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The Effects of Training in Safe Manual Handling on the Patient Lifting Techniques of Nursing Personnel

Bruce Paul Klein

Old Dominion University

THE EFFECTS OF TRAINING IN SAFE

MANUAL HANDLING ON THE PATIENT

LIFTING TECHNIQUES OF NURSING PERSONNEL

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B.S. May 1974, Quinni)iac College
M.A. June 1979, New York University

A Dissertation Submitted to the Faculty of
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ABSTRACT

THE EFFECTS OF TRAINING IN SAFE
MANUAL HANDLING ON THE PATIENT
LIFTING TECHNIQUES OF NURSING PERSONNEL

Bruce Paul Klein
Old Dominion University, 1985
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The purpose of this study was to determine the effects of training on the patient handling methods of nursing personnel. The study sought (1) to determine the effect of three class variables (Group, Session and Task) on behavioral performance, (2) to assess the influence of twelve organismic variables on behavioral performance, and (3) to determine the relationship between written exam scores and trainee behavioral performance.

Test and control groups were comprised of twelve and twenty-eight subjects, respectively. Behavioral performance in four specified tasks was determined via direct observation of individual subjects by trained observers using specific, dichotomously-measured behavioral criteria. Performance was recorded during three, two week sessions (prior to training, immediately following training and commencing six weeks post training). Additionally, each subject completed a questionnaire on organismic variables and trainees completed a written test

on safe patient handling following program participation.

Data analysis using a Model I Analysis of Covariance revealed a significant interaction ($\alpha=.05$) between class variables Group and Session suggesting training had both a desirable and lasting effect on the behavioral performance of trainees. Failure of any of the twelve organismic covariates to reach significance at the .05 level indicated that training had been effective for subjects regardless of their make up. Lastly, the finding that no significant correlation ($\alpha=.05$) existed between written exam scores and behavioral performance suggested knowledge of techniques was not a valid predictor of subsequent workplace performance.

The findings of this study indicate that an educationally-oriented training program on safe manual handling methods can produce desirable and lasting behavioral changes in the patient lifting methods of nurses. To urban training directors this study provides (1) evidence in support of the continued use of training for producing behavioral changes in workers, (2) a format for developing an effective training program, and (3) a model for evaluating the behavioral outcomes of training.

DEDICATION

This is dedicated to my wife, Jennifer, whose love, understanding and support are deeply appreciated.

ACKNOWLEDGEMENTS

As with many difficult tasks, the final product represents the help and support of many individuals. I would like to thank my friends at West Virginia University Hospital including the Departments of Hospital Administration, Nursing and Physical Therapy for their cooperation. In particular, I would like to thank therapists Dennis Hart, Steve Murphy, Paul Paroda, Cori Mancinelli, and Dr. Steven Stahl for their direct assistance in this study.

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Finally, I would like to acknowledge my wife, Jennifer, for her understanding throughout this period. Her love and emotional support pulled me through several times when I felt completion of this dissertation was impossible.

TABLE OF CONTENTS

Page

APPENDIXES

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

As hospitals across the western world attempt to control the rising costs of health care services, administrators are becoming increasingly aware of the large economic impact of work-related injuries among their employees. Of particular concern has become the high incidence of disabling low-back injury among nursing personnel.[1] In the United Kingdom, nurses have been reported to have the highest occurrence of back disorders of any working group with an annual incidence rate of disabling back injury of approximately seven percent.[2]

Similar injury figures have been reported from the United States. Statistics from workers' compensation claim programs reveal nursing aides (3.6 claims/100 workers) and practical nurses (3.3 claims/100 workers) to have the two largest occupation-specific claims ratios for

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[1]George Cust, J.C.G. Pearson, and A. Mair, "The Prevalence of Low Back Pain in Nurses," International Nursing Review, Vol. 19 (Feb. 1972), p. 171; D.A. Stubbs, et al., "Back Pain in the Nursing Profession. I. Epidemiology and Pilot Methodology," Ergonomics, Vol. 26 (Aug. 1983), pp. 757-9.

[2]Patricia MacMillan, "Being a Camel is a Pain in the Back," Nursing Times, (June 21, 1978), p. 1037.

low-back injury among American hospital workers[3]. With an average direct cost (medical payments plus indemnity compensation) of $3,135 per claim,[4] low-back injuries among nursing occupations represents a large and important issue for the health care industry.

Contributing to the high incidence of low-back injury among nursing personnel is the physically demanding nature of their work.[5] Nurses and nursing aides are frequently called upon to perform the heavy manual task of lifting/moving disabled patients which can expose their backs to injurious levels of physical stress.[6] In addition, it has been reported that nursing personnel frequently use unsafe patient handling techniques when performing these tasks which further enhances the risk of

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[3]Bruce P. Klein, Roger C. Jensen and Lee M. Sanderson, "Assessment of Workers' Compensation Claims for Back Strains/Sprains," Journal of Occupational Medicine, Vol. 26 (June 1984), p. 446.

[4]Bureau of Labor Statistics (Unpublished Data from the Supplementary Data System, 1980).

[5]Stover H. Snook, "Low Back Pain in Industry," in Idiopathic Low Back Pain, ed. by Agustus A. White and Stephen L. Gordon (St. Louis: C.V. Mosby, 1982), p. 29.

[6]D.A. Stubbs, et al., "Back Pain Research," Nursing Times, Vol. 77 (May 14, 1981), p. 857; F. Bell, et al., "Hospital Ward Patient-Lifting Tasks," Ergonomics, Vol. 22 (Nov. 1979), pp. 1269-70. Bernice D. Owen and C. Frazier Damron, "Personal Characteristics and Back Injury Among Hospital Nursing Personnel," Research in Nursing and Health, Vol. 7 (Dec. 1984), p. 311.

low-back injury.[7]

In an effort to reduce the magnitude and cost of low-back injuries, hospitals have begun allocating resources for the development and implementation of prevention-oriented programs. Training nurses in the techniques of safe patient handling has evolved into a popular intervention strategy designed to help minimize the stresses of patient handling and, thus, reduce the occurrence of low-back injury.

Problem

West Virginia University Hospital is a 452 bed, state-funded health care facility providing emergency, inpatient and outpatient services to residents of West Virginia and the surrounding states[8]. Presently, West Virginia University Hospital employs over 1,400 personnel. The Department of Nursing employs approximately 200 Registered Nurses (RNs), 150 Licensed Practical Nurses (LPNs) and 100 Nursing Aides (Aides).

A recent analysis of workers' compensation claim data

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[7]Ove Dehlin and Bengt Lindberg, "Lifting Burden for a Nursing Aide During Patient Care in a Geriatric Ward," Scandanavian Journal of Rehabilitation Medicine, Vol. 7 (Feb. 1975), p. 72.

[8]American Hospital Association, American Hospital Association Guide to the Health Care Field, 1982 ed. (Chicago: American Hospital Association, 1982), p. A231.

from four West Virginia hospitals, including West Virginia University, revealed that nursing personnel (RNs, LPNs and Aides) accounted for 235 (65.5%) of the 359 low-back injury claims filed by employees of these institutions between 1979 and 1982.[9] Of particular concern was the finding that nearly 80 percent of nursing back injuries were associated with manual handling activities including lifting, bending, pushing, pulling, twisting and catching. To address this health care problem, West Virginia University Hospital administrators requested the Department of Nursing to begin training their staff members in the techniques of safe patient handling.

Previous attempts to reduce the occurrence of low-back injuries among nursing personnel at West Virginia University had included training in safe patient handling methods. The Department of Physical Therapy had, upon request, provided employee training sessions on this topic. Since these programs did not include evaluation components, administrators were unsure whether these efforts produced any desirable and lasting changes in the patient handling techniques of trainees.

With hospital resources being directed toward the training of nursing personnel and because injury

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[9] Judith G. Greenwood, (Unpublished Data from the West Virginia Workers' Compensation Fund, 1982).

statistics continue to show nursing back injuries to be an important health problem, hospital administrators were receptive toward a program which included an evaluation mechanism. They approved the proposal that a high quality training program on safe patient handling techniques be developed and presented to a sample of the hospital's nursing staff. A systematic evaluation would then be conducted to determine whether trainees actually used the safe handling methods when they returned to their work stations.

Rationale for the Study

Training programs on safe manual handling methods have been used to address the problem of industrial low-back injuries since the mid 1930's.[10] Such programs have been based on two precepts. First, the handling technique used by a worker to perform a manual task is an important variable in the occurrence of many low-back injuries.[11]

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[10] John R. Brown, "Lifting as an Industrial Hazard," American Industrial Hygiene Association Journal, Vol. 34 (July 1973), p. 292.

[11] E.R. Tichauer, "Biomechanics Sustains Occupational Safety and Health," Journal of Industrial Engineering, Vol. 26 (Feb. 1976), pp. 49-51; J.D.G. Troup, "Biomechanics of the Vertebral Column," Physiotherapy, Vol. 65 (Aug. 1979), pp. 238-42; Don B. Chaffin, "Biomechanics of Manual Materials Handling and Low-Back Pain," in Occupational Medicine, Principles and Practical Applications, ed. by Carl Zenz (Chicago: Year Book Medical Publishers, 1980), pp. 443-53.

Second, since the handling technique used to accomplish a manual task is under the conscious control of the individual worker, these methods are capable of being modified via behavioral-based programs.[12]

Participation in safe manual handling programs has been viewed as especially important for workers whose jobs entail the frequent handling of heavy objects. These tasks (lifting, lowering, bending, twisting, carrying, holding, pushing and pulling) have been found to generate large and potentially dangerous tissue stresses on a worker's low-back.[13] Since a single, excessive exposure or repetitive, low level insults can contribute to a low-back injury, the use of handling methods which minimze the magnitude of low-back stresses has been generally accepted as a valuable prophylactic practice.[14]

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[12]E.G. Hooper, "Kinetic Handling - The Human Factor," Safety Surveyor, Vol. 10 (May 1980), p. 21; Martha Tabor, "Reconstructing the Scene: Back Injury," Occupational Health and Safety, Vol. 51 (Feb. 1982), p. 20.

[13]Peter R. Davis, "Posture of the Trunk During the Lifting of Weights," British Medical Journal, Vol. 1 (Jan. 1959), pp. 87-9; H.F. Farfan, et al., "The Effects of Torsion on the Lumbar Intervertebral Joints: The Role of Torsion in the Production of Disc Degeneration," Journal of Bone and Joint Surgery, Vol. 52-A (April 1970), pp. 494-5; Peter R. Davis and J.D.G. Group, "Pressures in the Trunk Cavities When Pushing, Pulling and Lifting," Ergonomics, Vol. 7 (April 1965), pp. 465-74.

[14]Francis Dukes-Dubos, "What is the Best Way to Lift and Carry?" Occupational Health and Safety, Vol. 46 (Jan.-Feb. 1977), p. 18.

Training programs have become recognized as an important vehicle for delivering information on safe handling methods to industrial workers. According to Christopher R. Hayne, the objectives of these programs are:

> ...to educate the right responses in the individual faced with a wide variety of situations, and to develop an acceptable level of technical skill in carrying through handling tasks without the risk to health.[15]

Following participation in training activities, it is expected that trainees will return to their work settings and effectively apply their newly acquired techniques to appropriate job-related tasks. Indeed, the value of handling techniques in reducing low-back stresses and lowering injury statistics will only be as good as their application.[16]

Despite the frequent and widespread use of training programs on safe handling techniques, the efficacy of

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[15] Christopher R. Hayne, "Lifting and Handling," Health and Safety at Work, Vol. 3 (Aug. 1981), p. 19.

[16] Bureau of Labor Standards, "Teach Them to Lift," Safety in Industry - Mechanical and Physical Hazards Series, Bulletin No. 110 (Washington: U.S. Government Printing Office, 1965), p. 6; Alan Morris, "Program Compliance Key to Preventing Low Back Injuries," Occupational Health and Safety, Vol. 53 (March 1984), p. 44.

these efforts remains an issue.[17] Contributing to this controversy has been a lack of concern for the educational quality of training programs and a tendency to either not evaluate training outcomes or to employ evaluative criteria of limited utility.

Since the purpose of any training program is to facilitate the acquisition of knowledge, skills and attitudes by trainees, it is important for training activities to be structured around educational principles (e.g. identical elements, conditions of practice, feedback to participants) which enhance the attainment of this purpose.[18] Despite the important relationship between active program participation and the acquisition of knowledge, skills and attitudes by trainees, a survey by the Bureau of Labor Statistics revealed that 65 percent of "trained" workers merely viewed lectures, demonstrations, films or written materials as their form of training in safe manual handling methods.[19] It is questionable

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[17]Mahmoud A. Ayoub, "Control of Manual Lifting Hazards: 1. Training in Safe Handling," Journal of Occupational Medicine, Vol. 24 (Aug. 1982), p. 577; E.G. Hooper, "Kinetic Handling - Have We Got It Right?" Safety Surveyor, Vol. 10 (Sept. 1980), pp. 20-1.

[18]Irwin L. Goldstein, Training: Program Development and Evaluation, (Monterey: Brooks/Cole Publishing Co., 1974), pp. 105-35.

[19]Bureau of Labor Statistics, "Back Injuries Associated with Lifting," Bulletin 2144 (Washington: U.S. Government Printing Office, 1982), p. 13.

whether such passive forms of learning can promote desirable and lasting behavioral changes in trainees, even if the handling techniques promoted in these sessions are valid and applicable to the trainee's work setting.

With respect to the evaluation of safe manual handling programs it is important to understand the theoretical relationship among the training program, a trainee's subsequent behavioral change, and injury statistics. During the training period(s), trainees are expected to master the principles and skills of safe manual handling. Following program participation, trainees are anticipated to return to their work settings and effectively apply these methods to appropriate tasks. Through desirable and lasting behavioral changes, workers will reduce their low-back stresses which will result in a fewer number of back injuries among the work force.

The most popular evaluation strategy used for safe handling programs has been to train workers and then monitor injury statistics as the measure of program effectiveness. While this type of evaluation provides management with valuable information, since the reduction of back injuries is usually the stimulus for training workers, it fails to document whether or not trainees have modified their handling techniques. Indeed, John R. Brown has speculated that the most common breakdown in the training-injury statistic relationship is the failure of

workers to apply the handling techniques when they return to their work settings.[20]

If safe handling programs are to be effective in reducing the incidence of low-back injuries among nursing personnel, trainees must master the biomechanically-valid patient handling techniques during training periods and then apply these methods in a consistent and effective manner to job-related tasks. By structuring training activities around education-based principles, instructors can maximize the likelihood that participants will acquire the desired knowledge, skills and attitudes. Through the use of a behavior-based evaluation, program sponsors can obtain objective information on the critical issue of workplace application.

Purpose

The purpose of this study is to determine if a specifically designed training program on safe patient handling techniques can produce desirable and lasting behavioral changes among nursing personnel. In addition, the study will attempt to determine the influence of twelve organismic variables on behavioral performance and, establish whether any relationship exists between a trainee's acquisition of information during the training

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[20]Brown, "Lifting as an Industrial Hazard," p. 292.

periods and their subsequent workplace application of the techniques.

The specific research questions which this study will attempt to answer are:

I. What are the effects of the three class variables (Group, Session and Task) on the behavioral performance of subjects?

II. What influence does age, height, weight, gender, occupation, years of experience, frequency of lifting, previous training, frequency of previous training, time since last training exposure, history of back pain while lifting patients, and present complaint of low-back pain, have on behavioral performance?

III. What relationship exists between a trainee's knowledge of safe patient handling techniques, measured at the conclusion of the training program, and behavioral performance?

The results of this study are expected to be used by hospital administrators in the following ways: 1) to help guide future policy decisions on the use of safe handling programs for nurses by providing evaluation-based evidence of the behavioral changes which can occur following exposure to a program of high educational quality, 2) to target specific organismic variables that can influence the application of safe handling methods in nurses so that

hospitals can make more cost-effective use of such programs, 3) to provide a model training program and evaluation design for future safe handling programs.

In addition to the direct applicability of this study to the area of back injury prevention, it is anticipated that the methodology and results from this study will have a broader generalizability to training and evaluation problems encountered in the urban environment. Urban managers are confronted daily by worker performance levels which fall short of some specified, desirable standards and which could be upgraded by training. While the training focus for these problems may vary greatly from back injury prevention, a common thread exists in the immediate objectives of these efforts: to promote the acquisition of knowledge, skills and attitudes by participants. By designing an educational program founded on sound "learning principles" this study provides a training model which can be adapted to a wide range of urban training topics.

Similarly, the issues of valid and objective program evaluation facing promoters of back injury prevention programs are being encountered by the sponsors of various urban training programs. Specifically, both factions are confronted with the methodological and logistical problems of measuring trainee performance once trainees return to their respective work settings. By employing a

behavioral-based evaluation strategy, this study provides a model format which can be adapted to the evaluation of similar, behavior-oriented efforts. Furthermore, the results of this study are expected to justify the use of the model training and evaluation formats in the urban environment.

Hypotheses

The following hypotheses will be put to statistical test to help determine the effects of a specifically designed training program on the patient handling techniques of nursing personnel.

Hypothesis #1: No interaction will exist among Group, Session and Task.

Hypothesis #2: No interaction will exist between Group and Task.

Hypothesis #3: No interaction will exist between Session and Task.

Hypothesis #4: No interaction will exist between Group and Session.

Hypothesis #5: No difference will exist between Groups.

Hypothesis #6: No difference will exist among Sessions.

Hypothesis #7: No difference will exist among Tasks.

Hypothesis #8: Each of the following twelve organismic variables: age, height, weight, gender, occupation, years of experience, frequency of lifting, previous training, frequency of previous training, time since last training exposure, history of back pain while lifting patients, and present complaint of low-back pain, will have no

influence on the behavioral performance of subjects.

Hypothesis #9: There will be no important relationship between the post-training test scores obtained by trainees and their behavioral performance following the training program.

Definition of Terms

Behavioral Performance - Refers to quantitative scores obtained by subjects from their performance of specified patient handling tasks that are observed, graded and recorded by a trained behavioral observer. Scores will be reported in the form of percent correct behaviors (Behavior performance = number of correctly performed behaviors ÷ total number of behaviors x 100).

Low-back Injury - Tissue damage to the anatomical structures of the lumbo-sacral region including muscle, bone, nerve, intervertebral disc, ligament, fascia or apophyseal joint.

Nursing Personnel - Nurses (RNs, LPNs), nursing aides, and ancillary personnel (ward clerks) who take care of sick individuals, including the manual handling of patients.

Session - Refers to a two week period during which behavioral data are collected on subjects by trained behavioral observers. Three specific sessions will be used in this study: Session 1 - pre training; Session 2 - immediately post training; Session 3 - commencing six weeks post training.

Tasks - Refers to four specific patient handling activities performed by nursing personnel and included in this study. These activities are: Task 1 - moving patients between bed and stretcher; Task 2 - moving patients between bed and wheelchair via a parallel transfer; Task 3 - moving patients between bed and wheelchair via a perpendicular transfer; Task 4 - moving patients between bed and standing with a walker.

Training - Refers to education-based activities designed to promote the acquisition of certain knowledge, skills and attitudes by participants. In this study, training will focus on the principles and techniques of safe patient handling.

Limitations

This study will be a behavior oriented evaluation of a specifically designed training program on safe patient handling techniques. In an attempt to create a high degree of realism, data will be obtained on subjects as they perform actual patient handling activities as a part of their normal work day. Since the only feasible way of collecting this data at the West Virginia University Hospital is by direct observation by a trained observer present at the time a task is performed, the subjects' awareness that they are being observed may influence their performances. By including a matched control group, it is

hoped the importance of this factor can be reduced. However, its potential impact will have to be recognized when data interpretation is performed.

In addition, the study will be restricted to nursing personnel currently working on the neurological and orthopedic wards at West Virginia University Hospital. Due to the variance which exists among nursing subspecialties in the frequency and types of patient handling required in their jobs, generalization of findings will have to be done with caution.

II. REVIEW OF THE LITERATURE

The growth of training programs on the topic of safe manual handling techniques as an intervention strategy for industrial low-back injuries has been influenced by research from various fields of study including epidemiology, biomechanics, education and program evaluation. This chapter will review these bodies of literature in an attempt to elucidate the theoretical underpinnings of these programs and to provide a basis for the interpretation of results from this study.

Epidemiological Aspects

Low-back pain has been recognized as an important occupational health problem since the mid 1600's.[21] However, as industrialization spread across western societies during the nineteenth and twentieth centuries, the drastic increase in low-back problems created a new classification of this occupational disease: industrial low-back pain.

While the association between industrial employment and low-back pain has been long recognized, the identification and prioritization of risk factors has been an

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[21]Timothy Larkin, "Ramazzini: Father of Occupational Medicine," Job Safety and Health, Vol. 2 (Nov. 1974), p. 21.

arduous task. Epidemiological studies into industrial low-back pain and injury have utilized data from general surveys, medical practices, State workmens' compensation systems and nationalized health programs to help uncover individual- and occupational-specific elements of risk. At present, any single low-back injury is believed to be a multifactorial interaction of variables including the worker's age, gender, occupation, years of experience in that occupation and physical conditioning.

