting action performed, duration of the lift, body attitude of the lifter, starting and stopping positions of the lifter, type and weight of the object to be lifted, and other relevant information. Demographic information was collected by interview.

Observers were trained in the use of the observation system by the system's developers. Reliability of the observations was established in two ways. Criterion-related observer agreement was established by comparing the scoring done by the observer in a test situation to that of an expert judge who viewed the same test situation. Consistency of observations over time was estab-

lished by having the study coordinator accompany the observers at various times over the course of the data collection period.

Lift Demand Index

To estimate, if only crudely, the work stress associated with a lift, we developed the Lift Demand Index (LDI). The LDI combines the information collected concerning the performance of a lift and the information collected concerning the physical characteristics of the lifter to estimate the work stress experienced by any particular individual while lifting. (A complete description of the LDI is included as an Appendix.)

Statistical Analysis

Statistical analysis consisted of univariate and multivariate techniques. Multivariate contingency analysis and logistic regression analysis were used to examine the relationships between the use of assistance while lifting and potentially relevant variables such as job title, department in which the lift occurred, type of object lifted, the environmental conditions surrounding the lift, and the idiosyncratic behavior pattern of the lifter with respect to use of assistance.

For the logistic regression analysis, the identity number of the subject was used as a rough proxy of idiosyncratic patterns of lifting behavior. Thus, we are able to say whether Subject 1, for example, is generally inclined to use assistance. However, this approach produces as many regression coefficients as there are subjects. Therefore, for purposes of presentation, the regression coefficients associated with patterns of lifting behavior specific to individuals have been combined into two categories: (a) inclined to use assistance and (b) not inclined to use assistance. The combinations were made by inversely weighting each of the individual coefficients by their respective variances and then averaging.

The formula for the logistic regression model used by the BMDP package (Dixon & Brown, 1985) was developed by Cox (1970) and can be written as follows:

$$P(\text{use of assistance} \mid \underset{\sim}{x}) = \frac{\exp(\alpha + \sum_{i=1}^{K} \beta_i x_i)}{1 + \exp(\alpha + \sum_{i=1}^{K} \beta_i x_i)}$$

RESULTS

Frequency Distributions of Lifts

Because of the circumstances of hospital work, in which lifts of different kinds occur at irregular intervals and involve varying weights, we considered the most appropriate unit of analysis to be the lift itself rather than the individual performing the lift.

The total number of lifts observed was 3,131. RNs performed 59% of the lifts, orderlies accounted for 35%, and LVNs accounted for only 6%. The percentage distribution of lifts by department was: Post-Anaesthesia Recovery Room (REC), 42%; Vascular-Surgical (V), 24%; Orthopedics (ORTH), 19%; Respiratory Critical Care Unit (RCU), 9%; and Delivery Room (DEL), 7%. The great majority of lifts (81%) were performed by individuals under the age of 36. Forty-one percent were performed by males. The percentage distribution of lifts by type of lift is as follows: isometric, 17%; push, 27%; pull, 47%; and carry, 9%.

The duration of the lifts observed ranged from 1 to 2,700 sec and averaged 21 sec. Most lifts (62%) required the lifter to raise an object or body that was between 1 and 2 ft (30.48 and 60.96 cm) from the lifter's body. The weights of the object to be lifted ranged from under 10 lb (4.54 kg) to 300 lb (136.2 kg) with a mean of 87 lb (39.49 kg). The mode was 20 lb (9.08 kg).

Patient lifts. Patient transfers accounted for 1,181 lifts (38%) and object transfers accounted for 1,946 lifts (62%). Fifty-three percent of the lifts performed by RNs and 65% of the lifts performed by LVNs involved direct contact with patients. In contrast, only 7% of lifts performed by orderlies were patient lifts.

Except in the case of LVNs, where age did not appear to be a factor, patient lifting was most often performed by older and more experienced workers. More than 63% of the

lifts performed by those 36 and over involved patients, whereas only 31% of the lifts performed by individuals under 36 involved patients. Similarly, more than 60% of patient lifts were performed by individuals with more than 10 years' experience, whereas 72% of object lifts were performed by individuals with less than 10 years' experience. Finally, the proportion of patient lifts (71%) was greater in the RCU than in any other department. In comparison, the REC had the lowest proportion (16%). The remaining departments ranged from 41% to 58% in the proportion of lifts involving patients.

Assisted lifts. In 466 (15%) of the lifts, the lifter sought assistance of some kind. In 399 (86%) of these lifts, the assistance was rendered by another person. Of the remaining assisted lifts, 89 (19%) were drawer sheet lifts, 8 (2%) were hoyer lifts, and 66 (14%) were classified as miscellaneous in type of assistance used.