Age

Although low-back injuries occur across all age categories, it has been shown the highest incidence of this disorder is between the early thirties to late forties.[22] An important impact of this finding is that low-back injuries frequently occur during an individual's most productive working years which can result in much social and financial hardship.[23]

Of particular interest has been the finding that

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[22]M. Laurens Rowe, "Low Back Pain in Industry. A Position Paper," Journal of Occupational Medicine, Vol. 11 (April 1969), p. 164; John W. Frymoyer, et al., "Epidemiologic Studies of Low-Back Pain," Spine, Vol. 5 (Sept.-Oct. 1980), p. 421; Bureau of Labor Statistics, "Back Injuries Associated with Lifting," p. 1.

[23]Marianne Berquist-Ullman and Ulf Larsson, "Acute Low Back Pain in Industry," Acta Orthopedica Scandanavia, Suppl. No. 170 (1977), p. 10.

workers who are exposed to the stresses of heavy work frequently experience their first onset of low-back pain at an earlier age, usually during their twenties.[24] A study by Alexander Magora on the relationship between occupation and low-back pain revealed the earliest onset of back pain occurred in bank clerks, farmers, heavy industrial workers and nurses.[25]

While the association between age and industrial low-back injury is generally recognized, there are questions concerning the cause-effect nature of this relationship. Theoretically, the cummulative effect of repeated exposures to back stresses would increase the suscepti-bility to back injury with age. However, back injury statistics drop off steadily beyond the age of fifty.[26] It has been suggested that older workers may either 1) not be exposed to the number, types and magnitudes of stresses

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[24]D. Stubbs and A.S. Nicholson, "Manual Handling and Back Injuries in the Construction Industry: An Investigation," Journal of Occupational Accidents, Vol. 2 (Aug. 1979), pp. 182-3; R.J. Blow and J.M. Jackson, "Rehabilitation of Registered Dock Workers," Proceedings Royal Society of Medicine, Vol. 64 (July 1971), p. 2; T. Videman, et al., "Low-Back Pain in Nurses and Some Loading Factors at Work," Spine, Vol. 9 (May-June 1984), p. 402.

[25]Alexander Magora, "Investigation of the Relationship Between Low Back Pain and Occupation. 6. Medical History and Symptoms," Scandanavian Journal of Rehabibilitation Medicine, Vol. 6 (Jan. 1974) p. 81.

[26]Klein, et al., "Assessment of Workers' Compensation Claims for Back Strains/Sprains," p. 445.

encountered by younger workers, or 2) they may have developed certain skills to avoid or reduce these hazards.[27] Thus, while a worker's age may contribute to the occurrence of a back injury, the importance of this risk factor probably derives from the association with other risk elements including physical make-up, occupational activities and level of experience.

Gender

The importance of gender as a risk factor for low-back injury derives largely from male-female differences in strength. Studies into sex differences in lifting strength have shown women to have approximately sixty percent the lifting strength of men.[28] In fact, since 1966 various labor organizations have recommended that women not be subjected to the same amount of manual

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[27]National Institute for Occupational Safety and Health, Work Practices Guide for Manual Lifting, NIOSH Pub. No. 81-122 (Washington: U.S. Government Printing Office, 1981), pp. 17-8.

[28]Don B. Chaffin, "Human Strength Capasity and Low-Back Pain," Journal of Occupational Medicine, Vol. 16 (April 1974), p. 251; S.H. Snook and V.M. Ciriello, "Maximal Weights and Loads Acceptable to Female Workers," Journal of Occupational Medicine, Vol. 16 (Aug. 1974), p. 532; S.H. Snook and C.H. Irvine, "Maximal Acceptable Weight to Lift," American Industrial Hygiene Association Journal, Vol. 27 (July-Aug. 1967), p. 324.

lifting as males.[29]

Investigations into the gender-specific incidence of low-back pain across general populations have revealed women and men to have an equal occurrence of back pain.[30] However, when workers' compensation claims have been used as a data base, males have been found to account for approximately eighty percent of all back injuries.[31] This discrepency in gender-specific incidence of low-back disorders between data bases suggests a large difference in exposure to job-related hazards (e.g. manual lifting, truck driving).

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[29]International Labor Organization, "Tailor Weight Lifting to Worker and Task, ILO Study Advises," Safety Standards, Vol. 15 (March-April 1966), pp. 12-3; Bureau of Labor Standards, "Teach them to Lift," pp.3-4.

[30]Jeri Horal, "The Clinical Appearance of Low Back Disorders in the City of Gothenburg, Sweden," Acta Orthopaedica Scandinvavica, Supplement No. 118 (1969), p. 59; Jennifer L. Kelsey, "An Epidemiological Study of Acute Herniated Lumbar Intervertebral Discs," Rheumatology and Rehabilitation, Vol. 14 (March 1975), p. 147; Frymoyer, et al., "Epidemidogic Studies of Low-Back Pain", p. 419.

[31]Stephen S. Leavitt, Tom L. Johnston and Robert D. Beyer, "The Process of Recovery: Patterns in Industrial Back Injury. Part 1. Costs and Other Quantitative Measures of Effort," Industrial Medicine, Vol. 40 (Nov. 1971), pp. 9-10; Stover H. Snook, Ralph A. Campanelli and Joseph W. Hart, "A Study of Three Preventive Approaches to Low Back Injury," Journal of Occupational Medicine, Vol. 20 (July 1978), p. 479; William W. Johnston, "Back Injuries - A Problem for Both Workers and Employers," Ohio Monitor, Vol. 55 (Feb. 1982), p. 15; Klein, et al., "Assessment of Workers' Compensation Claims for Back Strains/Sprains," p. 444.

When women are exposed to strenuous, job-related tasks, their susceptibility to low-back injury appears to be enhanced. Specifically, nursing is a female oriented field which requires the frequent performance of heavy manual tasks. The elevated incidence of low-back injury found to exist among nurses is felt to derive largely from the finding that a nurse's lifting burden frequently exceeds gender-specific recommendations for maximal permissible weights.[32] Because of the lower strength capacities among women, it is critical for them to employ safe handling techniques which reduce the magnitude of stress imposed on their low-backs.[33]

Occupation

The epidemiological finding that low-back injury rates vary greatly among occupational classifications has led to the belief that occupation is an important risk factor for back injury. What appears to be critical among the occupational-specific incidences of low-back injury are the types, frequencies and magnitudes of certain job-related activities.

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[32]Dehlin and Lindberg, "Lifting Burden for a Nursing Aide During Patient Care in a Geriatric Ward," p. 71.

[33]Margaret Scholey, "Back Stess: The Effects of Training Nurses to Lift Patients in a Clinical Situation," International Journal of Nursing Studies, Vol. 20 (Jan. 1983), pp. 1-2.

Manual handling has become widely recognized as one of the most important risk factors associated with low-back injury.[34] Indeed, compensation claim based studies have revealed manual handling tasks to be the activities most frequently associated with compensable back injuries, accounting for approximately seventy percent of all back injuries.[35] Similarly, manual handling tasks have been implicated in the occurrence of low-back injuries in studies conducted across specific industries[36] and among

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[34] John R. Brown, Manual Lifting and Related Fields. An Annotated Bibliography, (Ontario: Labour Safety Council, 1972), pp. 1-10; J.D.G. Troup, "Manual Materials Handling - the Medical Problem", in Safety in Manual Materials Handling, NIOSH Pub. No. 78-185, ed. by Colin G. Drury (Washington: U.S. Government Printing Office, 1978), pp. 17-8; National Institute for Occupational Safety and Health, Work Practices Guide for Manual Lifting, pp. 1-9.

[35] Leavitt, et al., "The Process of Recovery: Patterns in Industrial Back Injury. Part 1. Cost and Other Quantitative Measures," p. 11; Snook, et al., "A Study of Three Preventive Approaches to Low Back Injury," p. 479; Johnston, "Back Injuries - A Problem for Both Workers and Employers", p. 15; Klein, et al., "Assessment of Workers' Compensation Claims for Back Strains/Sprains," p. 445.

[36] Alexander P. Aitken, "Rupture of the Intervertebral Disc in Industry," American Journal of Surgery, Vol. 84, (Sept. 1953), p. 262; F.G.M. Seager, "Some Observations on the Incidence and Treatment of Back Injuries in Industry," Annals of Occupational Hygiene, Vol. 2 (April 1957), p. 180; J.W. Daniel, et al., "Low Back Pain in the Steel Industry: A Clinical, Economic and Occupational Analysis at a North Wales Integrated Steelworks of the British Steel Corporation," Journal of the Society of Occupational Medicine, Vol. 30 (Jan. 1980), p. 52; John M. Jackson, "Biomechanical Hazards in the Dockworker," Annals of Occupational Hygiene, Vol. 11 (Feb. 1968), p. 151; Stubbs and Nicholson, "Manual Handling and Back Injuries in the Construction Industry: An Investigation," pp. 182-5.

general populations.[37] From these findings it is not surprising that laborers, warehousemen and nursing personnel have some of the largest occupational-specific incidences of low-back injury.[38]

The causal relationship between manual handling and low-back injury derives largely from the biomechanical forces generated by these activites.[39] When a worker is exposed to heavy and/or frequent manual handling tasks, the risk of low-back injury escalates. This parameter of low-back injury will be discussed in more detail under "Biomechanical Aspects."

In contrast to the high physical stresses of manual handling jobs, workers whose occupation requires frequent and/or prolonged sitting have also been found to be at

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[37]Jennifer L. Kelsey, "An Epidemiological Study of Acute Herniated Lumbar Intervertebral Discs," p. 151; Frymoyer, et al., "Epidemiologic Studies of Low-Back Pain," p. 420; J.W. Frymoyer, et al., "Risk Factors in Low-back Pain," Journal of Bone and Joint Surgery, Vol. 65-A (Feb. 1983), p. 215.

[38]Snook, "Low Back Pain in Industry," pp. 27-9; Klein, et al., "Assessment of Workers' Compensation Claims for Back Strains/Sprains," pp. 445-6.

[39]Tichauer, "Biomechanics Sustains Occupational Safety and Health," pp. 49-51; Troup, "Biomechanics of the Vertebral Column," pp. 238-42; Chaffin, "Biomechanics of Manual Materials Handling and Low-Back Pain," pp. 443-53.

increased risk of low-back injury.[40] While the mechanism by which sitting postures predisposes an individual to low-back pain is uncertain, it may be associated with the high compression forces exerted on the intervertebral discs in this position.[41]

In addition to sitting, workers who sit and are simultaneously exposed to vibrations have been found to be at high risk of low-back injury. Specifically, the large number of low-back injuries among truck drivers has been attributed to the combination of prolonged sitting postures and mechanical vibration. Prolonged mechanical vibration may produce "microtrauma" to the intervertebral disc which, over years of exposure, may increase the

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[40]Alexander Magora, "Investigation of the Relationship Between Low Back Pain and Occupation. Part 3. Physcial Requirements: Sitting, Standing and Weight Lifting", Industrial Medicine and Surgery, Vol. 41 (Dec. 1972), p. 5; Zdenec Hrubec and Blaine S. Nashold, "Epidemiology of Lumbar Disc Lesions in the Military in World War II," American Journal of Epidemiology, Vol. 102 (May 1975), pp. 371-2; Jennifer L. Kelsey, "An Epidemiological Study of Acute Herniated Lumbar Intervertebral Discs," pp. 148-9.

[41]Alf Nachemson and James M. Morris, "In Vivo Measurements of Intradiscal Pressure," Journal of Bone and Joint Surgery, Vol. 46-A (July 1964), pp. 1087-90; Alf Nachemson, "The Load on Lumbar Discs in Different Positions of the Body," Acta Orthopaedica Scandinavica, No. 45 (March-April 1966), pp. 114-6; Alf Nachemson, "Towards a Better Understanding of Low-Back Pain: A Review of the Mechanics of the Lumbar Disc," Rheumatology and Rehabilitation, Vol. 14 (March 1975), pp. 139-40.

likelihood of low-back injury.[42]

Years of Experience

An individual's years of experience in a given occupation can influence his/her susceptibility to low-back injury, especially in jobs which entail frequent manual handling.[43] Since skill in safe manual handling methods occurs over time and with much practice, an inexperienced worker will be more likely to employ unsafe techniques which increase the risk of low-back injury. Conversely, years of exposure to physically demanding tasks can also enhance the risk of back injury due to the commulative effect of many subthreshold insults to the tissues of the low-back.

This "double peak" in low-back injuries has been identified in nurses and heavy industrial workers.[44] Such findings emphasize the importance of early training of new workers in the techniques of safe manual handling and, the need to consistantly use these methods over many years.

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[42]Gunnar Andersson, "Low Back Pain in Industry: Epidemiological Aspects," Scandanavian Journal of Rehabilitation Medicine, Vol. 11 (Jan. 1979), pp. 165-6.

[43]Scholey, "Back Stess: The Effects of Training Nurses to Lift Patients in a Clinical Situation," pp. 1-2.

[44]Cust, et al., "The Prevalence of Low Back Pain in Nurses," pp. 173-4; J.D.G. Troup, "Relation of Lumbar Spine disorders to Heavy Manual Work and Lifting," Lancet, Vol. 1 (April 17, 1965), p. 858.

Physical Conditioning

Work-related tasks which require workers to perform repetitive and stressful activities can produce muscular and/or cardio-vascular fatigue.[45] If the individual worker's endurance is inadequate to meet these physical demands, the risk of low-back injury is increased. Studies on the effect of physical conditioning programs and low-back pain have indicated that high levels of physical fitness can improve a worker's psychological perception of their work[46] and help prevent the occurrence of compensable low-back injury.[47]

Biomechanical Aspects

The association between manual handling tasks and low-back injury has stimulated a great deal of research

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[45]Stover H. Snook, "The Effect of Age and Physique on Continuous-Work Capasity," Human Factors, Vol. 13 (May 1971), pp. 473-8; A.S. Ljungberg, F. Gamberale, and A. Kilbom, "Horizontal Lifting - Physiological and Psychological Responses," Ergonomics, Vol. 25 (Aug. 1982), pp. 747-52; Anil Mital and I. Manivasagan, "Maximal Acceptable Weight of a Lift as a Function of Material Density, Center of Gravity Location, Hand Preference and Frequency," Human Factors, Vol 25 (Jan. 1983), pp. 39-41.

[46]Ove Dehlin, et al., "Effect of Physical Training and Ergonomic Counselling on the Psychological Perception of Work and on the Subjective Assessment of Low-Back Insufficiency," Scandanavian Journal of Rehabilitation Medicine, Vol. 13 (Jan. 1981), pp. 4-6.

[47]Lee D. Cady, et al., "Strength and Fitness and Subsequent Back Injuries in Firefighters," Journal of Occupational Medicine, Vol. 21 (April 1979), pp. 271-2.

into the cause-effect nature of this relationship. Biomechanical analyses of specific activities (e.g. lifting, twisting) and various methods for accomplishing these tasks have been important in 1) clarifying the mechanisms by which manual tasks produce damage to low-back tissues and 2) identifying handling techniques which minimize the likelihood of back injury.

Many of the early biomechanical studies performed on prepared human specimens attempted to establish the failure point of specific anatomical structures, including intervertebral disc,[48] ligaments,[49] and bone[50] when external forces (e.g. compression, tension, rotation) were applied. Such investigations demonstrated that forces which exceed a critical and tissue-specific thres-

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[48] W. Virgin, "Experimental Investigations into Physical Properties of Intervertebral Discs," Journal of Bone and Joint Surgery, Vol. 33-B (Nov. 1951), p. 607; T. Brown, R. Hansen and A. Yorra, "Some Mechanical Tests on the Lumbo-sacral Spine with Particular Reference to the Intervertebrae Discs", Journal of Bone and Joint Surgery, Vol. 39-A (Oct. 1957), p. 1135.

[49] H. Tkaczuk, "Tensile Properties of Human Lumbar Longitudinal Ligaments," Acta Orthopedica Scandinavica, 155 [Suppl] 1968.

[50] S. David Rockoff, Edward Sweet and Jeffery Bleustein, "The Relative Contribution of Trabecular and Cortical Bone to the Strength of Human Lumbar Vertebrae," Calcified Tissue Research, Vol. 3 (Oct. 1969), p. 163

hold produce observable damage to these structures.[51] Avoiding dangerous levels of tissue stress has become a central theme in the prevention of low-back injuries.

The linkage between manual handling tasks and low-back injury is that these tasks, especially lifting and twisting, can generate tissue stresses which far exceed an individual's tissue-specific thresholds. Studies conducted by Bradford and Spurling in the early 1940's showed lifting with a flexed spine could result in compressive forces on intervertebral discs as high as 1600 pounds.[52] Since discs can be damaged with compressive forces as low as 350 pounds,[53] spinal posture soon became recognized as an important variable in low-back injury prevention.

During the early 1970's, studies conducted by H.F. Farfan and associates identified the hazards of torsional

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[51]A. White and M. Panjabi, Clinical Biomechanics of the Spine, (Philadelphia: J.B. Lippincott, 1978), pp. 1-56.

[52]F.K. Bradford and R.G. Spurling, The Intervertebral Disc, (Springfield: Charles C. Thomas, 1945).

[53]D.L. Bartelink, "The Role of Abdominal Pressure in Relieving the Pressure on the Lumbar Intervertebral Disc," Journal of Bone and Joint Surgery, Vol. 39-B (April 1957), pp. 718-25.

(e.g. twisting) stresses on the intervertebral disc.[54] They concluded the majority of disc degeneration that occurs with age is the result of twisting stresses on the disc. It has become generally recognized that workers should avoid twisting activities as a prophylactic measure against low-back injury.

In addition to spinal postures and movements, the magnitude of the load being handled, the frequency of handling tasks, and the location of the load relative to the worker's body have been targeted as important variables in low-back stresses.[55] A study by Don B. Chaffin has demonstrated a direct relationship between the weight of a load being handled and the compressive forces imposed on the intervertebral disc between the fifth lumbar and first sacral vertebrae.[56] With all other factors being equal, the heavier the weight being lifted, the greater the risk of low-back injury.

As previously noted, repetitive and stressful activities can produce high levels of muscular and/or

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[54] H.F. Farfan, Mechanical Disorders of the Low Back, (Philadelphia: Lea and Febiger, 1973); Farfan, et al., "The Effects of Torsion on the Lumbar Intervertebral Joints: The Role of Torsion in the Production of Disc Degeneration," pp. 494-95.

[55] NIOSH, Work Practices Guide to Manual Lifting, p. 55.

[56] Don B. Chaffin, "Biomechanics of Manual Materials Handling and Low Back Pain," p. 447.

cardio-vascular fatigue. Thus, when a job requires a worker to perform tasks at a high pace, the subsequent fatigue may be an important factor in producing a low-back injury.[57] Some investigaters have proposed the establishment of "frequency limits" as a means of reducing low-back injuries.[58]

The position of the load with respect to the worker's body has become recognized as a crucial and controllable factor in low-back stresses. The application of simple, engineering-oriented models to manual lifting tasks have illustrated the fact that as a load moves further away from the trunk (e.g. the lever arm increases) the magnitude of stress imposed upon the tissues of the low-back increases drastically.[59] To help minimize the stress of any manual handling task, workers should attempt to reduce the distance between themselves and the load being handled.

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[57]B.J. Hamilton and R.B. Chase, "A Work Physiology Study of the Relative Effects of Pace and Weight in a Carton Handling Task," AIIE Transactions, Vol. 1 (Jan. 1969) pp. 106-11.

[58]S.H. Snook and C.H. Irvine, "Maximal Frequency of Lift Acceptable to Male Industrial Workers," American Industrial Hygiene Association Journal, Vol. 28 (Nov.-Dec. 1968), p. 533-5.

[59]Tichauer, "Biomechanics Sustains Occupational Safety and health," pp. 49-51; Chaffin, "Biomechanics of Manual Materials Handling and Low Back Pain," pp. 443-53.

Combining the biomechanically-based findings of manual handling research with the types of handling tasks performed by workers has led to the development of certain "principles" of manual handling. Such principles have served as the foundation of many low-back training programs which are intended to reduce the stresses of manual handling by promoting safe handling techniques to workers. The principles to be employed in this study have been advocated for general industrial use by the National Safety Council and the National Institute for Occupational Safety and Health.[60] They include:

a. Keep the feet apart and asymmetrical in the coronal plane.

Assuming this position prior to attempting a manual task provides a wide base of support which diminishes the likelihood of injury due to loss of balance while handling the load.

b. Keep the back straight and vertical.

Avoiding flexed spinal postures throughout handling tasks reduces the tissue stresses imposed upon the posterior elements of the back

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[60]National Safety Council, "A New Way to Lift," Stock No. 193.19 (Chicago: National Safety Council, 1970); NIOSH, "How to Lift Safely," Publ. No. 1980-660-964 (Washington: U.S. Government Printing Office, 1980).

(e.g. extensor muscles and posterior ligamentous structures).

c. Bend at the knees.

The large, phasic muscles of the legs are much better suited for the physical demands of lifting than the short, tonic muscles of the back. Flexing the knees prior to lifting and then extending the the knees to accomplish the lift is an effective means of using the leg muscles during handling tasks.

d. Keep the load close to the body.

This minimizes lever arms and helps reduce the stress imposed on low-back tissues.

e. Avoid twisting.

Since twisting activities hasten the breakdown of intervertebral discs, it is critical for workers to avoid these activities, especially when handling loads.

f. Teamwork.

Because many tasks require the coordinated effort of more than one worker, it is important that movements begin and conclude at the same time.

Educational Aspects

The awareness that certain methods of performing

manual tasks can markedly reduce the stresses imposed on the tissues of the low-back has led to the use of training programs as a means of disseminating this information to workers. By participating in training activities promoting safe handling techniques, it has been hoped that workers will master the appropriate handling skills and then return to their work settings and use these techniques. Since the educational quality of the training activities will have an important impact on the success of these endeavors, the educational principles of effective training will be examined to help structure the training program to be used in this study.

As educational activities, training programs are designed to produce learning within trainees. According to Irwin L. Goldstein in his book, Training: Program Development and Evaluation, instructional programs are:

> ...based on the belief that it is possible to design an environment in which learning can take place and later be transferred to another setting.[61]

What differentiates industrial training from other forms of education is the direct linkage between training activities and organization objectives.

The operational definition of learning which will be used throughout this dissertation is:

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[61]Irwin L. Goldstein, Training: Program Development and Evaluation, p. 93.

> ...the process of acquiring knowledge, skills and/or attitudes.[62]

It is critical to the success of training programs that instructors design and implement instructional activities which maximize the likelihood that trainees will acquire the knowledge, skills and attitudes promoted in the program. In addition, instructional activities should also include elements which facilitate the subsequent transfer of program information to the trainee's work setting.

Stages of Learning

In their book, Management of Training Programs, Frank A. DePhillips, William M. Berliner, and James J. Cribbin emphasize that learning is an active process designed to allow trainees to reach higher levels of proficiency.[63] To achieve this goal, training activities must help guide trainees through the four stages of learning:

1. unconscious incompetence--where trainees are unaware of their deficiencies,
2. conscious incompetence--when trainees are made aware of their inadequacies, but are still unable

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[62]John S. Randall, "You and Effective Training: Part 2 - 'The Learning Process'," Training and Development Journal, Vol. 32 (June 1978), p. 10.

[63]Frank A. DePhillips, William M. Berliner and James A. Cribbin, Management of Training Programs, (Homewood: Richard D. Irwin, Inc., 1960), p. 69.

to correct them,

3. conscious competence--when trainees are able to correct inadequacies via deliberate actions, and
4. unconscious competence--when trainees acquire desirable habits.

Christopher R. Hayne has applied these "stages of learning" to safe manual handling programs in an attempt to emphasize the need for efforts of high educational quality.[64] He states:

> The most satisfactory and certain way to take employees through the four stages of learning--from unconscious incompetence to conscious incompetence, to conscious competence, and finally to unconscious competence--is to create a broadly based program containing both theoretical and practical elements which are applied to real life situations of the factory floor.

Hayne acknowledges that creating effective training based on these stages requires both time and experienced instructors. Indeed, a company's inability or unwillingness to allocate these two resoures may be reasons why many safe handling programs have failed to yield desirable results.

Types of Learning

While training personnel frequently use the term "learning" as a generic entity, DePhillips, Berliner, and

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[64] Hayne, "Lifting and Handling," p. 19.

Cribbin point out that there are four kinds of learning with important training implications.[65] Sensori-motor learning entails the neuro-muscular acquisition of certain skilled movements. Conceptual learning is the mental assimilation of some fact, principle, law or generalization. Association learning involves the linkage of fact and ideas via a conditioning process in which one factor serves as a stimulus for the other. Attitudinal learning entails various extraneous factors linked to job satisfaction (e.g. morale, motivation, interest, human relations).

Since the learning emphasis of a training program may include one or more of these learning types, it is important for instructors to recognize the differences among these learning types and select training methods which enhance the likelihood of achieving their learning goals. Specifically, safe handling programs promote the acquisition of specific principles of safe handling (conceptual learning), the mastery of certain techniques of handling (sensori-motor learning), and the application of this knowledge and techniques to appropriate job-related tasks (associational and attitudinal learning).

To attain program-specific learning objectives,

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[65]DePhillips et al., Management of Training Programs, pp. 69-76.

instructors have ultilized a wide variety of educational methods including lectures, demonstrations, films, case studies, on-the-job training, sensitivity groups, programmed instruction, simulation, management games, and role playing.[66] While these instructional methods are all designed to promote learning within trainees, their effectiveness in achieving this goal will depend largely on the type of learning being sought.[67]

For instance, one of the goals of safe manual handling programs is to produce sensori-motor learning in the form of physical skills in certain handling techniques. Since the attainment of manual skills requires practical sessions with adequate feedback on techniques, it is imperative that safe handling programs incorporate such practical components.[68] Unfortunately, the frequent use of movies, lectures, posters, and booklets as the sole training method for promoting safe handling techniques reduces the likelihood of skill

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[66]Homer C. Rose, The Instructor and His Job, (Aslip: American Technicaal Publ. Co., 1961), pp. 35-55; Malcolm W. Warren, Training for Results, Second Edition (Reading: Addison-Wesley Publ Co., 1979), pp. 77-100.

[67]Stephen J. Carroll, Frank T. Paine, and John J. Ivancovich, "The Relative Effectiveness of Training Methods - Expert Opinion and Research," Personnel Psychology, Vol. 25 (May 1972), pp. 497-505.

[68]Troup, "Biomechanics of the Vertebral Column," p. 242.

acquisition by trainees since these methods provide neither practical sessions nor feedback to trainees.

Principles of Learning

Unlike physical scientists who frequently have universal laws to guide their clinical applications, educationalists have based many of their activities on the various theories of human learning. DePhillips, Berliner and Cribben discuss three learning theories upon which industrial training programs have been based: behaviorism, Gestalt-Field and connectionism.[69] In addition, recognizable differences in the learning styles of adults and children/adolescents has provided a fourth educational model (Adult Learning Theory) which also has applicability to training programs.[70]

Despite certain philosophical differences among these four learning theories, common elements do exist. The "learning principles" generally accepted by all camps include the following:

1) Individuals learn to fulfill needs.

2) All learning is a form of self-active behavior.

3) The learner must have some motivation, internal

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[69] DePhillips et al., Management of Training Programs, pp. 82-95.

[70] Randall, You and Effective Training: Part 2 - 'The Learning Process,'" pp. 10-12.

or external, which causes him/her to address problems.[71]

4) The learner should be rewarded as-soon-as possible after success.[72]

5) Learning can not be forced.

6) The learner must not only learn what is to be mastered, but must also apply it.[73]

7) The criterion for learning is not what an instructor thinks, grades, or the ability to use a technique at the request of the instructor, but rather the extent to which the learner ultilizes what he has learned voluntarily from day to day.[74]

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[71]Joel K. Leidecker and James J. Hall, "Motivation: Good Theory - Poor Application," Training and Development Journal, Vol. 35 (June 1981), pp. 152-3; B.L. Rosenbaum, How to Motivate Workers, (New York: McGraw-Hill, 1982), pp. 6-7.

[72]R.W. McIntire and J. White, "Behavioral Modification," in The Human Side of Accident Prevention, ed. by Bruce L. Margolis and William H. Kroes (Springfield: Charles C. Thomas, 1975), pp. 125-9.

[73]William C. Byham, Diane Adams and Ann Kiggins, "Transfer of Modeling Training to the Job," Personnel Psychology, Vol. 29 (March 1976), p. 345; Melissa S. Leifer and John W. Newstrom, "Solving the Transfer of Training Problems," Training and Development Journal, Vol. 34 (Aug. 1980), pp. 42-6; David L. Georgenson, "The Problem of Transfer Calls for Partnership," Training and Development Journal, Vol. 34 (Oct. 1982), p. 75.

[74]DePhillips et al., Management of Training Programs, p. 98.

The training program on safe patient handling techniques to be presented to nursing personnel will be structured around these common elements of human learning. On this basis it is hoped that the evaluative results will reflect the trainees' tendencies to apply program information to job tasks and reduce the likelihood of artifacts resulting from irrelevant course content and/or inadequate program presentation.

Program Development

Over the past decade, application of the principles of systems analysis to training programs has led to a more scientific approach to these efforts. According to Irwin L. Goldstein:

> The systems approach to instruction emphasizes need assessment for the specification of instructional objectives, precisely controlled and monitored training experiences to achieve these objectives, multiple criteria for performance and evaluative information based upon carefully planned research designs.[75]

Through the adherence to development guidelines set forth by Goldstein, it is anticipated that the training program used in this investigation will be educationally valid and evaluatively feasible.

According to Goldstein, the instructional system

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[75]Irwin L. Goldstein, "Training," in The Human Side of Accident Prevention, ed. by Bruce L. Margolis and William H. Kroes (Springfield: Charles C. Thomas, 1975), p. 92.

includes three components: Assessment Phase, Training and Development Phase, and Evaluation Phase.[76] During the Assessment Phase, a task analysis is performed which should accurately describe the activities required by the job and the knowledge, skills and attitudes needed by workers to accomplish these tasks. Of particular importance during the Assessment Phase is to identify those behavioral characteristics present in the prospective trainees and those which need to be introduced and/or upgraded.

From the Assessment Phase should emerge specific behavioral objectives for the training program. In addition, these behavioral criteria should also be included in the Evaluation Phase as a means of measuring the success of training activities in promoting desirable behavioral changes.

During the Training and Development Phase, the instructor should devise an environment in which the specific behavioral objectives can be achieved. Goldstein states:

> This a delicate process that requires a blend of learning principles and media selection, based on the tasks that the trainee is eventually expected to perform.[77]

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[76]Goldstein, _Training: Program Development and Evaluation_, pp. 17-25.

[77]Ibid., p. 21.

The final component, Evaluation Phase, measures and assesses the degree to which desirable behavioral changes have occurred. Information from a systematic program evaluation can address the issues of program effectiveness, provide valuable information which can lead to improvements in activities, and provide managers with objective information for future decisions regarding resource allocation.[78]

Evaluation Aspects

Despite the frequent use of training to address a host of industrial problems including worker safety, employee performance and interpersonal relations, the efficacy and effectiveness of these efforts remains highly subjective. Contributing to this subjectivity has been a general tendency to implement training programs without evaluation components. Following a review of training studies in 1971, John P. Campbell characterized the literature as voluminous, nonempirical, nontheoretical, poorly written and dull.[79]

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[78] Judi Komaki, "Alternative Evaluation Strategies in Work Settings: Reversal and Multiple Baseline Designs," Journal of Organizational Behavioral Management, Vol. 1 (Summer 1977), p. 53.

[79] John P. Campbell, "Personnel Training and Development," Annual Review of Psychology, Vol. 22 (Feb. 1971), p. 174.

Since Campbell's report, there has been a large movement toward a more consistent and systematic evaluation of training activities. Indeed, a follow-up study to Campbell's by I. L. Goldstein in 1980 revealed an increase in both the quantity and quality of evaluation-oriented reports.[80] Yet, the inclusion of evaluation components in industry-specific training programs continues to be cited as one of the most important weaknesses among industrial training.[81]

In addition to the general lack of evaluation efforts, this area of industrial safety training has also suffered from the use of evaluation criteria of limited validity. Since the works of H. W. Heinrich in 1931, unsafe acts on behalf of workers have been recognized as the principle cause of work-related accidents.[82] However, the majority of these unsafe acts result in either no injuries (e.g. near misses) or only minor injuries which are frequently not reported. Heinrich estimated only one out of 330 accidents results in a major, and thus report-

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[80] I.L. Goldstein, "Training in Work Organizations," Annual Review of Psychology, Vol. 31 (March 1980), pp. 237-41.

[81] William A. Deterline, "Credibility in Training: Part 1. Why Are You Going to Do That?" Training and Development, Vol. 30 (Dec. 1976), p. 3.

[82] H.W. Heinrich, Industrial Accident Prevention, Fourth Ed. (New York: McGraw-Hill, 1959), pp. 26-31.

able, work-related injury.

Despite the fact that disabling injuries are a statistically rare result of unsafe work practices, evaluators of safety training programs have made frequent use of accident data (e.g. accident reports, compensation claims, medical records) to measure the effectiveness of their behavior based programs. As a means of measuring safety performance, Thomas H. Rockwell has described accident data as vague, invalid and insensitive criteria.[83] Other safety professionals have also attacked the continued use of accident data as an evaluation criteria and have recommended the application of more valid measures such as behavior-based criteria.[84]

In response to the need for more valid evaluations of safety programs, investigators have begun employing behavioral criteria in their evaluation designs. In

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[83] Thomas H. Rockwell, "Safety Performance Measurement," Journal of Industrial Engineering, Vol. 10 (Jan.-Feb., 1959), p. 12.

[84] James W. Altman, "Behavior and Accidents," Journal of Safety Research, Vol. 2 (March 1970), p. 121; John V. Grimaldi, "The Measurement of Safety Engineering Performance," Journal of Safety Research, Vol. 2 (March 1970), p. 137; Herbert H. Jacobs, "Towards More Effective Safety Measurement Systems," Journal of Safety Research, Vol. 2 (March 1970), p. 160; Thomas H. Rockwell and Vivek D. Bhise, "Two Approaches to a Non-Accident Measure for Continuous Assessment of Safety Performance," Journal of Safety Research, Vol 2 (March 1970), p. 176; Robert C. Gallegos and Joseph G. Phallen, "Using Behavioral Objectives in Industrial Training," Training and Development Journal, Vol. 28 (April 1974), pp. 42-8.

particular, Judi Komaki has applied the behavioral approach to various business and industrial setting to assess the impact of behavior-oriented programs.

In 1977, Komaki, Waddell and Pearce used a behavioral analysis approach to quantify behavioral changes in employees at a grocery store and a game room.[85] Desirable and undesirable behaviors were recorded by trained behavioral observers and reported in the form percent desired behaviors (number of desired behaviors ÷ total number of behaviors x 100). The authors concluded the behavioral approach to be a useful strategy in assessing the behavioral outcomes of intervention programs.

Similar evaluation formats have been used by Komaki et al., to evaluate safety programs at a food manufacturing plant and a vehicle maintenance division.[86] In both studies a dichotomously measured, behavioral criteria was applied in which behaviors were categorized as either

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[85]Judi Komaki, William M. Waddell and M. George Pearce, "The Applied Behavior Analysis Approach and Individual Employees: Improving Performance in Two Small Businesses," Organizational Behavior and Human Performance, Vol. 19 (1977), pp. 338-48.

[86]Judi Komaki, Kenneth D. Barwick and Lawrence R. Scott, "A Behavioral Approach to Occupational Safety: Pinpointing and Reinforcing Safe Performance in a Food Manufacturing Plant," Journal of Applied Psychology, Vol. 63 (April 1978), pp. 336-41; Judi Komaki, Arlene Heinzmann and Loralie Lawson, "Effect of Training and Feedback: Component Analysis of a Behavioral Safety Program," Journal of Applied Psychology, Vol. 65 (March 1980), pp. 262-8.

"safe" or "unsafe". The behavioral approach allowed the authors to quantify behaviors and analyze performance based on the percentage of safe behaviors being performed by subjects.

A more recent application of the behavioral approach to industrial safety was performed by Cohen and Jensen at an industrial warehouse.[87] Following a task analysis where the job activities of forklift operators were identified, the authors created dichotomous criteria (correct or incorrect) for assessing worker performance. Using a time series research design, they collected data pre- and post-training in safety procedures. Behavioral performance was found to increase dramatically (e.g. fewer unsafe acts) immediately following training which was retained for at least 10 weeks following the training program. As in the Komaki et al. studies, the behavioral approach allowed for the analysis of observable and measurable behaviors.

As a form of safety training, safe manual handling programs have been characterized by both a lack of objective program evaluation and, when evaluation has been performed, the use of invalid criteria. The current

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[87] H. Harvey Cohen and Roger C. Jensen, "Demonstration of the Effectiveness of an Industrial Lift Truck Operator Safety Training Program Utilizing a Behavior Sampling Procedure," NIOSH Contract 210-79-0018, August 1982.

status of safe manual handling programs as an intervention strategy for low-back injuries is summed up by Duncan Troup who states:

> Not surprisingly, there is little evidence based on controlled trials that training does any good.[88]

One of the first evaluations of safe manual lifting programs was performed by John M. Jackson on a group of dock workers.[89] Slow motion films were taken before and after a training session to determine if trainees acquired the lifting techniques promoted during training activities. Jackson concluded:

> This series of slow motion film analyses shows that new lifting postures can be acquired during a training programme by those who are receptive. It is clear that those who have below average response need a longer period of instruction and practice. The response to training is variable and the re-educative capacities of subjects are affected by age, attitude and previous disability. There is no evidence to show what long-term effects of training can accomplish in safe handling and whether back injuries can be reduced.[90]

Thus, while Jackson's behavior based study revealed training programs can produce the desirable acquisition of safe handling techniques, the lack of similar measurements

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[88] J.D.G. Troup, "Back Injuries Can Be Prevented," Health and Safety at Work, Vol. 4 (Dec. 1982), p. 15.

[89] Jackson, "Biomechanical Hazards of the Dockworker," pp. 155-56.

[90] Ibid., p. 156.

in the actual work setting prevents any estimation on the degree to which these skills are transferred to job tasks.

In 1972, John R. Brown analyzed accident statistics from across the United Kingdom to assess the impact of safe handling programs.[91] The failure of back injury statistics to fall over a twenty-six year period between 1940 and 1956 when industries actively promoted the "straight back, knees bent" method of lifting prompted Brown to conclude that this handling method was ineffective in preventing back injuries.

In addition to using evaluative criteria of limited validity (accident statistics), no effort was made to account for the educational differences among training programs or the degree to which workers actually applied this handling method. At best, Brown's study raised an important question concerning the validity of handling methods being taught to workers. However, as an assessment of training effectiveness, his analysis exerted too few controls to be considered valuable.

In a second study of industrial low-back pain, Brown employed a questionnaire to help determine factors which contribute to this condition.[92] In a comparison between workers who reported back injuries with those who did not,

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[91] Brown, Manual Lifting and Related Fields. An Annotated Bibliography, pp. 1-26.

Brown found the back injury group reported adopting the prescribed methods of lifting advocated in training sessions more frequently than the asymptomatic group. From this finding Brown questioned the benefit of attending lectures and the lifting procedures being taught to workers.

The subjective nature of questionnaire studies leads to questions concerning Brown's findings on training. Because a respondee states he/she had adopted correct handling methods does not prove that he/she had effectively and consistently employed those techniques to appropriate job tasks.

In 1976, Ove Dehlin, Bo Hedenrud and Jeri Horal conducted an interview survey of nursing aides in a Swedish geriatric hospital to determine factors which contributed to low-back pain.[93] Nursing aides with complaints of low-back pain were compared to a similar group without back symptoms. The finding that the back pain group reported using the same manual handling methods as the asymptomatic group prompted the authors to conclude

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[92]John R. Brown, "Factors Contributing to the Development of Low Pack Pain in Industrial Workers," American Industrial Hygiene Association Journal, Vol. 36 (Jan. 1975), pp. 26-31.

[93]Ove Dehlin, Bo Hedenrud and Jeri Horal, "Back Symptoms in Nursing Aides in a Geriatric Hospital," Scandanavian Journal of Rehabilitation Medicine, Vol. 8 (Jan. 1976), p. 53.

safe handling instruction was of little value in preventing low-back pain.

This study was similar to the 1975 study by John R. Brown in that subjective reports via questionnaires were used to assess the impact of training. The fact that all subjects in the Dehlin et. al. study had repeated exposures to training (e.g. lectures repeated every three months) strengthens the belief that subjects were aware of what the proper handling techniques were but, as in the Brown study, the lack of further behavioral data prevents the identification of particular problem areas (e.g. Is the handling method invalid? Are workers failing to use it when they return to their job settings?).

An investigation into the long term effect of training on low-back pain was conducted by M.J. Karvonen, T. Jarvinen and J. Nummi among nurses in Helsinki, Katsautsia.[94] The authors found via a questionnaire to nurses several years following training in safe handling methods, that trained nurses had less subjective complaints of low-back pain than untrained nurses. While these findings support the belief that training programs in safe handling methods may help reduce the subjective

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[94]M.J. Karvonen, T. Jarvinen and J. Nummi, "Follow-up Study on the Back Problems of Nurses," Institute of Occupational Health, Helsinki, Katsauksia, Vol. 14 (1977), p. 8.

onset of low-back symptoms, the same questionnaire-related deficiencies cited against the Brown and Dehlin et al. works detract from the validity of this study.

In 1978, Stover H. Snook, Ralph A. Campanelli and Joseph W. Hart investigated the prevention of low-back injury in American industries.[95] Using accident statistics on low-back injury and questionnaires to workers, the authors addressed the impact of three preventive strategies: training, worker selection and job design. With respect to training, a comparison between trained and untrained workers revealed no significant difference in low-back injury prevention. They concluded:

> The second message is that training on safe lifting procedures as it is presently being administered today is not an effective control for low-back injuries.[96]

While the Snook et al. study represents one of the more scientific approaches to low-back injury evaluation, several methodological problems detract from the utility of the results. First, the use of accident data as a criteria for assessing workers' behaviors has been attacked as being unreliable and invalid. Second, the grouping together of training programs of varying educational quality under the generic heading of "training"

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[95]Snook, et al., "A Study of Three Preventive Approaches to Low-back Injury in Industry." p. 478.