Factors Associated with Assisted Lifts

Stepwise logistic regression analysis was used to develop a model of factors predicting the use of assistance during lifting. The order of variable entry indicates the importance of that variable in the model. The addition of variables into the equation was halted when the Hosmer-Lemeshow goodness-of-fit test showed the best-fitting logistic model.

Although complete data concerning the lift performed were collected for 3,131 lifts, some subjects refused to provide personal information such as age and body weight. Thus, complete data concerning both personal and lift-related factors exist for only 2,221 lifts performed by 50 subjects. It was these 2,221 lifts that were used in the logistic regression analysis.

As a result of the stepwise process, eight variables and a constant were selected for inclusion in the logistic regression equation. In order of importance, they are as follows: type of object lifted, estimated work stress associated with a lift (LDI), number of preparations made before a lift was performed, the lifter's years of experience in his

or her present occupation, and the idiosyncratic behavior pattern of the lifter with respect to using assistance (ID). Even though variable selection procedures are dependent on the particular sample being used, the large number of lifts analyzed makes it unlikely that the variables chosen to be included in the logistic regression model would be different had a different sample of lifts been drawn.

Table 1 presents a summary of the logistic model coefficients and their standard error of the estimate by variable entry.

With this information. one can predict the use of assistance for any given lift. For example, suppose that a nurse with 9 years' experience ($X6 = 9$), who is generally not inclined to use assistance ($X7 = 0$, $X8 = 1$), is lifting a patient ($X1 = 0$). The LDI ($X2$) is .27, and the conditions require no previous preparations to be made ($X3 = 0$, $X4 = 0$, $X5 = 0$). The logistic regression model presented earlier can be rewritten as follows:

$$P(\text{use of assistance} \mid \underset{\sim}{x}) = \frac{\exp(y)}{1 + \exp(y)}$$

where

$$y = \alpha + \beta_1 X1 + \beta_2 X2 + \ldots + \beta_8 X8.$$

Then

$$y = -8.678 + (-1.590)(0) + (15.056)(.27) +$$
$$(-0.123)(0) + (1.106)(0) + (0.134)(0) +$$
$$(-0.104)(9) + (-1.134)(0) + (1.177)(1)$$

$$= -4.37188$$

and

$$P(\text{use of assistance} \mid \underset{\sim}{x}) = \frac{\exp(-4.37188)}{1 + \exp(-4.37188)}$$

$P(\text{use of assistance} \mid \underset{\sim}{x}) = .012$ for this lift.

Therefore, assistance is not likely to be used.

TABLE 1
SUMMARY OF LOGISTIC REGRESSION

Construct	Variable	Coefficient	Standard Error
	Constant	-8.678 (α)	0.944
Type of object[a]	X1	-1.590 (β_1)	0.152
Estimated work stress (LDI)	X2	15.056 (β_2)	1.347
Number of preparations			
One	X3	-0.123 (β_3)	0.248
Two	X4	1.106 (β_4)	0.282
Three	X5	0.134 (β_5)	0.470
Years experience	X6	-0.104 (β_6)	0.090
Behavior pattern (ID)[a,b]			
Inclined to use assistance	X7	-1.134 (β_7)	0.246
Not inclined to use assistance	X8	1.177 (β_8)	0.140

Note. These variables entered into the model and caused a significant ($p < .001$) improvement in the model's predictive ability.
[a] Because of the values assigned to these variables, negative coefficients predict that assistance will be used.
[b] The coefficients presented are weighted averages.

DISCUSSION

Using assistance during lifting is a desirable behavior, because assistance can eliminate or reduce the amount of biomechanical stress associated with a lift, thereby significantly reducing the risk of low back injury. If the results of this study are indicative of the national situation, however, only about 15% of all lifts performed by hospital nursing personnel are assisted lifts. If low back injury is to be prevented, it is important to determine why some lifts are assisted and others are not.

The analysis presented here suggests that the use of assistance by nursing personnel can be predicted by specific factors. Most assisted lifts, for example, involve patients. One explanation for this may be that lifting patients is more difficult than lifting objects. Patients are irregularly shaped and highly flexible with weight distributed unevenly over their bodies. Patient lifts often require unorthodox lifting techniques and may produce asymmetric reactive exertions of forces on the lifter — conditions that may substantially alter the work stress associated with a particular lift. Furthermore, patient cooperation may affect work stress by causing the lifter to use high levels of force momentarily while in unbalanced and unstable positions. Other reasons for using assistance when lifting patients may include: (a) official hospital policies concerning patient care, (b) better preparation for and more importance attached to patient lifting as a result of nursing training, and (c) general concern for patient welfare.