[96]Ibid., p. 480.

fails to control for this important factor. Third, the assumption rather than proof that desirable behavioral changes occurred among trainees allows one to question what was the cause of Snook et al.'s findings - an invalid handling method? Poor transfer to the work setting? or both?

In response to the growing numbers of low-back injuries, the Bureau of Labor Statistics used a questionnaire-based survey of 900 injured workers to determine factors contributing to low-back injury.[97] This 1982 study included several questions on training. Of the 836 workers responding to a question on what type of information was provided on safe lifting/handling, only forty-four percent reported participation in formal training in safe handling techniques.

When these trained workers were asked to describe the method used to deliver this information to them, the majority (65%) reported passive participation programs including lecture, demonstration, films and/or written materials. Of particular interest was the responses of those trained workers to whether they felt the proper use of the promoted handling techniques could have prevented their individual back injury. Fifty percent stated "No,"

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[97] Bureau of Labor Statistics, "Back Injuries Associated with Lifting," p. 12.

the use of proper handling techniques would not have prevented their injury, with another thirty-one percent stating "Don't know." Only nineteen percent of trained workers felt the safe lifting techniques were a valid preventive approach to their low-back injury.

As a questionnaire study, the BLS investigation could not prove any cause-effect relationship between training and low-back injury. Interestingly, the responses of workers to their use of safe lifting techniques suggests that few trainees actually use this information, many because they feel these techniques will not help prevent a low-back injury.

In 1983, Margaret Scholey performed a more biomechanically-oriented investigation of handling techniques.[98] In response to the controversy over whether safe handling methods could significantly reduce low-back tissues stresses, Scholey used a radio transmitter to monitor intra-abdominal pressures before and after training activities. A reduction in intra-abdominal pressures in three of the four nurses trained in safe patient handling methods suggested training and the subsequent application of safe patient handling techniques by subjects were valuable in reducing back tissue

[98] Scholey, "Back Stress: the Effects of Training Nurses to Lift Patients in a Clinical Setting," pp. 1-13.

stresses. Unfortunately, the small number of subjects and the limited follow-up on workplace behaviors prevents discussion on whether desirable behavioral changes and lower tissue stresses were a lasting outcome of training.

A second study using intra-abdominal pressures to assess the effects of training in safe patient handling methods was conducted by D. A. Stubbs et al., on two female student nurses.[99] Each subject was trained in eight patient handling procedures with pressure measurement being taken before, during and 15 weeks post training. The authors found intra-abdominal pressures in the two subjects fell only slightly during the training sessions. Furthermore, after 15 weeks, continued high pressure readings during each of the 8 tasks suggested subjects did not retain the principles and techniques promoted in the training sessions. While the small number of subjects in this study restricted the conclusions which could be made, Stubbs et al. stated:

> ... the results of the 15 week follow-up study have suggested that the ability to retain any skills which may have been acquired is another area requiring further research.[100]

Finally, a recent study of safe handling training

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[99] D.A. Stubbs, et al., "Back Pain in the Nursing Profession. II. The Effectiveness of Training," Ergonomics, Vol. 26 (Aug. 1983), pp. 772-7.

[100] Ibid., p. 775.

suggests a well-devised and implemented program can reduce the liability and lost workday costs of low-back injuries. Bruce A. LePore, Chris N. Olson, and George M. Tomer reported a back care training program reduced the liability and lost workday costs at a Lockheed Missle and Space Company Plant by 67.5 percent and 71 percent, respectively.[101] Although this study does not prove these impressive statistics were the result of desirable behavioral changes among trainees, the results do provide a financial incentive for the use of safe handling programs.

In summary, the published literature on the topic of safe handling programs fails to clearly demonstrate whether such programs are effective means of lowering back injuries. The use of invalid criteria (accident statistics), subjective responses by workers and limited test samples allow individuals to challenge the findings of most investigations. A large and important gap in the present knowledge of safe handling programs involves the amount of learning and workplace application these efforts can produce. If workers are not mastering the appropriate knowledge and skills during training periods or are

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[101] Bruce A. LePore, Chris N. Olson and George M. Tomer, "The Dollars and Sense of Occupational Back Injury Prevention Training," Clinical Management in Physical Therapy, Vol. 4 (March-April, 1984), p. 38.

failing to apply this information when they return to their job settings, safe handling programs represent a waste of company resources in the effort to reduce low-back injuries.

III. METHODOLOGY

This chapter describes the method used to answer the research questions. The design is based on the model put forth by Irwin L. Goldstein and will entail three components: Assessment Phase, Training and Development Phase and Evaluation Phase.[102] Each of these components will be discussed to help clarify the research protocol employed.

Assessment Phase

Together with nursing administrators at the West Virginia University Hospital, it was determined that two independent yet, functionally similar, patient wards be selected for inclusion in the study. Stations 31 (Neurosurgery) and 32 (Orthopedics) were chosen since the level of disability among patients and the types of patient handling tasks performed by nursing personnel were comparable. In addition, the high frequency of patient transfers performed on these wards increased the likelihood of an adequate number of subject observations during data collection periods.

With the two locations and their respective nursing

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[102] Goldstein, Training: Program Development and Evaluation, pp. 18-88.

staffs identified, the Assessment Phase was begun. Together with Mr. Dennis Hart, P.T., the Principle Investigator (PI) attempted to establish 1) the types of patient handling tasks being performed on these wards and 2) a biomechanically-valid technique for accomplishing each task. The Assessment Phase included three components: informal interviews with nursing staff members, direct observation of patient handling activities and the establishment of criteria for performing each task safely.

Interviews

From discussions with nursing administrators, first line supervisors and staff personnel, it was apparent the daily patient handling responsiblities of nurses/aides fluxuated greatly. Contributing to this fluxuation was the ward census, the physical and psychological statuses of the patients, the number of scheduled procedures, and the availability of staff members to assist with handling tasks.

For example, a patient may be scheduled for a surgical procedure on a certain day. If the patient is markedly disabled, nursing staff members will have to manually lift the patient from the bed to a stretcher upon which he/she will be transported to the operating room. However, if the patient is able to independently manipu-

late himself/herself from the bed to the stretcher, the nursing personnel will be required to do no more than stabilize the stretcher during the transfer.

While patients are handled throughout the day, interviewees reported the morning hours, between 8 a.m. and 12 noon, and late afternoon hours, between 3 p.m. and 6 p.m. to be the busiest periods for patient handling tasks. This was attributed to the wards' procedures to get non-confined patients out of bed following breakfast and morning bath, prior to lunch and before dinner. In addition, special tests (e.g. X-rays) and surgeries were frequently scheduled during the morning hours which required patient transfers to stretchers/wheelchairs for transport to these locations. These patients commonly returned to the wards in the late afternoon, requiring staff personnel to transfer them back to bed.

When questioned about the types of patient handling tasks performed during a regular work day, nursing personnel stated that the most frequent task was to transfer a patient between a bed and a chair/wheelchair. While less frequent than the bed-chair task, transferring disabled patients between the bed and a stretcher was believed to be the most stressful patient handling activity. Subjectively, interviewees felt the bent postures they had to assume and the heavy patients they had to lift accounted for the perceived stress of the bed-

stretcher task.

In addition, staff members stated that malfunctioning hospital equipment and space limitations frequently made patient transfers more difficult. Specifically, the wheelchairs used to sit patients up in commonly had faulty brakes, immovable foot rests or were just too cumbersome to use effectively. Also, the small size of patient rooms frequently forced staff members to use incorrect body postures when transferring patients.

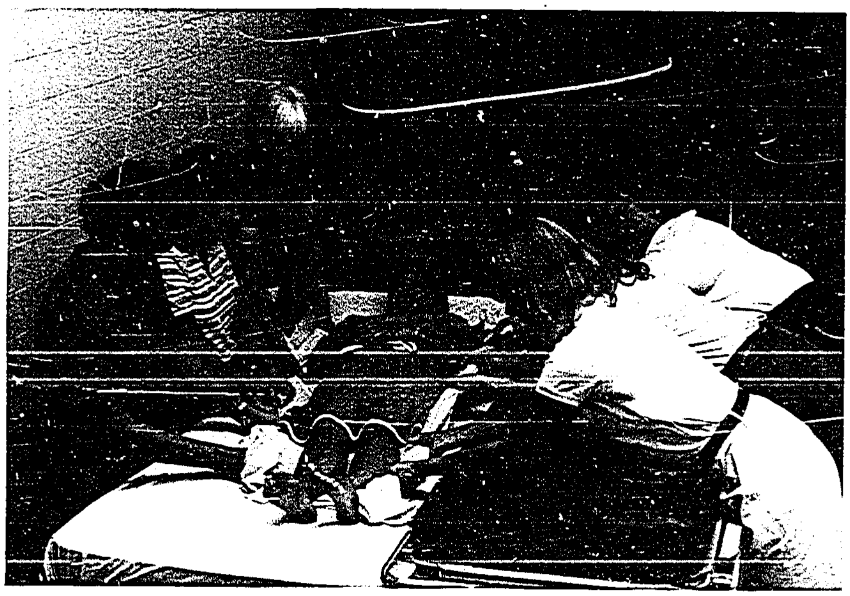
Observations

Over a two week period, Mr. Hart and the PI spent eight hours on Stations 31 and 32 observing 1) the types of patient handling tasks being performed by nursing staff members and 2) the manual handling techniques used by nurses/aides to accomplish these tasks. The outcome of these observational sessions was to serve as the content focus of the training program and the criteria for the evaluation component. The specific tasks and handling techniques observed during this session are as follows:

TASK 1: Bed to/from stretcher.

This transfer was most frequently used for disabled patients going to or coming from the operating room or X-ray (see Figure 1). The task involved:

1. Placing a draw sheet beneath the patient.
2. Aligning the stretcher against the bed.



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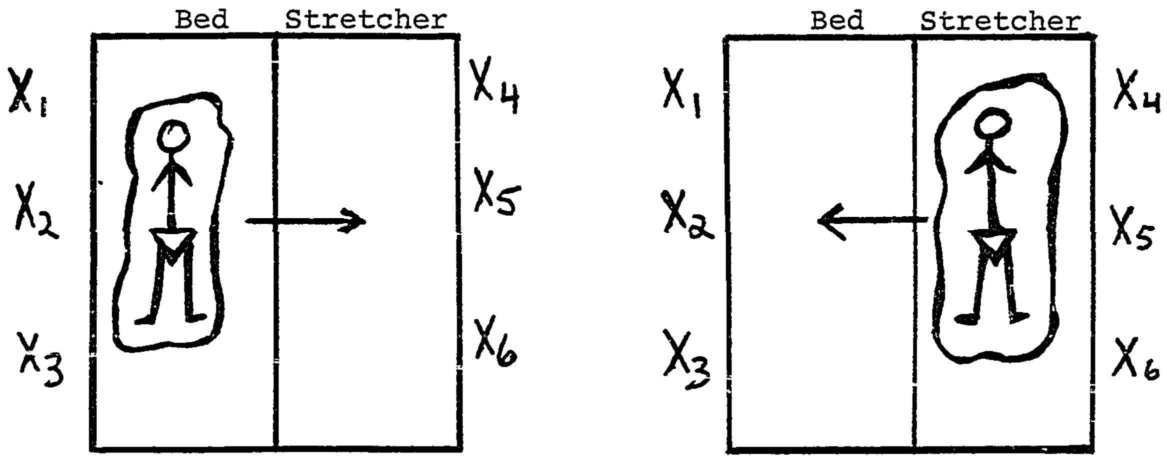


Fig. 1. Task 1: Transferring a Patient From/To a Bed To/From a Stretcher.

X_i - Subject position

3. Recruiting four to six staff members to assist with the transfer (one to three nurses/aides on both the bed and stretcher side).
4. Each staff member grasped the draw sheet and, in unison, lifted the patient via the draw sheet and moved him/her to/from the bed from/to the stretcher.

TASK 2: Bed to/from a wheelchair via a parallel transfer.

This transfer was used to move a patient who was severely disabled or comatosed (see Figure 2). The task involved:

1. Placing a wheelchair against a bed in a parallel position so that the seat of the wheelchair aligned with the midportion of the bed.
2. One staff member stood behind the wheelchair and grasped the patient by the arms or through the axilla, while a second staff member stood at the foot of the wheelchair and grasped the patient's legs.
3. In unison, the staff members lifted the patient and moved him/her to/from the bed from/to the wheelchair.

TASK 3: Bed to/from a wheelchair via a perpendicular transfer.

This transfer was used to move a patient with lower extremity involvement such as a fractured leg with a large and heavy cast (see Figure 3). This task involved:

1. Placing a wheelchair against a bed in a perpendicular

MODEL

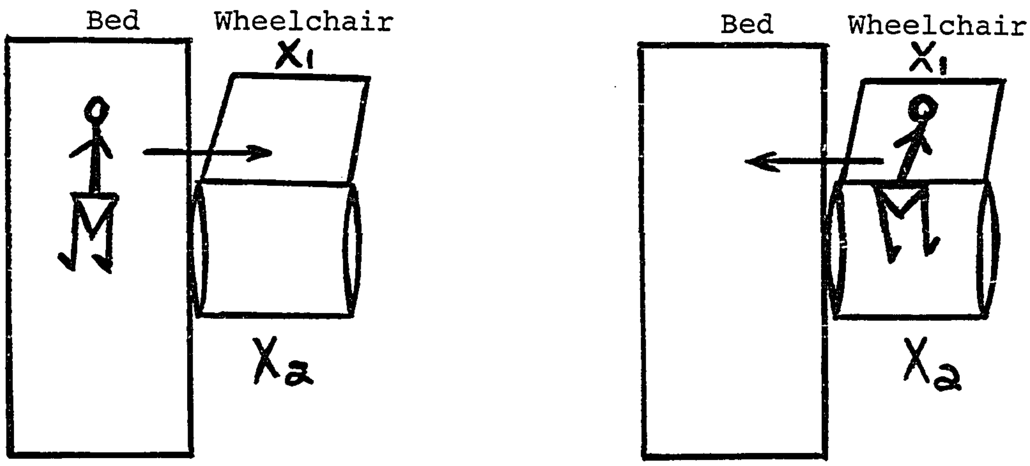
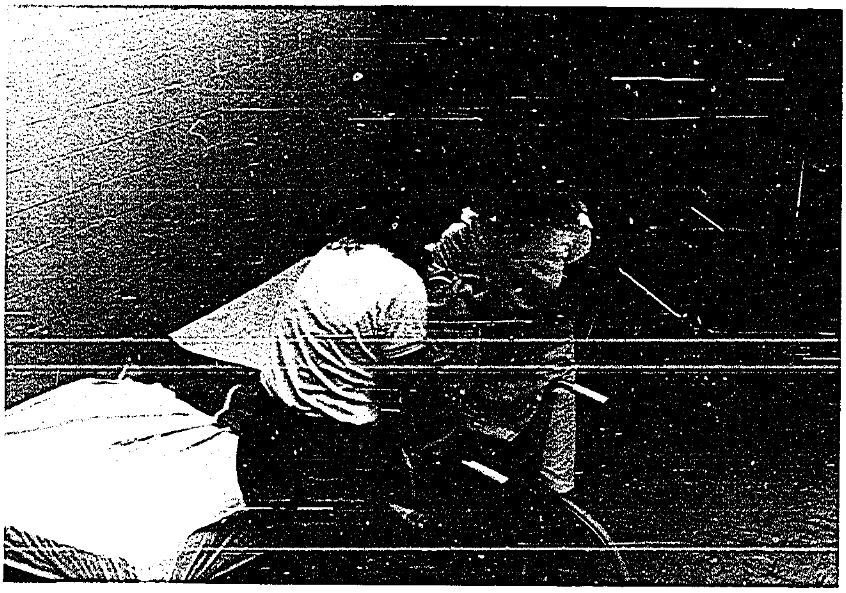


Fig. 2. Task 2: Transferring a Patient From/To a Bed To/ From a Wheelchair Via a Parallel Transfer.

X_i - Subject position



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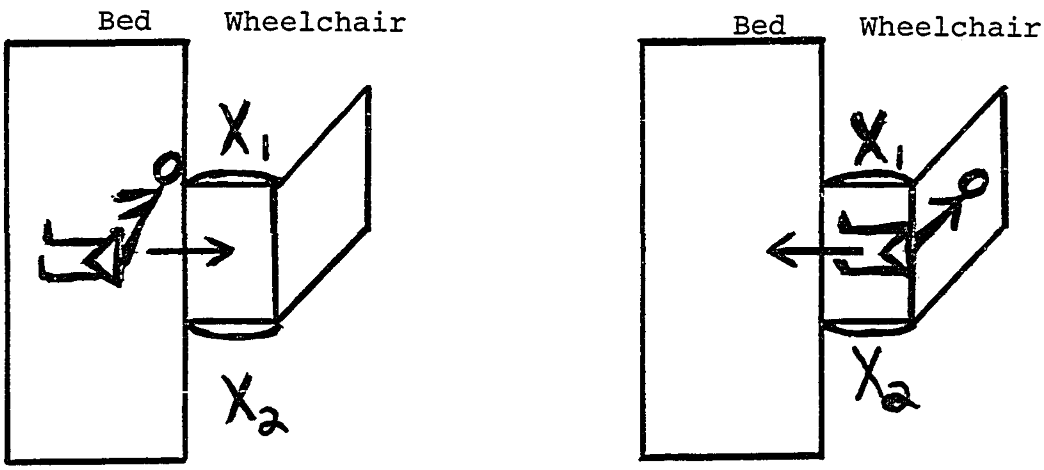

Fig. 3. Task 3: Transferring a Patient From/To a Bed To/ From a Wheelchair Via a Perpendicular Transfer.

X_i - Subject position

position so that the seat of the wheelchair aligned with the midportion of the bed.

2. When the patient was being moved from the bed to the wheelchair, he/she was placed in a sitting position, facing away from the wheelchair.
3. A staff member was positioned on each side of the patient and grasped the patient under the axilla.
4. In unison, the staff members lifted the patient and pulled him/her into the wheelchair.
5. When going from the wheelchair to the bed, the patient's feet were first placed up on the bed, then the staff members assumed the same position as stated in #3, and then lifted and moved the patient to the bed.

TASK 4: Bed to/from standing with a walker.

This transfer was used for patients who were able to ambulate with this assistive device (see Figure 4). The task involved:

1. Sitting the patient at the side of the bed, facing the walker if going from bed to the walker.
2. Staff members stood on each side of the patient with arm support under the patient's axilla.
3. In unison, the staff members helped lift the patient to a standing position.
4. If the patient was going from the walker to the bed,

MODEL

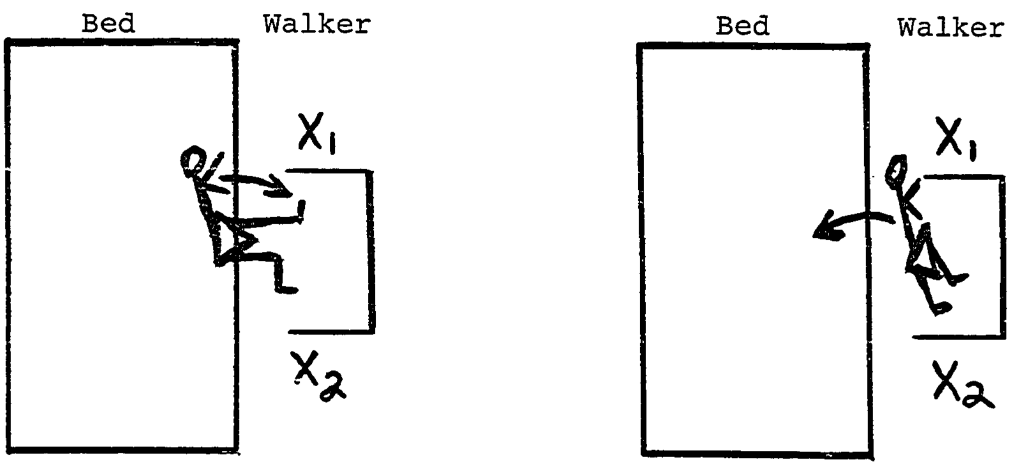

Fig. 4. Task 4: Transferring a Patient From/To a Bed To/From a Walker.

X_i - Subject position

staff members positioned themselves as in Step #2, and aided the patient by gradually lowering him/her to the seated position.

Behavioral Criteria

With the identification of the four patient handling tasks, the next step was to develop a biomechanically-valid technique for performing each task. The principles of safe manual lifting outlined by the National Safety Council and NIOSH were applied to each task and observable, dichotomously measurable (yes-no) items were established and incorporated into task-specific data collection forms (see Appendixes 1 through 4).

The following behavioral items were incorporated into all four tasks (see Table 1):

1. Prior to initiating a transfer, a subject should adjust the height of the bed to the level of the stretcher/chair to which the patient will be transferred to/from.
2. Each task should be performed in a specific number and sequence of steps.
3. Verbal cues should be used among staff members to help coordinate the tasks.
4. The subject's feet/knees should be adequately spaced apart in both the sagital and coronal planes.
5. The subject's knees should be flexed to at least 25

TABLE 1

Behavioral Items Included in All Tasks

Item	Task 1	Task 2	Task 3	Task 4
A. Adjust Bed Height	3	5	5	4
B. Proper Number of Steps	4	6	6	5
C. Verbal Cues	5	7	7	6
D. Foot/Knee Spacing (Sagital Plane)	8,13	8	9	7
E. Foot/Knee Spacing (Coronal Plane)	9,14	9	10	8
F. Knees Flexed	15	11	12	9
G. Trunk Straight	10,16	12	13	10
H. Load Position	11,17	10	11	11
I. Trunk Rigid	18	14	15	13
J. Avoid Rotation	19	15	16	14

degrees prior to initiating a task.

6. The subject's trunk should be placed between 25 degrees of flexion and full extension prior to initiating a task.

7. The subject should minimize the distance between them-self and the patient prior to initiating the task.

8. During the performance of the task, the subject should maintain their spine in a rigid position and avoid any trunk rotation.

In addition to the above items, eight additional items were applicable to only certain tasks (see Table 2). These were:

1. When wheelchairs are used, the subject should lock the brakes and remove the leg rests, if possible, prior to initiating the transfer.

2. When transferring a patient to/from a stretcher, subjects positioned on the bed side should assume a kneeling position on the bed prior to initiating the transfer.

3. Subjects kneeling on the bed and performing a stretcher transfer should shift their weight during the transfer to/from the forward knee from/to the back knee, depending on whether the patient is being moved to or from the bed.

TABLE 2

Behavior Items Included in Selected Tasks

Item	Task 1	2	3	4
K. Lock Chair		3	3	
L. Remove Legs		4	4	
M. Kneel on Bed	7			
N. Shift Weight	20			
O. Supinate Forearms	6,12			
P. Knee Motion		13	14	12
Q. Face Direction of Movement			8	
R. Safety Belt				3

4. When preparing for a stretcher transfer, subjects should grasp the draw sheet with their forearms in supination.
5. Subjects should lift and lower patients by extending and flexing their knees, respectively.
6. When transferring a patient to/from bed from/to a perpendicular wheelchair, subjects should face the direction in which the patient is to be moved.
7. When transferring a patient to/from bed from/to standing with a walker, a safety belt should be placed around the patient's waist and grasped by the subjects during the transfer.

At the conclusion of the Assessment Phase, all subjects (RNs, LPNs, Aides and Ward Clerks on Stations 31 and 32) were requested to sign a Subject Consent Form which had been previously approved by the West Virginia University Committee for the Protection of Human Subjects (see Appendix 5). In addition, each subject was requested to complete a Subject Information Form which contained questions on the twelve organismic variables being analyzed in this study (see Appendix 6).

Training and Development Phase

The task-specific criteria that derived from the Assessment Phase provided the content for the training program. The immediate goal of the training program,

therefore, was to produce the acquisition of knowledge, skills and attitudes of safe patient handling techniques by trainees as defined by the task-specific criteria.

To accomplish the transfer of information and skills to trainees, an instructional program was designed which included:

1. Presentation and demonstration by a trained instructor (Mr. Hart) of the correct and incorrect techniques for accomplishing each task.
2. Practice periods during which subjects performed each task on mock patients using actual beds, stretchers, wheelchairs and walkers.
3. Problem solving periods in which subjects were requested to observe their peers performing patient handling tasks and identify correct and incorrect behaviors.
4. Individual feedback to each trainee on his/her patient handling techniques by the instructor.

Each trainee participated in two, one hour training segments spaced one week apart. Each segment was restricted to 3 to 5 persons to insure an adequate amount of individual attention. Both training segments were offered on three different days and times to help minimize conflicts with work responsibilities.

At the conclusion of the second one hour training segment, trainees were required to perform correctly each

of the four patient handling tasks (using a mock patient) in the presence of the instructor who verified the trainee's competency. In addition, each trainee was requested to complete a twenty item, true-false test on the principles of safe patient handling (see Appendix 7).

Evaluation Phase

In addition to supplying the content for the training program, the task-specific criteria from the Assessment Phase provided a format for evaluating behavioral changes among trainees. A dichotomous (yes-no) format was used for each item included under a specific patient handling task (see Appendix 1 thru 4). Trained observers watched a subject perform one of the four specified tasks and graded each item according to whether the subject performed it correctly (yes) or incorrectly (no). The subject's behavioral performance for that particular task was reported as the number of correct items ÷ total number of items x 100.

Observer Training

Three individuals served as behavioral observers for this study. Each observer was instructed in the use of the data collection form, including the observation of task performance and the grading of behaviors. Following this instruction observers practiced their observational and grading skills on nurses performing actual patient

transfers. Each observation was discussed among the observers to enhance uniform grading. Immediately prior to the first data collection session, the three observers performed observations on a single subject performing each of the four tasks. Interobserver reliability was established from this procedure via a Coefficient of Agreement of .95.

Group

To help assess the effect of the training program on the behavioral performance of trainees, two groups were created: Test group (T-group) and Control group (C-group). In an effort to prevent contamination between individuals in different groups and to facilitate data collection, a Quazi-Experimental design was employed using intact groups for both the Test and Control groups. Station 32 was randomly determined to be the site of the T-group and its nursing personnel were scheduled to participate in the training program. Conversely, Station 31 comprised the C-group and its staff members received no training.

Session

To allow for the temporal analysis of training effects, behavioral observations were made on both the T-group and C-group subjects during three, 2 week intervals (see Appendix 8). These data collection sessions were:

Session 1. The two week interval terminating just prior to the training program.

Session 2. The two week interval commencing immediately following the training program.

Session 3. The two week interval commencing six weeks following the training program.

On days in which behavioral data were collected, each of the three behavioral observers was scheduled for a two hour period during which they would collect data on both stations. Since Stations 31 and 32 were connected by a short hallway, it was feasible for one person to obtain observations from both locations. Nursing supervisors and staff members were requested to inform the available observer if a patient handling task was to be performed. In order to have an observer present on the wards during their busiest patient handling periods (e.g. 8 a.m. to 12 p.m. and late afternoon), the following observer schedule was employed:

Observer #1: 8 a.m. - 10 a.m.

Observer #2: 10 a.m. - 12 p.m.

Observer #3: 3:30 p.m. - 5:30 p.m.

Since each observation required an observer to be physically present in the same room as the subject(s) performing the patient handling task, biasing certain subjects to perform tasks more safely because of an awareness that they were being observed was a potential

problem. To help control for this form of biasing, subjects were told that observers were cateloging the "types" of patient handling tasks being performed on these wards in preparation for a future training program. In addition Mr. Hart, who presented the training program to T-group subjects, did not participate in any of the data collection activities.

Data Analysis

To determine the effect of the training program on the patient handling techniques used by trainees in their actual work settings, behavioral performance of subjects (% correct behaviors) was used as the dependent variable. Three independent class variables were employed: Group (trained vs. untrained), Session (pre-training, immediately post training, six weeks post training), and Task (1, 2, 3, 4). Variance deriving from differences among subjects was included in the error term because the study design allowed individual subjects to be observed multiple times for a single task during any one session.

Univariate analysis of the dependent variable was performed using a Model 1 Analysis of Covariance. Major sources of variance which were analyzed by this procedure were the three class variables and their various interactions (see Figure 5). Analysis was conducted in a descending order of interaction (second order to first

Step	Order	Model
1.	Second	Group * Session * Task
2.	First	Group * Session; Group * Task; Session * Task
3.	Main Effect	Group; Session; Task

Fig. 5. Sequence of Data Analysis for Class Variables. The effects of the three class variables (Group, Session and Task) on behavioral performance was determined via a Model I Analysis of Covariance in a descending order of interaction (second order to first order to main effect) with data analysis being terminated at the level where a significant ($\alpha = .05$) interaction/main effect was obtained.

order to main effect) and terminated at the level where a statistically significant result (alpha level of .05) was obtained. When a statistically significant result was found to exist, a Duncan's New Multiple Range test was performed among mean values.

Since differences among individuals have been reported to influence the occurrence of low-back pain/ injury and because similar characteristics could effect the behavioral performance of subjects, information collected from subjects via a Subject Information Form was incorporated into the data analysis. First, each of the twelve organismic variables was analyzed between groups to determine whether there were any statistically significant differences among the subjects performing the tasks. This was accomplished using either a Student T-test or a Chi Square test, depending on whether the data was interval or nominal, respectively. An alpha level of .05 was enforced.

Second, data from both groups was pooled to determine the influence of each organismic variable on behavioral performance. When an interal scale was employed (age, height, weight, occupation, years of experience, lifting frequency, frequency of previous training, last time trained), these variables were treated as covariants in the Model 1 Analysis of Covariance. When a nominal scale was used (gender, previous training, previous back pain,

present back pain), these variables were treated as peripheral variables in the Analysis of Covariance. An alpha level of .05 was enforced for each covariant and peripheral variable analysis.

Finally, the scores obtained by trainees on the written exam administered immediately following the training program were used to determine if this measure of learning was of any predictive value for a trainee's behavioral performance when they returned to their work setting. A Pearson Correlation Coefficient was calculated between the mean exam score for trainees and their respective behavioral performance in Sessions 2 and 3. An alpha level of .05 was enforced for each coefficient.

IV. RESULTS

This chapter will present the data and results of the statistical analyses used to answer the questions posed by this study. Following a description of the data that was collected, results will be presented according to the three major questions being addressed: 1) What are the effects of the three class variables (Group, Session and Task) on behavioral performance? 2) What is the influence of the twelve organismic variables on behavioral performance? 3) What is the relationship between the scores obtained by T-group subjects on the post-training written test and their session-specific behavioral performance?

General Description

Forty subjects (37 females, 3 males) participated in this study. Twelve subjects (10 females, 2 males) made up the T-group, while the C-group was comprised of twenty-eight subjects (27 females, 1 male). The discrepency between the number of subjects in the two groups derives from two factors. First, more nursing personnel were employed on the C-group ward (28 individuals) than on the T-group ward (18 individuals). Second, six individuals on the T-group ward did not participate in the training activities due to illness (2), vacation (1) or conflicting

schedules (3). Since the criteria for being a T-group subject included both employment on Station 32 and the participation in two training sessions, the number of individuals comprising the T-group was reduced to twelve.

A breakdown of the behavioral observations made during the three data collections Sessions is presented in Table 3. Of the 324 observations made, 139 or 43 percent were made on T-group subjects and 185 or 57 percent on C-group subjects. The Session-specific breakdown of the 324 behavioral observations showed 123 or 38 percent were made during Session 1, 77 or 24 percent during Session 2, and 124 or 38 percent during Session 3.

Table 4 presents the breakdown of behavioral observations by Group and Task. Task 1 (bed to/from stretcher) was the most frequently observed transfer among T-group subjects accounting for 37 percent of observations. Among the C-group subjects, Task 3 (bed to/from wheelchair via perpendicular transfer) was the most frequently observed task accounting for 39 percent of observations. Pooling the T- and C-group data revealed Task 3 to be the most frequently observed task (34 percent), followed by Task 1 (31 percent), Task 4 (25 percent), and Task 2 (10 percent).

The breakdown of behavioral observations by Group, Session and Task is presented in Table 5. It was noted

TABLE 3

Behavioral Observations by Group and Session

Group	Session			Total
	1	2	3	
Test	38[a] (27)[b]	32 (23)	69 (50)	139 (43)
Control	85 (46)	45 (24)	55 (30)	185 (57)
Total	123 (38)	77 (24)	124 (38)	324 (100)

[a]Frequency

[b]Percent

TABLE 4

Behavioral Observations by Group and Task

Group	Task				Total
	1	2	3	4	
Test	52[a] (37)[b]	6 (4)	37 (27)	44 (32)	139
Control	48 (26)	27 (15)	73 (39)	37 (20)	185
	100 (31)	33 (10)	110 (34)	81 (25)	324

[a]Frequency

[b]Percent

TABLE 5

Behavioral Observations
by
Group, Session and Task

Group	Task	Session			Total
		1	2	3	
Test	1	20[a]	15	17	52
	2	--	--	6	6
	3	5	10	22	37
	4	13	7	24	44
Control	1	26	8	14	48
	2	17	--	10	27
	3	24	25	24	73
	4	18	12	7	37
		123	77	124	324

[a]Frequency

that the number of observations for a specific task within a group could vary greatly among Sessions. Task 3 for the C-group had the most consistency across the three Sessions with Session-specific numbers of 24, 25 and 24. Task 1 for the C-group had the largest range in observational values with the three Session-specific values of 26, 8 and 14. Of particular interest was the finding that Task 2 was not observed during three Group-specific Sessions: T-group Sessions 1 and 2, and C-group Session 2.

Class Variables

Three major class variables were analyzed in this study to determine their interaction or individual effects on the behavioral performance of subjects. These classes and their respective levels were 1. Group (trained vs. untrained), 2. Session (pre-training, immediately post-training, and between six to eight weeks post training), and Task (1- bed to/from stretcher, 2- bed to/from wheel-chair via parallel lift, 3- bed to/from wheelchair via perpendicular lift, 4- bed to/from standing with a walker).

Behavioral performance by Group and Session is presented in Table 6. The T-group had a pre-training (Session 1) mean score of 47 percent with a standard deviation of 18 percent. Immediately following participation in the training program (Session 2), the mean

TABLE 6

Behavioral Performance by Group and Session

	Session		
Group	1	2	3
Test	47[a]	74	61
	38[b]	32	69
	18[c]	22	20
	23-82[d]	21-100	25-100
Control	43	33	35
	85	45	55
	14	14	12
	17-82	08-79	14-64

[a]Mean score in percent
[b]Number of observations
[c]Standard deviation in percent
[d]Range in percent

behavioral score rose to 74 percent with a standard deviation of 22 percent. Six weeks following the training program (Session 3) the T-group mean performance fell to 61 percent with a standard deviation of 20 percent.

The C-group had a mean behavioral score of 43 percent during Session 1, with a standard deviation of 14 percent. For Session 2, the mean performance fell to 33 percent with a standard deviation of 14 percent. During Session 3, the mean behavioral performance of the C-group rose slightly from Session 2 to 35 percent with a standard deviation of 12 percent.

The breakdown of behavioral performance by Task and Session for the T-group is presented in Table 7. The mean behavioral performance for Tasks 1, 3 and 4 all showed large increases from Session 1 to Session 2. Task 1 performance rose from 43 percent to 75 percent, a gain of 32 percent. Task 3 performance rose from 42 percent to 65 percent, a gain of 23 percent. Task 4 performance rose 27 percent from 56 percent to 83 percent.

Between Sessions 2 and 3, the mean performance of Tasks 1 and 4 both fell off considerably. Task 1 performance fell from 75 percent to 53 percent, a drop of 22 percent. Task 4 performance fell 26 percent from 83 percent to 57 percent. On the other hand, Task 3 performance continued to improve between Sessions 2 and 3, increasing 5 percent from 65 percent to 70 percent.

TABLE 7

T-Group Behavioral Performance by Session and Task

	Session		
Task	1	2	3
1	43[a] 16[b]	75 24	53 22
2	--	--	65 23
3	42 18	65 26	70 19
4	56 18	83 5	57 17

[a]Mean score in percent
[b]Standard deviation in percent

Because Task 2 was not observed on the T-group ward during either Session 1 or 2, the only data available for analysis was for Session 3. The mean performance for Task 2 during Session 3 was 65 percent.

Table 8 presents the breakdown of behavioral performance by Task and Session for the C-group. Tasks 1, 3 and 4 all showed decreases in the mean behavioral performance between Sessions 1 and 2. Task 1 performance fell from 37 percent to 23 percent, a drop of 14 percent. Task 3 performance fell from 43 percent to 38 percent, a fall of 5 percent. Task 4 performance fell 21 percent, from 50 percent to 29 percent.

Between Sessions 2 and 3, mean behavioral performance rose for Tasks 1 and 4, but fell slightly for Task 3. Task 1 performance rose 8 percent, from 23 percent to 31 percent. Task 4 performance rose from 29 percent to 32 percent, a gain of 3 percent. Task 3 performance fell 1 percent, from 38 percent to 37 percent.

Because Task 2 was not observed on C-group subjects during Session 2, the only comparison which could be made was between Sessions 1 and 3. Between Sessions 1 and 3 mean behavioral performance fell 7 percent, from 44 percent to 37 percent.

A Model 1 Analysis of Covariance was performed to determine the effect of the three class variables on the behavioral performance of subjects. Type III sums of

TABLE 8

C-Group Behavioral Performance
by
Session and Task

	Session		
Task	1	2	3
1	37[a] 14[b]	23 10	31 14
2	44 14	--	37 10
3	43 10	38 14	37 13
4	50 16	29 9	32 6

[a]Mean score in percent
[b]Standard deviation in percent

squares were used as the denominator since three cells (Task 2 for T-group Sessions 1 and 2, and Task 2 for C-group Session 2) had missing data. The mean square of error, .02459305, was used as the denominator to determine the various F values. The results of this analysis are presented in Table 9 and will be used to answer the following hypotheses:

Hypothesis #1. No interaction will exist among Group, Session and Task.

The calculated F value for the interaction among Group, Session and Task was 1.61. The probability that this value is equal to zero was determined to be $p=.17$. Thus, Hypothesis #1 was accepted.

Hypothesis #2. No interaction will exist between Group and Task

The calculated F value for the interaction between Group and Task was .72. The probability that this value is equal to zero is $p=.54$. Thus, Hypothesis #2 was accepted.

Hypothesis #3. No interaction will exist between Session and Task.

The calculated F value for the interaction between Session and Task was 2.13. The probability that this value is equal to zero is $p=.06$. Thus, Hypothesis #3 was

TABLE 9

General Linear Model Procedure
for
Major Class Variables

Source	DF	Type III Sum of Squares	F Value	Prob F=0
Group*Session*Task	4	0.01588165	1.61	.17
Group*Task	3	0.05344240	0.72	.54
Session*Task	5	0.26239326	2.13	.06
Group*Session	2	1.12559897	22.88	.0001*
Group	1	0.88816196	36.11	.0001*
Session	2	0.05434839	1.10	.33
Task	3	0.24117154	3.27	.02*

*Significant at .05 level.

accepted.

<u>Hypothesis</u> <u>#4</u>. No interaction will exist between Group and Session.

The calculated F value for the interaction between Group and Session was 22.88. The probability that this value is equal to zero is p=.0001. Thus, Hypothesis #4 was rejected and further analysis of the individual class variables was stopped.

In an effort to identify differences in performance within Groups, a Duncan's New Multiple Range Test was performed on mean behavioral performance across Sessions. This post hoc analysis revealed the three Session-specific means for the T-group differed significantly from each other at the .05 level. The Session 2 mean behavioral score (74%) was found to be signficantly larger than the Session 1 mean (47%). Six weeks following training, the Session 3 mean (61%) was significantly smaller than the Session 2 mean, but still significantly larger than the pre-training mean of Session 1.

A similar analysis of C-group mean behavioral scores across Sessions revealed the Session 2 mean (33%) was significantly smaller than the Session 1 mean (43%). The Session 3 mean (35%) was not significantly different from the Session 2 mean but, was significantly smaller than the Session 1 mean.

Figure 6 presents a graphic display of Group-specific behavioral performance by Session. From this visual display of mean values and standard deviations, it appears the basis for the statistically significant interaction between Group and Session derives largely from the shared variances of Session 1.

Organismic Variables

Prior to the collection on any behavioral data, each subject in both the Test and Control groups was requested to complete a Subject Information Form. Individual-specific data was obtained on twelve organismic variables including age, height, weight, gender, occupation, years of service in that occupation, average number of patient lifts performed each day, previous training in safe patient handling techniques, the number of times trained in safe patient handling techniques (if applicable), previous experience of low-back pain while lifting a patient, and present complaint of low-back pain.