The level of work stress (LDI) associated with a particular lift is also of considerable importance in predicting the use of assistance. In general, the higher the work stress involved, the more likely an individual is to use assistance. However, more than three quarters of object lifts high in work stress and more than half of patient lifts high in work stress were unassisted. Thus, even

when taken together, the type of object to be lifted and the level of work stress do not provide sufficient information to predict use of assistance. Additional factors must be considered.

The number of preparations that must be made before a lift can be performed is another factor that affects the use of assistance. As the number of preparations that must be made increases, so does the likelihood that assistance will be used. This may be because an individual who perceives that more tasks need to be done is more likely to get help.

The use of assistance also appears to be, in part, a function of the number of years of experience that the lifter has in nursing care. In general, individuals with more experience are more likely to use assistance.

Finally, the prediction of assistance is, in part, a function of the lifter's idiosyncratic pattern of behavior with respect to seeking assistance. For whatever reason, perhaps as a matter of attitude, training, or personal style, some individuals are more inclined to use assistance than others.

This inclination to use assistance may be affected to some extent by the interpersonal dynamics that exist between members of a work crew. Most human behavior, and certainly much lifting behavior, takes place within a social context (Lindzey & Aronson, 1985). Indeed, in 86% of the lifts performed in this study in which assistance was used, the assistance was rendered by another person. To recognize this is to admit the potential psychological effects of coworkers and work groups on lifting behavior. A person is not likely to ask for assistance from another person if she or he does not get along with that other person (Hare, 1976). Even if, however, members of the work group do get along, the norms for behavior within a group still must clearly encourage safe lifting practice for that behavior to be engaged in (Margolis & Kroes, 1975).

Yet, the overwhelming fact remains that 85% of all lifts performed by the hospital nursing personnel in this study were unassisted. Moreover, when assistance was used it was often associated with factors independent of the lift itself. If the use of assistance is to increase, conditions under which it can increase must be created. What is needed is a close examination of factors such as training in lifting, attitude toward lifting, provision of lifting aids, additional personnel, supervisor encouragement for use of assistance, norms for lifting behavior, and interpersonal dynamics of work crews. When sufficient attention is given to psychological and social, as well as biomechanical, factors perhaps significant gains can be made in the control of low back injury.

APPENDIX

The Lift Demand Index

The LDI summarizes in a single score the interaction of several factors that operate simultaneously to affect an individual's ability to perform physical work. The LDI combines somatic and work factors and, in so doing, provides a crude approximation of the relationship between work load and individual work capacity. Therefore, it can be used as a crude estimator of work stress.

The LDI is calculated with adjustments based on a review of appropriate published literature (Astrand & Rodahl, 1977; Chaffin & Park, 1973; Freivalds, Chaffin, & Langolf, 1983; Grether, 1975; Guyton, 1977; Schultz & Andersson, 1981; Sharkey, 1974; Tichauer, 1973). Some more complicated weighting might be superior, but as a first approximation we weighted the various factors comprising the index equally.

$$LDI = (Intensity + Duration + Technique + Position + Schedule + Age + Sex + HWR)/100$$

where:

Intensity is the workload estimated in kiloponds (estimated object weight in pounds $\times$ 1 foot $\times$ 0.13825).

Duration is the time required to complete the lift measured in minutes.

Technique is the type of lifting action observed (i.e., push, pull, carry, or isometric). Isometric actions were those patient contact activities in which the subject maintained a static antigravity posture for at least 30 sec and in which there was no transfer of a patient or object. Each type of lift is assigned a value ranging from 1 for isometric (least difficult) to 4 for carry (most difficult).

As a first approximation, the assigned values are ordinal.

Position is the product of the starting position of the object to be lifted relative to the lifter and the distance of the object (in ft) from the lifter's trunk at the start of the lift. The starting position of the object is assigned a value ranging from 1 for waist high (least difficult) to 4 for below the knees (most difficult). As a first approximation, the assigned values are ordinal.

Schedule is the sum of the values assigned to shift and hours. Values ranging from 1 for day (least difficult) to 3 for swing (most difficult) are assigned to shift. A value of 1 for normal (8 hours worked) and 2 for longer than normal were assigned to hours. As a first approximation, the assigned values are ordinal.

Age is the chronological age of the lifter. Age is categorized and assigned a value of 1 to 3 (under 35, 35 to 49, 50 and over). As a first approximation, the assigned values are ordinal.

Sex is the gender of the lifter. Sex is assigned a value of 1 for male and 2 for female. As a first approximation, the assigned values are ordinal.

HWR is a height to weight index for the lifter computed according to Quetelet's method.