This data was used for two purposes: 1) to determine if any differences existed between the two groups for each variable and, 2) to determine if any of these factors could have influenced the behavioral performance of subjects. A Student T-test or Chi-Square test was used to establish whether inter-group differences existed. A Model 1 Analysis of Covariance (AOC) was employed to

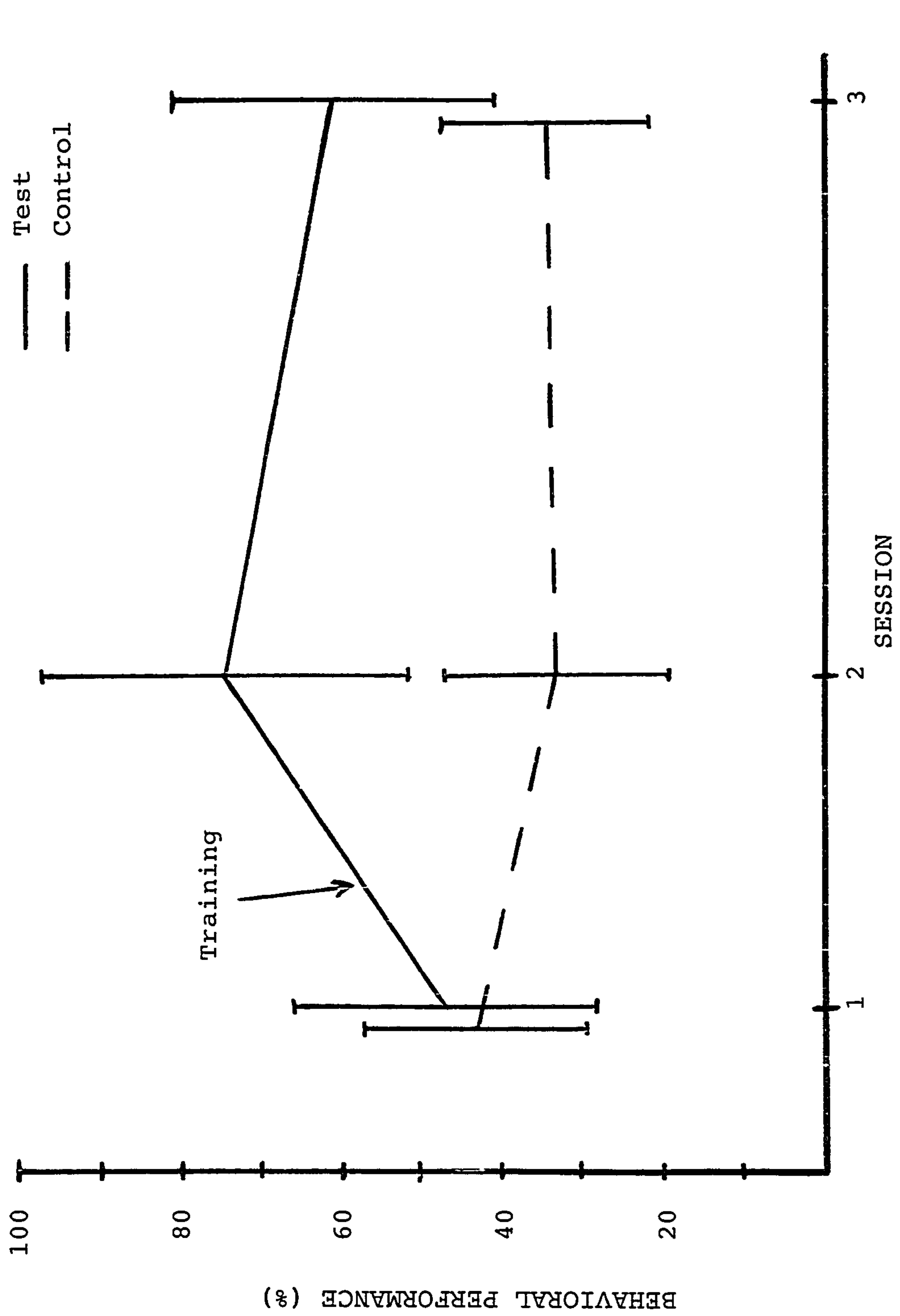

Fig. 6: Behavioral Performance for Test and Control Groups by Session.

determine the effect of the organismic variables. However, it should be noted that four of these (gender, training, pain while lifting, and present complaint of pain) employed nominal (yes-no) scales. Additional classes (peripheral variables) were created to allow these variables to fit the AOC model and a Chi Square Test was used to determine inter-group differences. Each of the other nine organismic variables were treated as covariants in the AOC model and a Student T-test was used to determine inter-group differences.

Age

Four categories (under 24, 25-34, 35-44 and over 45) were created to help determine intergroup differences and the effect of age on behavioral performance. For the purpose of analysis, these categories were assigned the values of 1, 2, 3 and 4, respectively. The mean age category for the 139 T-group observations was 2.34 with a standard deviation of 1.11. The mean age category for the 185 C-group observations was 2.01 with a standard deviation of 0.84. A student T-test between Groups revealed the mean age category of T-group subjects performing observable tasks to be significantly older than C-group subject observations (p=.0035, see Table 10). However, analysis of this covariant revealed age did not influence the behavioral performance of subjects (p=.33,

TABLE 10

Group-Specific Statistics on Variables:

Age, Height, Weight and Occupation

Variable	Group	Mean	SD	Prob. !T!
Age	Test	2.34	1.11	.0035*
	Control	2.01	0.84	
Height	Test	2.52	0.67	.0008*
	Control	2.28	0.58	
Weight	Test	2.70	0.46	.0148*
	Control	2.53	0.77	
Occupation	Test	1.85	0.99	.7514
	Control	1.82	0.82	

*Significant T value at .05 level

see Table 11).

Height

To assess the intergroup differences and effect of height, four categories were created (under 5', 5' to 5'6 1/2", 5'7" to 5'11 1/2" and over 6') and assigned the values of 1, 2, 3 and 4, respectively. The mean height category of the T-group observations was 2.52 with a standard deviation of 0.67. The mean height category for the C-group was 2.28 with a standard deviation of 0.58. A Student T-test between Groups revealed the height of T-group subjects performing observable tasks to be significantly greater (p=.0008) than C-group subjects (see Table 10). However, analysis of this covariant revealed height did not influence the behavioral performance of subjects (p=.63, see Table 11).

Weight

Four weight categories (under 100 lbs., 100-135 lbs., 136-170 lbs., and over 170 lbs.) were created for weight and assigned the values of 1, 2, 3, and 4 respectively. The mean weight category of T-group subjects performing tasks was 2.70 with a standard deviation of 0.46. The mean weight category of C-group subject observations was 2.53 with a standard deviation of 0.77. A Student T-test between Groups revealed the T-group subjects performing

TABLE 11

General Linear Model Procedure for Organismic Variables

Source	DF[a]	Type III Sum of Squares	F Value	Prob F=0
Age	1	0.02323011	0.94	0.33
Height	1	0.00582735	0.24	0.63
Weight	1	0.00492610	0.20	0.65
Gender*	1	0.04971535	1.89	0.16
Occupation	1	0.04645050	2.02	0.17
Years	1	0.01154006	0.47	0.49
L. Freq.	1	0.00074109	0.03	0.86
Training*	1	0.01223868	0.50	0.48
T. Freq.	1	0.04810851	1.96	0.16
When Train	1	0.05841971	2.38	0.12
Pain Lift*	1	0.00612348	0.25	0.62
Pain Now*	1	0.01983574	0.81	0.37

Mean Square Error: 0.02459305
[a]Degrees of Freedom
*Peripheral Class Variables

tasks to be signficantly heavier (p=.01) than C-group subjects (see Table 10). However, analysis of this covariant revealed weight did not influence the behavioral performance of subjects (p = .65, see Table 11).

Gender

Examination of the gender of subjects performing patient handling tasks revealed females performed 105 of the 139 tasks observed on the T-group ward and 179 of the 185 observed tasks on the C-group ward. A Chi Square test between the variables gender and Group was significant at the .0001 level (see Table 12). Although further statistical testing was not performed on this data, it would appear the major source of variance is between the number of observations made on females (284) compared to males (40). However, analysis of this peripheral variable revealed gender to have no influence on the behavioral performance of subjects (p=.16, see Table 11).

Occupation

Occupation was listed into four categories (RN, LPN, Aide, and Other) and assigned the numerical values of 1, 2, 3, and 4, respectively. The mean occupational category of T-group subjects performing observable tasks was 1.85 with a standard deviation of 0.99. The mean occupational category of the C-group ovservations was 1.82 with a standard deviation of 0.82. A Student T-test between

TABLE 12

Behavioral Observations for Group by Gender

	Group		
Gender	Control	Test	Total
Female	179[a] (55.25)[b]	105 (32.41)	284 (87.65)
Male	6 (1.85)	34 (10.49)	40 (12.35)
Total	185 (57.1)	139 (42.9)	324 (100.00)

Chi square 33.02
p=0.0001
DF=1

[a]Frequency
[b]Percent

Groups revealed no significant difference (p=.75) in occupational classification (see Table 10). Similarly, analysis of this covariant on behavioral performance by subjects revealed occupation to have no effect on performance (p=.17, see Table 11).

Years of Service

Years of service in the subjects' present occupation was classified into five categories (less than 1 year, 1-3 years, 4-6 years, 7-10 years and over 10 years) and assigned the numerical values of 1, 2, 3, 4, and 5, respectively. The mean category for years service in the T-group was 2.60 with a standard deviation of 0.96. The mean years of service category for C-group observations was 2.97 with a standard deviation of 1.12. A Student T-test between Groups revealed the mean years of service for the C-group to be significantly longer (p=.002) than the T-group (see Table 13). However, analysis of this covariant revealed years of service in the present occupation to have no effect on the behavioral performance of subjects (p=.49, see Table 11).

Average number of lifts per day

Three categories (0-3, 4-7,and over 7) were created to assess the intergroup differences and effect of lifting frequency, and these categories were assigned the values

TABLE 13

Group-Specific Statistics on Variables: Years of Service, Frequency of Lifting, Frequency of Training, and When Trained

Variable	Group	Mean	SD	Prob !T!
Years of Service	Test	2.60	0.96	.002*
	Control	2.97	1.12	
Frequency of Lifting	Test	2.57	0.60	.45
	Control	2.62	0.53	
Frequency of Training	Test	1.62	0.97	.50
	Control	1.70	0.92	
When Trained	Test	2.44	0.81	.0001*
	Control	3.00	0.00	

*Significant T value at .05 level

of 1, 2, and 3, respectively. The mean category of lifting frequency of the T-group was 2.57 with a standard deviation of .60. The mean category for the C-group was 2.62 with a standard deviation of 0.53. A Student T-test between groups revealed no significant difference (p=.45) between Groups for the frequency of patient lifts performed by subjects on an average work day (see Table 13). Similarly, analysis of lifting frequency revealed no effect of this covariant on the behavioral performance of subject (p=.86, see Table 11).

Training

To determine the inter-group differences and effect of previous training, subjects were asked if they had ever participated in programs on safe patient handling methods. All twelve subjects in the T-group (100%) had received such previous instruction while only 19 of the 28 C- group subjects (68%) reported similar experiences. Trained subjects performed all 139 of the tasks performed on the T-group ward, while only 110 of the 185 tasks (59%) of the C-group observations were performed by trained individuals.

A Chi Square Test between the variables training and Group revealed a significant difference (p=.0001, see Table 14). While no further statistical testing was performed, it would appear the major source of variance is

TABLE 14

Behavioral Observations for Group by Training

	Group		
Training	Control	Test	Total
No	75[a] (23.15)[b]	0 (0.00)	75 (23.15)
Yes	110 (33.95)	139 (42.90)	249 (76.85)
Total	185 (57.10)	139 (42.90)	324 (100.00)

Chi square 71.06
p=.0001
DF=1

[a]Frequency
[b]Percent

between the number of observations made on trained (249) versus untrained (75) subjects. However, analysis of this peripheral variable on the behavioral performance obtained by subjects showed no significant influence of training on these measures (p=.48, see Table 11).

Frequency of Previous Training

For those subjects who had received previous training in safe patient handling techniques, four categories (once, 2-3, 4-6, over 7) were created and assigned the values 1, 2, 3, and 4, respectively. For the 139 observations of T-group subjects, the mean category for frequency of previous training was 1.62 with a standard deviation of 0.97. For the 110 observations of previously trained C-group subjects, the mean frequency category was 1.70 with a standard deviation of 0.92. A Student T-test between Groups revealed no significant difference (p=.50) for the frequency of previous training experiences (see Table 13). Similarly, the analysis of this covariant revealed no significant influence of training frequency on the behavioral performance of subjects (p=.86, see Table 11).

Last Training Experience

For those individuals who had received previous training, three categories (less than 6 months ago, 6-1½ months ago, and over 1 year ago) were created and assigned

the values of 1, 2 and 3, respectively. The mean category for T-group subjects was 2.44 with a standard deviation of 0.81. The mean category for C-group subjects was 3.00 with a standard deviation of 0.00. A Student T-test between groups for last training experience revealed a significant difference (p=.0001) with T-group subjects being trained more recently than C-group subjects (see Table 13). However, analysis of this covarient revealed no significant influence of when trained individuals received their last training experience on behavioral performance (p=.12, see Table 11).

Pain While Lifting Patients

To assess whether a previous history of low-back pain while performing patient lifting tasks had an influence on the behavioral performance of subjects, each subject was asked whether or not they had ever had an episode of low-back pain while doing a patient lift. Nine of the twelve T-group subjects (75%) reported such low-back symptoms while nineteen of the twenty-eight C-group subjects (68%) reported such a history. A Chi Square Test between the variables previous low-back pain while performing a patient lift and Group revealed a significant difference existed (p=.0006). Although no further statistical testing was performed it appeared the major source of variance was in the number of observations performed by

subjects who reported an episode of low-back pain while lifting patients (24) than without a history of such low-back pain (77) (see Table 15). An analysis of this peripheral variable revealed a history of previous low-back pain while lifting patients had no influence on the behavioral performance of subjects (p=.62, see Table 11).

Present Complaint of Low-back Pain

To determine if a present complaint of low-back pain would influence the behavioral scores obtained by subjects, each subject was asked if they had low-back pain at the time they were completing the Subject Information Form. Five of the twelve T-group subjects (42%) reported the present complaint of low-back pain while only three of the twenty-eight C-group subjects (11%) reported this symptom. A Chi Square Test between the variables present complaint of pain and Group revealed a significant difference existed (p=.0001, see Table 16). Although no further statistical testing was performed on this data, it appears the major source of variance derives from the differences between observations of subjects with the present complaint of low-back pain (97) and those without this symptom (227). Analysis of this peripheral variable revealed a present complaint of low-back pain had no influence on the behavioral performance of subjects (p=.37, see Table 11).

TABLE 15

Behavioral Observations
for
Group by Pain Lift

	Group		
Pain Lift	Control	Test	Total
No	57[a] (17.59)[b]	20 (6.17)	77 (23.77)
Yes	128 (29.51)	119 (36.73)	247 (76.23)
Total	185 (57.10)	139 (42.90)	324 (100.00)

Chi square 11.81
p=0.0006
DF=1

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[a]Frequency
[b]Percent

TABLE 16

Behavioral Observations
for
Group by Pain Now

	Group		
Pain Now	Control	Test	Total
No	155[a] (47.84)[b]	72 (22.22)	227 (70.06)
Yes	30 (9.26)	67 (20.68)	97 (29.94)
Total	185 (57.10)	139 (42.90)	324 (100.00)

Chi square 38.71
p=0.0001
DF=1

[a]Frequency
[b]Percent

Hypothesis #8. Each of the twelve organismic variables (age, height, weight, gender, occupation, years of experience, frequency of lifting, previous training, frequency of previous training, time since last training exposure, history of back pain while lifting patients, and present complaint of low-back pain) will have no influence on the behavioral performance of subjects.

The number of behavioral observations between Groups differed significantly at the .05 level with respect to the following variables:

1) age

2) height

3) weight

4) gender

5) years of service

6) training

7) last training experience

8) history of low-back pain while lifting patients

9) present complaint of low-back pain

Analysis of the twelve organismic variables via a Model 1 Analysis of Covariance revealed each variable had no influence on the behavioral performance of subjects. Thus, the null hypothesis is accepted.

Post-Training Exam

Following participation in the specifically designed training program on safe patient handling techniques, each

trainee was requested to complete a 20 item written exam on the principles and techniques presented in the training program. The results of this exam are presented in Table 17. The scores on this exam ranged from 70 to 100. The mean score was 91.7 with a standard deviation of 10.07.

Hypothesis #9. There will be no important relationship between the post-training test scores obtained by trainees and their behavioral performance following the training program.

A Pearson Correlation Coefficient was used to determine whether any relationship existed between the written exam scores of T-group subjects and their subsequent behavioral performances during Sessions 2 and 3 (see Table 18). The calculated R-value for Session 2 was -0.05. The probability that this value was equal to zero was p=.76. The calculated R-value for Session 3 was -0.23. The probability that this value was equal to zero was p=.06. Since neither R-value achieved significance at the .05 level, the null hypothesis is accepted: no relationship exists between written exam scores of trainees and their behavioral performances in Sessions 2 and 3.

TABLE 17

Written Exam Scores for T-Group Subjects

Subject	Score
1	95
2	70
3	100
4	100
5	100
6	90
7	100
8	80
9	100
10	100
11	85
12	80

Mean: 91.7
S.D.: 10.07
Range: 70-100

TABLE 18

Pearson Correlation Coefficient Between Exam Scores and Behavior Performance

Session	Exam Score	Behavioral Performance	R-Value	!R!
2	90.9[a] 32.0[b] 12.2[c]	74[d] 32[e] 22[f]	-0.05	.76
3	94.1 69.0 9.7	61 69 20	-0.23	.06

[a]Mean exam score in percent
[b]Number of observations
[c]Standard deviation in percent
[d]Mean behavioral performance in percent
[e]Number of observations
[f]Standard deviation in percent

V. DISCUSSION

The intent of this study was to determine if a specifically designed training program on safe patient handling techniques could produce large and desirable changes in the handling methods used by nursing personnel in their work settings. In addition, this study also examined the influence of twelve organismic variables on behavioral performance and the relationship between scores obtained on a written exam administered at the conclusion of the training program and subsequent behavioral performance. This chapter includes discussion of 1) the results of this study with respect to the existing literature; 2) theoretical implications of the study; 3) impact on hospital safety programs; 4) some limitations of this study; 5) application to the urban environment; and 6) directions for future research.

Program Effectiveness

Since the mid 1930s, American industrial employers have ultilized training programs on safe manual handling methods to reduce the occurrence of low-back injury among their employees.[103] The underlying basis for these programs has been that participation in such educational

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[103]Brown, "Lifting as an Industrial Hazard," p. 292.

activities will produce acquisition of the knowledge, skills and attitudes of safe handling by trainees. By returning to their work settings and applying their newly acquired techniques, it has been felt that trained workers can significantly reduce the stresses imposed on their low-backs and, thus, reduce the risk of low-back injury during manual handling tasks.[104]

Despite the recognition that behavioral changes must occur in trainees for training programs to be effective, most investigations into the effectiveness of safe manual handling programs have neglected the issue of behavioral changes in their evaluation designs. Indeed, the most popular type of evaluation of such programs has been to train workers in the techniques of safe handling and then monitor accident data to determine whether these programs reduced the occurrence of low-back injury. Without analysis of the trainees' workplace application of program information the conclusions of Brown and Snook, that training in safe handling methods is ineffective in preventing low-back injuries, are difficult to interpret.[105] Specifically, were the lifting techniques

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[104]Chaffin, "Biomechanics of Manual Materials Handling and Low-Back Pain," pp. 443-53.

[105]Brown, Manual Lifting and Related Fields. An Annotated Bibliography. pp. 1-26; Snook, et al., "A Study of Three Preventive Approaches to Low back Injury," p. 478.

promoted to trainees biomechically invalid? Did trainees not acquire the desired knowledge, skills and attitudes during the training sessions? Did trainees fail to apply these techniques to their job tasks? Is the use of accident data to assess behavioral programs too unreliable to give these studies much weight?

In this study, participation in training activities by the twelve T-group subjects had an important effect on their subsequent behavioral performance. Statistical analysis of the three class variables (Group, Session and Task) via a Model 1 Analysis of Covariance revealed a significant interaction (p=.0001) between the variables Group and Session.

To assess the short term effect of the training program, the mean T-group behavioral performance for a pre-training period (Session 1) was compared to mean behavioral performance for a post-training period conducted immediately following the training program (Session 2). Mean performance rose significantly from 47 percent in Session 1 to 74 percent in Session 2.

To assess a more long term effect of training, a second post training period commencing six weeks following the training period (Session 3) was included in the evaluation design. Mean T-group performance in Session 3 was 61 percent. While this value represented a significant drop from Session 2 performance, mean behavioral

performance during Session 3 remained significantly larger than the performance in Session 1.

Three studies have previously attempted to assess behavioral changes among trainees following participation in safe handling programs. In 1968, John M. Jackson used slow motion picture films of subjects to determine if trainees acquired the handling techniques promoted during training periods.[106] While no statistical analysis was performed, Jackson reported that trainees did acquire the desired knowledge and skills following program participation. No attempt was made to do any long term follow-up of these behavioral changes.

The short term results (e.g. Session 1 and Session 2 comparisons) of this study appear to be in agreement with the observations of Jackson. Trainees returned to their work settings following training and made more frequent use of safe patient handling methods. Short term mean performance rose 27 percent from pre-training observations to immediately post-training observations.

The other two studies employed an indirect measure of behavioral performance: abdominal pressure readings. Since abdominal pressure readings have been found to be a

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[106] Jackson, "Biomechanical Hazards in the Dockworker," pp. 155-6.

reliable measure of back tissue stresses, studies by Margaret Scholey and D.A. Stubbs, both reported in 1983, used abdominal measure readings to assess the use of safe patient handling techniques.[107] Because the magnitude of back tissue stress (and thus abdominal pressure) incurred during a manual task is directly related to the level of safety of the handling method used, trainees who acquire and apply safe handling techniques should lower their abdominal pressure readings.

Scholey reported that 3 out of 4 nursing trainees significantly reduced their abdominal pressures immediately following participation in a safe patient handling program. Stubbs reported his two nurse subjects showed a slight reduction in abdominal pressures immediately post training but, in measurement made 15 weeks later showed pressure readings similar to the pre-training values.

Both of these studies imply that nursing trainees improved the safety of their patient handling techniques immediately following training. The short term results of this study appear to be in concert with the immediate results of both the Scholey and Stubbs studies. The 27 percent improvement in behavioral performance found to

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[107]Scholey, "Back Stress: The Effect of Training Nurses to Lift Patients in a Clinical Setting," pp. 1-13; Stubbs, "Back Pain in the Nursing Profession. II. the Effectiveness of Training," pp. 772-77.

occur in T-group subjects between Sessions 1 and 2 would, theoretically, produce lower-back tissue stresses. Unfortunately, just as abdominal pressures are indirect measures of behavioral performance, so too is behavioral performance an indirect measure of abdominal pressures and back tissue stresses.

In this study, the long term follow-up consisted of behavioral observations made 6 to 8 weeks post training (Session 3). At this point, the mean performance of the T-group subjects was significantly larger than the pre-training (Session 1) value although it had fallen off significantly from the mean performance recorded immediately post training (Session 2). Since the length of follow-up made by Stubbs et al. was 15 weeks post training, it is not possible to compare the long term behavioral changes of this study to his. However, if performance continued to fall as evidenced by the comparison between the Session 2 and 3 values, it is possible that at 15 weeks, there would be little difference between that value and the pre-training value.

In addition to the three previous studies which either directly or indirectly assessed behavioral changes following training, John R. Brown[108] has reported that

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[108]Brown, "Lifting as an Industrial Hazard," p. 292.

behavioral changes are one of the major limitations of safe handling programs. He states trainees frequently return to their work setting and fail to use the techniques promoted in the training sessions.

The results from this study appear to be in disagreement with Brown's observations. Statistical analyses showed that trainees can significantly improve their workplace application of safe handling methods and these changes can persist for up to eight weeks following training.

One important aspect which needs to be stressed here is the educational quality of the training program. If trainees are not acquiring the knowledge, skills and attitudes consistent with safe handling during training activities, it is doubtful that any significant behavioral change will be observed in the workplace. By structuring training activities around the principles of learning, sponsors of such programs can maximize the likelihood that trainees will master the desirable knowledge and skills. As evidenced by the recent survey by the Bureau of Labor Statistics, most workers are currently trained in safe handling methods by exposures to lectures, demonstrations, films and written materials.[109] Under these conditions of

[109]Bureau of Labor Statistics, "Back Injuries Associated With Lifting," p. 13.

passive participation in the training activities, Brown's observations may be more accurate.

A matched control group was included in this study to serve as a basis of comparison for T-group scores. The largest mean behavioral score for the C-group (43 percent) was otained in Session 1. The overlap of variances between the mean scores of the T- and C-groups for Session 1 suggest the pre-training performances of these two groups was similar.

Interestingly, the mean performance of C-group subjects for Session 2 (33 percent) and Session 3 (35 percent) fell off significantly from the pre-training mean score. Statistically, Sessions 2 and 3 mean scores were similar.

This pattern in mean performance of the C-group raises questions on the effect of direct behavioral observations on subject performance. Since subjects were aware that they were being observed and graded during patient handling tasks, they may have used "better" lifting techniques, especially during Session 1 when the presence of the observers was more novel to them. However, with time, subjects may have accommodated to the presence of the observers or felt less need to "put on their Sunday clothes" and returned to the handling techniques which they normally would use. It may be valuable in future

studies to conduct a mock observation session prior to actual data collection sessions for the purpose of eliminating this apparent Hawthorne effect from the data analyses.

An important factor in the high incidence of low-back injury among nurses has been reported to be the tasks performed by nursing personnel.[110] In addition to the frequent handling of disabled patients, Dehlin et al., have reported these tasks to be performed under "less than ideal" conditions.[111] Because of the importance of various patient handling activities in low-back injuries among nurses, Task was included as a class variable in this study.

The results of this study failed to show Task as a variable effecting the behavioral performance of subjects. Neither the Group * Task ($p=.54$) nor the Session * Task ($p=.06$) interaction achieved statistical significance at the .05 level.

The failure of the Task variable to effect behavioral scores has important ramifications for safe patient handling programs. Since behavioral performance was similar across the four tasks included in this study, it

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[110]Stubbs, et al., "Back Pain Research," p. 857.

[111]Dehlin et al., "Back Symptoms in Nursing Aides in a Geriatric Hospital," p. 53.

suggests that training programs can promote desirable handling methods among trainees, regardless of the task(s) being performed. This finding appears to strengthen the use of training programs for promoting safe handling techniques since trainees appear to be capable of applying their knowledge and skills to tasks which vary greatly in their physical demands.

Studies of low-back problems across populations have indicated several organismic factors are associated with the incidence of both low-back pain and low-back injury.[112] These include the individual's age, gender, occupation, years of experience, and physical conditioning. Due to the complex nature of low-back pain/injury, the cause-effect relationship between these individual factors and low-back disorders remains an issue. Currently, the general belief is that any single incident of low-back pain or injury is probably of a multifactorial nature involving some or all of these variables.

Since a variety of organismic variables can contribute to a low-back injury, it was decided to incorporate

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[112]Kelsey, "An Epidemiological Study of Acute Herniated Lumbar Intervertebral Discs," p. 151; Frymoyer et al., "Epidemiologic Studies of Low-Back Pain," p. 420; Snook, "Low Back Pain in Industry," pp. 27-9; Andersson, "Low Back Pain in Industry: Epidemiological Aspects," pp. 165-6.

several individual-specific variables into this study to determine their influence on behavioral performance. Eight covariants (age, height, weight, occupation, years of experience, lifting frequency, training frequency, when trained) and four peripheral variables (gender, training, pain while lifting, present pain) were included in the data analysis.

Between-group analysis of the subjects performing the Tasks revealed significant inter-group differences in age, height, weight, years of service, gender, training, frequency of training, last training experience, pain while lifting patients, and the present complaint of back pain. However, when each organismic variable was analyzed with respect to behavioral performance, none of them produced a statistically significant influence on behavioral performance at the .05 level.

Thus, while organismic variables may effect an individual's risk of low-back pain or injury, the twelve variables included in this study did not influence behavioral performance during patient handling tasks. This finding is of importance to safe handling programs in that desirable behavioral changes can be produced in all types of individuals regardless of their age, gender, height, weight, occupation, training experience or back pain history. Unfortunately, the lack of previous research on the effects of these organismic variables on

the acquisition and application of safe handling methods prevents any comparisons with other studies.

Since the purpose of the training program is to produce the acquisition of knowledge, skills and attitudes, it was theorized that individuals who did better at mastering these training objectives would return to their work settings and do a better job at applying the desired techniques. To assess this relationship, a correlation was run between the scores obtained on a written exam administered at the conclusion of the training program and the Session 2 and 3 behavioral performance.

The correlation coefficients obtained for exam scores-Session 2 behavioral performance (-0.05) and exam scores-Session 3 behavioral performance (-0.23) failed to achieve statistical significanace at the .05 level, indicating that no relationship existed between these sets of scores. This finding makes one question the value of a written post training test as a predictor of a trainee's future workplace application of handling techniques. Indeed the negative R-values obtained suggest that those individuals who did best on the post-training written test had poorer behavioral performances when they returned to the work setting than those individuals with lower test scores. While a post training written test may be useful in quantifying a trainee's initial mastery of program materials, a form of workplace observation (e.g. direct

observation, video taping) appears essential for the verification that the transfer of information from the classroom to the workplace has occurred.

Before concluding the discussion on the results of this study, it appears warranted that the role of a training program of high educational quality be addressed. The design of this study was based upon the training model put forth by Irwin L. Goldstein.[113] By following his "systems approach" to training including Assessment, Training and Development and Evaluation Phases, an educational program was created which was founded on the actual job requirements of trainees, based on sound biomechanical principles, and capable of being statistically analyzed.

In addition, by structuring training activities around the various principles of learning an effort was put forth to make the program a valuable educational experience for trainees. Specifically, by having trainees discuss and perform each of the patient handling tasks to be evaluated, each T-group subject became an active participant in the training program. The mean performance of trainees on the twenty item, post-training written exam (91.7) suggests that the group, as a whole, adequately mastered the information presented to them.

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[113]Goldstein, Training: Program Development and Evaluation, p. 93.

Theoretical Implications

While the purpose of safe patient handling programs is to produce desirable and lasting behavioral changes among trainees, the use of such programs is based on the belief that by employing safe handling methods a worker can reduce his/her risk of low-back injury. Thus, the effectiveness of any safe handling program in reducing low-back injuries will derive from a combination of the biomechanical validity of the handling techniques promoted to trainees, and the willingness and/or ability of trainees to apply these methods.

The theoretical basis for using safe handling methods when performing manual tasks has derived from two sources: static/dynamic models of the human body and in vivo measurements. In both types of studies the purpose has been to determine the tissue forces imposed on the low-back when different spinal postures are assummed or various handling techniques are employed.

Studies by Erwin Tichauer, Duncan Troup and Don Chaffin using engineering-based models of the body have been extremely useful in identifying postures which increase or decrease the stresses of manual handling.[114]

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[114]Tichauer, "Biomechanics Sustains Occupational Safety and Health," p. 49-51; Troup, "Biomechanics of the Vertebral Column," p. 238-42; Chaffin, "Biomechanics of Manual Materials Handling and Low-Back Pain," pp. 443-53.

From their findings they have recommended a sequence of steps which a worker should employ while performing manual tasks which will help reduce the stresses imposed on low-back tissues.

In vivo measurements of tissue stresses have helped confirm the importance of body postures during handling tasks. Nachemson inserted a pressure gauge into the lumbar discs of volunteers and reported the forward flexed position to markedly increase the compression forces applied thru the discs.[115] Margaret Scholey and D.A. Stubbs both had trainees swallow a pressure-sensitive radio tansmitter and then monitored abdominal pressures during patient handling tasks.[116] Both reported truncal stresses decreased following training in safe patient lifting due to the trainees application of the handling methods.

Since both mathmatical models and in vivo measurements suggest safe handling methods can reduce the tissue stress imposed on an individual's back, the major variable in the training model for reducing low-back stresses is

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[115] Nachemson, "In Vivo Measurements of Intradiscal Pressure," pp. 1087-90.

[116] Scholey, "Back Stress: The Effects of Training Nurses to Lift Patients in a Clinical Setting," p. 9-13; Stubbs, "Back Pain in the Nursing Profession. II. The Effectiveness of Training," pp. 772-7.

the effective application of these techniques by trainees. The findings from this study suggest that a training program of high educational quality on safe patient handling methods can produce desirable behavioral changes in the handling techniques used by nursing personnel for at least eight weeks following training.

Since no effort was made to measure tissue stresses on subjects performing patient handling tasks, it is not possible to determine whether the improved performance in handling techniques by T-group subjects actually produced lower back tissue stresses. However, by having a greater compliance with the biomechanically-valid handling methods following training than prior to training, T-group subjects would have, theoretically, lowered low-back tissue stresses by more consistently avoiding body postures which are known to increase these stresses.

In addition, it cannot be proven that T-group subjects would have a lower low-back injury rate than C-group members solely on the basis of a better behavioral performance. As previously noted, any low-back injury is probably the result of a multifactorial interaction of numerous individual- and environmental-specific variables. While handling technique is one factor in the causation of low-back injury, there is no proof that control over this one factor is a totally effective prophylatic measure

against low-back injury.

Policy Implications

One of the largest and most costly employee health care problems currently facing hospital administrators is low-back injuries among nursing personnel.[117] Of particular concern is how to exert cost-effective control over this growing problem?

Over the past two decades, hospitals have begun training their nursing personnel in safe patient handling methods in the hope that the effective use of these techniques would result in fewer back injuries. Unfortunately, while many hospitals have made frequent use of these training programs, including West Virginia University Hospital, few have performed valid evaluations to objectify outcomes. One result has been the "blind" use of such training efforts.

As stated by Judi Komaki, organizations need to obtain valid, evaluation-based information on their training programs if they are to make appropriate policy decisions concerning the future use of these efforts.[118]

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[117] Cust et al., "The Prevalence of Low Back Pain in Nurses," p. 171; MacMillan, "Being a Camel is a Pain in the Back," p. 1037.

[118] Judi Komaki, "Alternative Evaluation Strategies in Work Settings," Journal of Organizational Behavior Management, Vol. 1 (Summer 1977), p. 53.

Furthermore, in the wake of economic recession, institutions are still exerting caution over the use of resources for activities which may be ineffective in their purpose.

This study provides some important information to West Virginia University Hospital and other health care institutions who are using safe patient handling training to address their problem with nursing back injuries. First, it provides a training model for delivering safe patient lifting information to trainees. Institutions must recognize that training programs do fluxuate in educational quality which can effect the success of the programs. While it was not the intent of this study to compare the effectiveness of different training methods, the lecture, demonstration and group participation format used did produce the acquisition of the desired knowledge and skills by trainees. Also, by basing the training program on job-specific information obtained through a systematic task analysis, the program content was made highly relevant to trainees.

Second, the study provides an evaluation strategy for evaluating the behavioral outcomes of safe patient handling programs. By employing a similar evaluation design to their institutional-specific training efforts, hospitals can better assess the strengths and weaknesses of their own programs.

Third, this study demonstrated that a specifically designed training program on safe patient handling techniques can produce significant and desirable behavioral changes in trainees. Since such behavioral changes are the principle purpose of the training activities, hospitals can be confident that this program goal is realistic. Furthermore, the desirable behavioral changes among trainees should persist for at least eight weeks. With other forms of back injury prevention available to administrators (e.g. worker selection, job redesign), hospitals must select the form of intervention which meets their individual budgetary constraints. With behavior-based information on training outcomes, administrators can make more appropriate decisions on the cost-effective means of low-back injury prevention.

Limitations of the Study

The findings of this study should be generalized to other hospitals and nursing personnel with caution. First, due to the physical impracticability of performing workplace behavioral observations on randomly selected members of the WVU nursing staff, two intact ward units were selected for study (Orthopedic, Ward 32; Neurosurgery, Ward 31). Also since these wards frequently accommodate patients with severe disabilities, the patient handling responsibilities of nursing staff members is

quite high. It is questionable whether randomly selected nurses, including those whose jobs did not include much patient handling, would show similar gains in behavioral performance post training.

Second, because the study attempted to observe nursing personnel performing actual patient transfers, the number of Session-specific observations was subject to influence by a host of factors including the number of patients on the ward, the level of disability of patients, and the types of transfers required to handle a patient. Specifically, the patient census on both wards fell significantly during Session 2. Thus, the number of total observations for the two groups was 77, compared to the 123 and 124 observations recorded in Sessions 1 and 2, respectively. In addition, because of the patient types on Station 32 during Sessions 1 and 2, and Station 31 during Session 2, Task 2 (bed to/from stretcher via parallel transfer) was not observed.

Third, to obtain behavioral observations on subjects observers had to be physically present in the room at the time the transfer was being performed. Since nursing staff members were aware that their patient handling techniques were being observed and recorded, their behavioral performances may have been higher than they would have been if no observer was present. However, since the mean performance on the C-group ward dropped off

during Sessions 2 and 3 with respect to Session 1, it was interpreted that the groups had accommodated to the presence of the observers and did not significantly change their performance soley for this reason.

Urban Application

While the focus of this dissertation was the effect of training on the patient handling techniques of nursing personnel, both the results and methodology of this study have applicability to employee training programs conducted within the urban environment. This generalizability derives from the belief that worker training efforts are linked by their underlying purpose to produce desirable and lasting behavioral changes among trainees. Thus, while the focus of any single training program may vary greatly from the focus of this dissertation, the common intent to effect behavioral changes provides a basis upon which studies can be compared and generalized.

By employing a training program of high educational quality and a behavioral observation technique to measure subject performance, this study found training produced statistically-significant (α=.05) and lasting (eight weeks) improvement in the patient handling techniques of nursing personnel. In addition, this upgraded performance was found to be independent of a number of organismic factors which have been reported to influence the

occurrence of low back pain/injury.

Both of these results have generalizability to urban training. First, a training program of high educational quality is capable of producing desirable and lasting behavioral changes among participants. This cause-effect relationship between training and behavioral change has been the basis for using training to address worker performance problems. However, due to a lack of objective evidence substantiating this relationship, the use of training has been justified primarily on theoretical grounds. In combination with the findings of Cohen and Jensen, and Komaki et al., this study provides objective evidence of the behavioral changes which can occur following training exposure.[119] If nursing personnel can acquire the knowledge, skills and attitudes of safe patient handling from training and then apply this learning to job-related tasks, there is reason to believe that similar results can be obtained in other urban areas (e.g. service delivery, personnel development).

Second, training can be effective in producing behavioral changes within groups of workers despite many

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[119] Cohen and Jensen, "Demonstration of the Effectiveness of an Industrial Lift Truck Operator Safety Training Program Utilizing a Behavior Sampling Procedure," pp. 4-7; Komaki, Heinzmann and Lawson, "Effect of Training and Feedback: Component Analysis of a Behavioral Safety Program," pp. 262-8.

inter-trainee differences. While this generalization must be made with caution, it appears that an educational program which provides individual participants with a maximal opportunity to master the desired knowledge, skills and attitudes can offset many pre-training differences among trainees (e.g. experience, level of education, physical characteristics). Thus, when faced with a heterogenous group of trainees, it may be advisable for training directors to further emphasize the educational quality of their programs.

A third finding of this study was that a trainee's initial acquisition of knowledge (determined by a written exam immediately post training exposure) did not significantly correlate with the subsequent application of learning to job-related tasks. When such written exams are used to measure learning, urban trainers should avoid using these scores to predict future workplace performance. This restriction may be especially important when workplace application requires a high level of manual skill since a worker's cognative ability and level of manual skill may differ markedly.

In addition to the results of this study, the methodology employed has applicability to urban training efforts. Specifically, the design of the training program and the evaluation format used provide valuable frameworks for structuring various training programs.

As educational activities, training programs are intended to produce the acquisition of certain knowledge, skills and/or attitudes by trainees. This study attempted to maximize the likelihood of trainee learning by employing the training model put forth by I.L. Goldstein which emphasizes the use of training activities based on sound educational principles.[120] The results of the post training written exam and subjective observations by the principal investigator suggest this training program was successful in producing trainee learning. On these grounds it is anticipated that training directors can adopt the program design outlined in the methodology section to their own program topics in an effort to upgrade the educational quality of their efforts.

Finally, program evaluation has traditionally been a training component which has either been overlooked completely or performed using criteria which were more convenient than valid. This study examined one of the most basic and essential outcomes of training (workplace application) via behavior-oriented criteria. This type of evaluation was found to be easily performed and provided data which quantified trainee behaviors and were ammenable to statistical analyses. It is anticipated that this

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[120]Goldstein, Training: Program Development and Evaluation, pp. 18-88.

evaluation format can be applied by training directors to their own training efforts to better quantify their results and to help direct other, future training programs.

Directions for Future Research

While this study provided some answers to issues surrounding the effectivenss of safe patient handling programs, it served to raise several more questions which must be addressed in future studies. These are:

1. What effect does the training method used to instruct trainees have on the behavioral performance of subjects when they return to their work settings?
2. How would behavioral performance change following training if all observations were made without subject awareness (e.g. via hidden camera)?
3. How long, beyond eight weeks, do the desirable behavioral changes noted in trainees in this study persist?
4. What is the relationship between the behavioral performance of subjects and low-back tissue forces? For instance, is there a specific performance level which represents an "acceptable" level of low-back stress.
5. What is the relationship between the behavioral performance between groups and subsequent low-back injury rates?

Summary and Conclusions

The purpose of this study was to determine if a specifically-designed training program on safe patient handling techniques could produce desirable and lasting behavioral changes in trainees. In addition, twelve organismic variables were incorporated into the analysis to help determine if they produced any influence on the behavioral performances and scores were obtained on a post training written exam to determine if these scores correlated in any manner with the subsequent behavioral performances of trainees.

Behavioral data was obtained by three behavioral observers during three, two-week observational sessions (prior to training, immediately following training, and six weeks following training). Organismic data was obtained from a subject questionnaire completed by each participant prior to the start of the study. The exam scores were obtained from each trainee immediately following their participation in the training activities, but before the commencement of the second observational session. Data analysis was performed via a Model 1 Analysis of Covariance with the three main class variables being Group, Session and Task. Also, Student T-tests and Chi-square tests were used to determine organismic-specific differences between Groups and a Pearson's Correlation

Coefficient was used to determine the relationships between exam scores and behavioral performance.

The Analysis of Covariance among the three class variables revealed a significant interaction between Group and Session (P=.0001). This finding was attributed to the effect of training on the T-group mean performance. The finding that task did not have a significant effect on behavioral performance led to the conclusion that training can be used to improve behavioral performances, regardless of the particular tasks being performed by subjects.

Student T-tests and Chi-square tests revealed several differences between Groups for the covariates age, height, weight, years of experience and when trained, and the peripheral variables gender, training, pain while lifting and present pain. However, none of these variables were found to influence the behavioral performance of subjects. This findiing was interpreted to mean that training can produce desirable behavioral changes in subjects, regardless of their classification according to these variables.

Finally, a correlation was run between the scores obtained by trainees on a post training written exam and their subsequent behavioral performance (Sessions 2 and 3). No statistically-significant relationship was found to exist between those variables at the .05 level. Thus, while post program exam scores may be useful as measures

of a trainees knowledge of program materials, they are of little value in predicting performance when that individual returns to their work setting.

In conclusion, the findings of this study support the use of training programs of high educational quality for the purpose of promoting desirable behavioral changes among nursing personnel. Such programs appear to be capable of producing behavioral changes for at least eight weeks, regardless of the tasks being performed in the work setting and regardless of the individual characteristics of the trainee.