Rhythm or pace is not used in this calculation of the LDI, because the population of workers for which it was developed were hospital workers and the circumstances of hospital work (i.e., lifts occurring at irregular intervals and involving varying weights) suggested that for most purposes the unit of analysis should be the individual lift. Health is also excluded from this calculation because it is assumed that an individual actively working for pay is in generally good health. The LDI yields a value between 0.00 and 1.00 for most lifts. The higher the value, the greater the work stress estimated for the task. The estimated work stress indicated by the LDI for individual lifts in this study ranged from 0.07 to 0.60 with a mean value of 0.22.

Very little work has been done with the index as yet. The adjustments used are admittedly crude and the weighting of factors arbitrary. Moreover, several of these factors may be affected by training, adaptation, and the external environment (Astrand & Rodahl, 1977). Thus, the refinement and validation of the index may take some time.

Despite these problems, the LDI is theoretically plausible and the values of the LDI drawn from our research among hospital personnel have shown the LDI to be in the direction expected.

We invite further work on the LDI by all who may be interested.

REFERENCES

Astrand, P., & Rodahl. K. (1977). *Textbook of work physiology, physiological bases of exercise* (2nd ed.) New York: McGraw-Hill.

Bureau of Labor Statistics, U.S. Department of Labor. (1982a). *Back injuries associated with lifting (work injury report)* (Bulletin 2144). Washington, DC: U.S. Government Printing Office.

Bureau of Labor Statistics, U.S. Department of Labor. (1982b). *Occupational injuries and illnesses in the United States by Industry 1980* (Bulletin 2130). Washington, DC: U.S. Government Printing Office.

Cal-OSHA, Department of Industrial Relations. (1984). *Preventing back injuries*. San Francisco: State of California.

Centers for Disease Control. (1983). Leading work-related diseases and injuries — United States. *Morbidity and Mortality Weekly Report, 32.* 24–26, 32.

Chaffin, D. B. (1979). Manual materials handling: The cause of overexertion injury and illness in industry. *Journal of Environmental Pathology and Toxicology. 2*, 31–66.

Chaffin, D. B., & Park. K. S. (1973). A longitudinal study of low-back pain as associated with occupational weight lifting factors. *American Industrial Hygiene Association Journal, 34*, 513–525.

Cox, D. R. (1970). *Analysis of binary data*. London: Methuen.

Cust, G., Pearson, J. C. G., & Mair. A. (1972). The prevalence of low back pain in nurses. *International Nursing Review, 19*, 169–179.

Dixon, W. J., & Brown, M. B. (Eds.). (1985). *BMDP*. Los Angeles: University of California Press.

Freivalds, A., Chaffin, D. B., & Langolf, G. D. (1983). Quantification of human performance circadian rhythms. *American Industrial Hygiene Association Journal, 44*, 643–648.

Grether, C. B. (1975). Engineering psychology. In B. L. Margolis, & W. H. Kroes (Eds.). *The human side of accident prevention, psychological concepts which bear on industrial safety*. Springfield, IL: Thomas.

Guyton, A. C. (1977). *Basic human physiology: Normal function and mechanisms of disease*. Philadelphia: Saunders.

Harber, P., Billet, E., Gutowski, M., SooHoo, K., Lew, M., & Roman, A. (1985). Occupational low-back pain in hospital nurses. *Journal of Occupational Medicine, 27*, 518–524.

Hare, A. P. (1976). *Handbook of small group research* (2nd ed.). New York: Free Press.

Kelsey, J. L. (1982). *Epidemiology of musculoskeletal disorders*. Oxford: Oxford University Press.

Klein, B. P., Jensen, R. C., & Sanderson, L. M. (1984). Assessment of worker's compensation claims for back strain/sprain. *Journal of Occupational Medicine, 26*, 443–449.

Liles, D. H., & Mahajan, P. (1985). Using NIOSH lifting guide decreases risks of back injuries. *Occupational Health and Safety, 54*, 57–60.

Lindzey, G., & Aronson, E. (Eds.). (1985). *The handbook of social psychology* (Vol. 2, 3rd ed.). New York: Random House.

Margolis, B. L., & Kroes, W. H. (Eds.). (1975). *The human side of accident prevention*. Springfield, IL: Thomas.

Rowe, M. L. (1983). *Backache at work*. Rochester, NY: Perinton Press.

Schultz, A. B., & Andersson, G. B. J. (1981). Analysis of loads on the lumbar spine. *Spine, 6,* 76–89.

Sharkey, B. J. (1974). *Physiological fitness and weight control*. Mountain Press Publishing.

Stubbs, D. A., Buckle, P. W., Hudson, M. P., Rivers, P. M., & Worringham, C. J. (1983). Back pain in the nursing profession I. Epidemiology and pilot methodology. *Ergonomics, 26,* 755–765.

Tichauer, E. R. (1973). Ergonomic aspects of biomechanics. In NIOSH, *The industrial environment, its evaluation and control*. Washington, DC: U.S. Government Printing Office.

56