Whether or not the desirable behavioral changes found in this study represent a significant reduction in low-back tissues stresses or low-back injury statistics is unknown. However, since promoting desirable and lasting behavioral changes in patient handling methods are important steps in reducing back injuries, the continued use of training programs of high educational quality for nursing personnel appears warranted.

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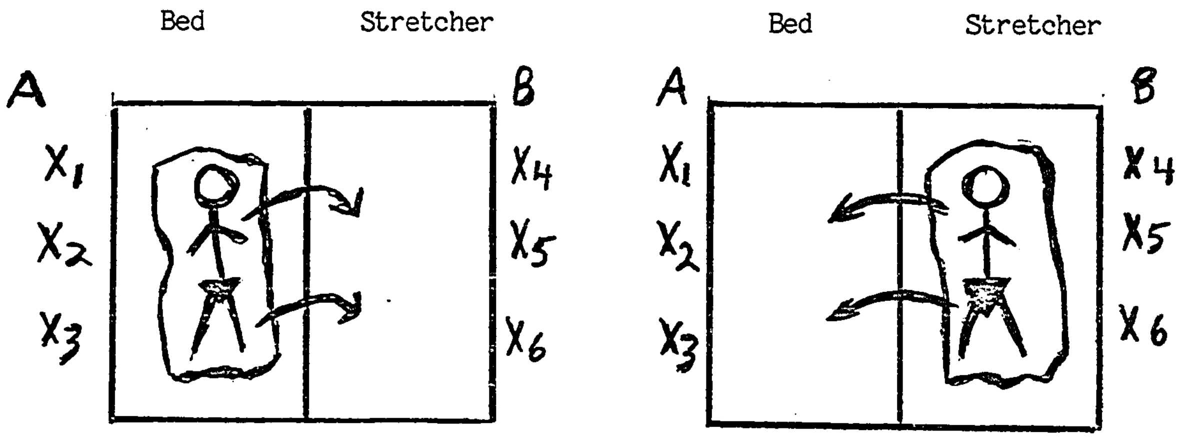
APPENDIX 1

Data Collection Form For Task 1

TASK 1: BED ⇄ STRETCHER
Circle One



<u>OBSERVATIONS</u>:

I. IDENTIFICATION

1. Subject's Name ______________________________

2. Position: X1 X2 X3 X4 X5 X6

II. MISCELLANEOUS

		YES	NO
3.	Bed height adjusted to height of stretcher	____	____
4.	Task performed in three distinct steps	____	____
5.	One subject coordinated the lift via oral commands to the other subjects	____	____

III. STATIC COMPONENTS

<u>A. If on Side A (X1, X2, X3)</u>

		YES	NO
6.	Draw sheet grasped with forearms in supination	____	____
7.	Subject kneeled on the edge of the bed (If "no", skip to IV, Dynamic Components)	____	____
8.	Knees were at least 6" apart	____	____
9.	One knee was at least 3" in front of the other	____	____
10.	Trunk positioned between 25^0 of flexion and in lordosis	____	____
11.	Arms kept as close to body as possible	____	____

B. If on Side B (X4, X5, X6)

	YES	NO
12. Draw sheet grasped with forearms in supination	____	____
13. Feet positioned at least 12" apart	____	____
14. One foot positioned at least 6" in front of the other	____	____
15. Knees positioned in at least 25^0 of flexion	____	____
16. Trunk positioned between 25^0 of flexion and in lordosis	____	____
17. Elbows positioned against body	____	____

IV. DYNAMIC COMPONENTS

18. Trunk remained rigid throughout the task	____	____
19. The subject avoided rotational motions of the trunk throughout the task	____	____
20. The subject shifted weight onto the appropriate lower extremity during task	____	____

V. COMMENTS

____

____

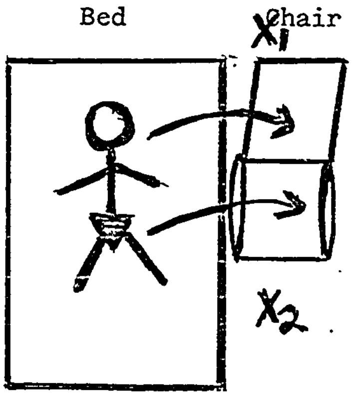
____

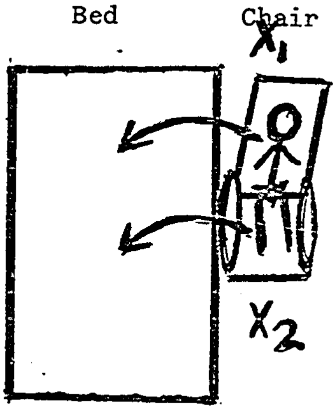
____

APPENDIX 2

Data Collection Form For Task 2

TASK 2: BED ⇄ WHEELCHAIR VIA PARALLEL (2 PERSON) TRANSFER
Circle One





OBSERVATIONS:

I. IDENTIFICATION

1. Subject's Name: ______________________________

2. Position: X1 X2

II. MISCELLANEOUS	YES	NO
3. Chair locks engaged	____	____
4. Wheelchair legs removed	____	____
5. Bed height even with arm height of chair	____	____
6. Task performed in two distinct steps	____	____
7. One subject coordinated the lift via oral commands to the other subject	____	____
III. STATIC COMPONENTS		
8. Feet positioned at least 12" apart	____	____
9. Appropriate foot positioned at least 6" in front of the other	____	____
10. If X1 - arms locked with patient's and kept close to body. If X2 - arms placed beneath knees and kept close to body	____	____
11. Knees flexed to at least 25^{0}	____	____
12. Trunk positioned between 25^{0} flexion and in lordosis	____	____

IV. DYNAMIC COMPONENTS

	YES	NO
13. Lift accomplished by extending knees to lift and bending knees to lower	_____	_____
14. Trunk remained rigid throughout the task	_____	_____
15. The subject avoided rotation of the trunk throughout the task	_____	_____

V. COMMENTS

____

____

____

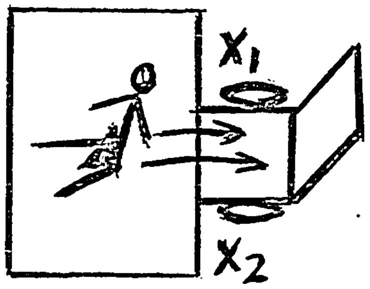
____

APPENDIX 3

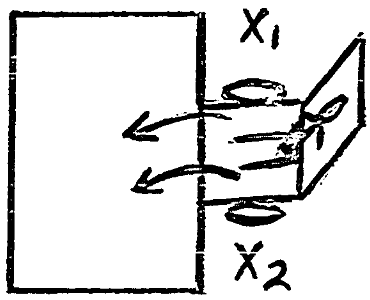
Data Collection Form For Task 3

TASK 3: BED ⇄ WHEELCHAIR VIA PERPENDICULAR TRANSFER
Circle One

Bed Chair



Bed Chair



OBSERVATIONS:

I. IDENTIFICATION

1. Subject's name: ______________________________

2. Position: X1 X2

II. MISCELLANEOUS	YES	NO
3. Chair locks engaged	____	____
4. Wheelchair legs removed	____	____
5. Bed height even with seat height or bed in lowest position	____	____
6. Task performed in one smooth step	____	____
7. One subject coordinated the lift via oral commands to the other subject	____	____
III. STATIC COMPONENTS		
8. Subject faced in direction of movement	____	____
9. Feet positioned at least 12" apart	____	____
10. Outward foot positoned at least 6" in front of other	____	____
11. Inner arm placed through patient's axilla - and kept close to body	____	____
12. Knees flexed to at least 25^0	____	____
13. Trunk positioned between 25^0 of flexion and in lordosis	____	____

IV. DYNAMIC COMPONENTS

	YES	NO
14. Task accomplished by extending knees to lift and flexing knees to lower	_____	_____
15. Trunk remained rigid throughout the task	_____	_____
16. The subject avoided rotation of the trunk throughout the task	_____	_____

V. COMMENTS

____

____

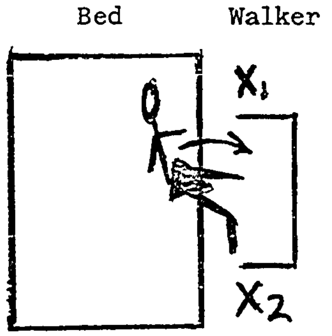
____

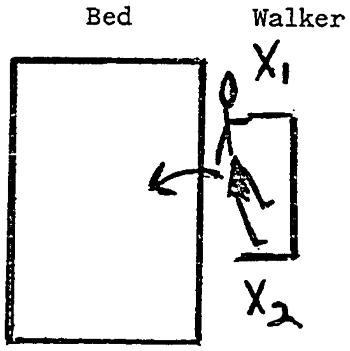
____

APPENDIX 4

Data Collection Form For Task 4

TASK 4: BED ⇄ STANDING WITH WALKER
Circle One





OBSERVATIONS:

I. IDENTIFICATION

1. Subject's name:______________________________

2. Position: X1 X2

II. MISCELLANEOUS	YES	NO
3. Safety belt on patient	_____	_____
4. Bed lowered so that patient's good foot can touch floor	_____	_____
5. Task performed in one smooth step	_____	_____
6. One subject coordinated the lift via verbal commands to the other subject and the patient	_____	_____
III. STATIC COMPONENTS		
7. Feet positioned at least 12" apart	_____	_____
8. Outer foot positioned at least 6" in front of the other	_____	_____
9. Knees flexed to at least 25^0.	_____	_____
10. Trunk positioned between 25^0 of flexion and in lordosis	_____	_____
11. Inner hand on safety belt and outer hand under axilla	_____	_____

IV. DYNAMIC COMPONENTS

	YES	NO
12. Task accomplished by extending knees to lift and flexing knees to lower	____	____
13. Trunk remained rigid throughout the task	____	____
14. The subject avoided trunk rotation throughout the task	____	____

V. COMMENTS

____

____

____

____

Division of Physical Therapy
304 293-3610/3611

School of Medicine
Medical Center
Morgantown, West Virginia
26506

APPENDIX 5

West Virginia University

CONSENT TO ACT AS A SUBJECT

FOR RESEARCH AND INVESTIGATION

PROJECT DIRECTORS: Bruce P. Klein, MA, PT
(599-6149)

Dennis L. Hart, MPA, PT
(293-3611)

PROJECT TITLE: Training Nursing Personnel in Safe Patient Handling Technique: A Behavioral Evaluation

SUBJECT'S NAME: ______________________________

DATE: ______________________________

I voluntarily consent to participate in a study designed to evaluate the effects of a training program on safe patient lifting techniques. I realize that my patient lifting techniques will be periodically observed and graded during my regular working hours over approximately an 8 month period. I also realize that many of these observations may be made when I am unaware of the fact that my patient lifting techniques are being recorded.

I realize that I will be randomly assigned to either an experimental or control group. If assigned to the experimental group, I realize that I will receive a 2 hour training program on safe patient lifting methods. I realize that, as part of this training program, I will be required to demonstrate both knowledge and skills in the specific lifting technique taught as measured by scores on

written and practical tests, respectively. If assigned to the control group, my patient lifting techniques will be observed periodically during regular working hours.

I realize that the safe lifing techniques taught in the training program are designed to reduce my risk of low-back injury during patient handling tasks. I also realize that my effective use of these safe lifting techniques does not guarantee that I will not incur a back injury during a patient handling task.

I understand that any information about me from this research, including observational data, test scores, and answers made on questionnaires, will be kept strictly confidential. I realize that any publications which result from this study will in no way identify subjects by name or by other personal information that could easily identify an individual. I understand that my research records, like hospital records, can be subpoenaed by court order or inspected by Federal regulatory authorities.

I understand that my use of safe patient lifting methods, as determined by this study, will in no way influence my position or reputation in the Department of Nursing. I understand that his study's intent is to look at the effects of the training program and is in no way intended to be an assessment of individual performance.

I thoroughly understand the nature of this study which has been explained to me by one of the researchers. All of my questions have been answered to my complete satisfaction.

I understand that I may withdraw from this study at any time without prejudice.

I have received a copy of this consent form.

SUBJECT SIGNATURE ______________________________

ATTENDING INVESTIGATOR SIGNATURE ______________________________

DATE ______________________________

APPENDIX 6

Subject Information Form

1. Name: ________________________________

2. Station (circle one):
   31 32

3. Age (circle one):
   Under 24 25-34 35-44 over 45

4. Height (circle one):
   Under 5' 5'-5'6 1/2" 5'7"-5'11 1/2" over 6'

5. Weight (circle one):
   Under 100 lbs 100-135 lbs. 136-170 lbs. over 170 lbs.

6. Gender (circle one):
   Male Female

7. Occupation (circle one):
   RN LPN Aide Other (specify):____________________

8. Years of service in this occupation (circle one):
   Less than 1 1-3 4-6 7-10 over 10

9. On an average, how many times in a normal work day do you participate in patient lifting tasks? (circle one):
   0-3 4-7 over 7

10. Have you ever received training in safe patient lifting techniques? (circle one):
    YES NO

11. If you have received previous training, how many times have you been trained in safe patient lifting techniques? (circle one):
    Once 2-3 4-6 over 7 not applicable

12. If you hve received previous training, when was the last time you were trained in safe patient lifting techniques? (circle one):
    Less than 6 mo. ago 6-12 mo. ago over 1 year ago not applicable

13. Have you ever experienced back pain while lifting a patient? (circle one):
    YES NO

14. Do you presently have any back pain? (circle one):
    YES NO

APPENDIX 7

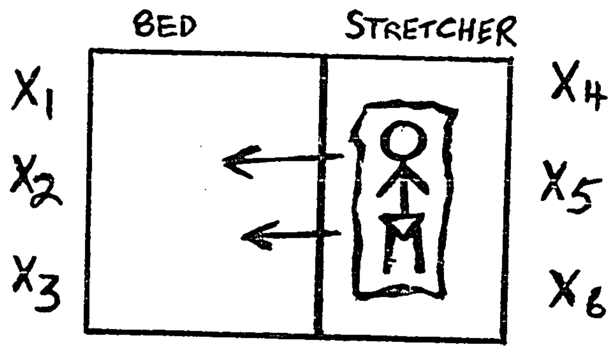
Post Training Written Exam

NAME:

DATE:

Each of the following items presents a statement concerning lifting techniques which can be employed when transferring patients. Read each question and then circle either TRUE or FALSE depending on whether you feel the statement represents a correct or safe method (TRUE) or an incorrect or unsafe one (FALSE). Diagrams are provided to aid in the understanding of certain items.

The following diagram illustrates the transfer of a patient from a stretcher to a bed. Six staff members (X1, X2, X3, X4, X5, X6) will work together to move the patient by grasping the draw sheet upon which the patient lies.



Answer items 1–8 using this diagram.

1. The bed height should be adjusted so that the bed is about 6 inches lower than the height of the strethcer.

   TRUE FALSE

2. Each staff member should grasp the draw sheet such that his/her palms are facing down (e.g. forearms are in pronation).

   TRUE FALSE

3. The lifting task should be performed in the following three steps:
   a) Move the patient to the edge of the stretcher.
   b) Transfer the patient from the stretcher to the edge of the bed.
   c) Move the patient from the edge of the bed to the center of the bed.

   TRUE FALSE

4. One staff member should always coordinate the lift by using oral commands (e.g. "one, two, three....lift").

   TRUE FALSE

5. If you are staff member X2, you should be kneeling on the bed during the transcribe of the patient from the stretcher to the bed.

TRUE FALSE

6. If you are staff member X6, your feet should be no more than 3" apart during the transfer.

TRUE FALSE

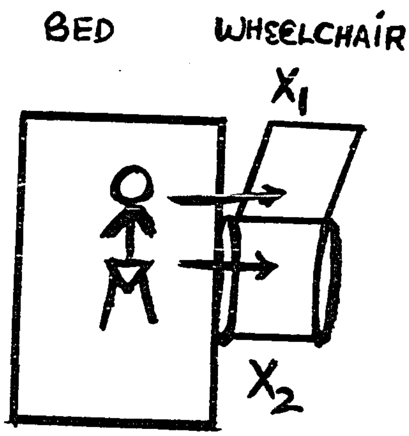
7. Each staff member should have his/her back positioned in extension (e.g. lordotic position) prior to attempting to transfer the patient

TRUE FLASE

8. Each staff member should keep his/her back rigid throughout the patient transfer.

TRUE FALSE

The following diagram illustrates two staff members performing a "two man" transfer of a patient from a bed to a wheelchair.



Answer items 9-15 using this diagram.

9. Prior to attempting to transfer the patient, wheelchair locks should be engaged.

TRUE FALSE

10. If the legs of the wheelchair are removable, they should be removed prior to transferring the patient.

TRUE FALSE

11. The height of the bed should be adjusted so that it is level with the seat of the wheelchair.

TRUE FALSE

12. The task should be performed in two distinct steps:
    a) Move the patient to the edge of the bed.
    b) Transfer the patient from the bed to the wheelchair.

TRUE FALSE

13. Prior to lifting the patient, both staff members, X1 and X2, should bend their knees to at least 25° of flexion.

TRUE FALSE

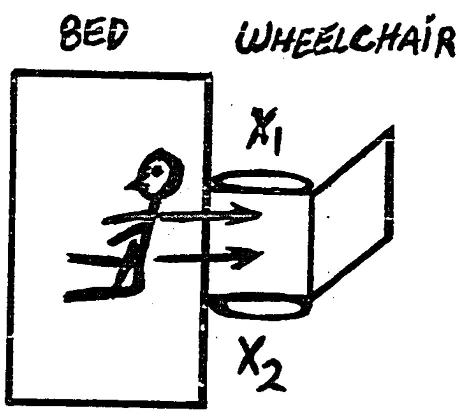
14. If you are staff member X1, you should lift the patient by bending your knees and lower the patient by extending (e.g. straightening) your knees.

TRUE FALSE

15. If you are staff member X2, the safest way for you to perform your part of the transfer is to twist (e.g. torsion) your low back.

TRUE FALSE

The following diagram illustrates two staff members, X1 and X2, transferring a patient from a bed to a wheelchair. The patient is sitting on the bed, facing away from the wheelchair. Staff members X1 and X2 will slide the patient from the bed into the wheelchair.



Answer items 16-18 using this diagram.

16. Both X1 and X2 should be facing the direction they will be moving the patient.

TRUE FALSE

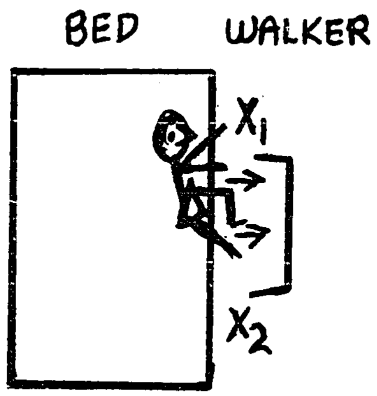
17. Both X1 and X2 will lock their inner arm (e.g. arm closest to the patient) under the patient's arm and stand as close to the patient as possible.

TRUE FALSE

18. This transfer should be performed in one smooth step.

TRUE FALSE

The following diagram illustrates two staff members, X1 and X2, transferring a patient from a bed to a standing position with a walker.



Answer items 19 and 20 using this diagram.

19. A safety belt should always be placed around the patient's waist prior to performing the transfer.

TRUE FALSE

20. Prior to transferring the patient, the bed should be lowered so that the patient's good leg touches the floor.

TRUE FALSE

APPENDIX 8

Research Schedule

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
MAY 7	8	9 Obs.	10 Obs.	11 Obs.
14 Obs.	15 Obs.	16 Obs.	17 Obs.	18 Obs.
21 Obs.	22 Obs.	23 Train	24 Train	25 Train
28 Train	29 Train	30 Train	31 Train	JUNE 1 Train
4 Obs.	5 Obs.	6 Obs.	7 Obs.	8 Obs.
11 Obs.	12 Obs.	13 Obs.	14 Obs.	15 Obs.
18	19	20	21	22
25	26	27	28	29
JULY 2	3	4	5	6
9	10	11	12	13
16 Obs.	17 Obs.	18 Obs.	19 Obs.	20 Obs.
23 Obs.	24 Obs.	25 Obs.	26 Obs.	27 Obs.

Obs.: Observation
Train: Training

AUTOBIBLIOGRAPHICAL STATEMENT

Bruce Paul Klein was born in Greenwich, CT on January 22, 1953, the son of Mary and Ralph Klein. He graduated from Quinnipiac College, Hamden, CT, in May 1974 with a B.S. in Physical Therapy. As a physical therapist with the United States Public Health Service from 1976-1981, he was stationed in New York City, Norfolk, VA, and Morgantown, WV. While in New York, he completed an M.A. in Kinesiological Research at New York University.

While a physical therapist with the PHS, he was actively involved in clinical research and co-authored several papers which were presented at local, state and national professional meetings.

Currently, he is enrolled in Medical School at West Virginia University.

Publications

Klein, B.P., Jensen, R.C., and Sanderson, L.M.; "Assessment of Workers Compensation Claims for Back Strains/Sprains." Journal of Occupational Medicine 26 (June 1984): 443-7.