

**LONG-TERM EFFECTIVENESS OF “ZERO-
LIFT PROGRAM” IN SEVEN NURSING HOMES
AND ONE HOSPITAL**

Arun Garg
Industrial & Manufacturing Engineering
University of Wisconsin – Milwaukee
P.O. Box 784
Milwaukee, WI 53021

Contract No. U60/CCU512089-02

U.S. Department of Health & Human Services
Center for Disease Control and Prevention
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45226

August 16, 1999

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ACKNOWLEDGEMENTS

A number of people contributed a great deal of time and effort to bring this study to completion. The author is grateful to all nursing personnel, management and their parent companies for their participation in this study, for sharing information, valuable data and spending endless hours with the author. Their names are being withheld to safeguard their identities.

The author would like to recognize Drs. Vern Putz-Anderson, Tom Waters and Traci Galinsky of the National Institute for Occupational Safety and Health who provided continued encouragement and support for the author's endeavors over the last four years.

A special note of thanks is extended to Dr. Brian T. McMahon without whose enthusiasm and cooperation this project would never have been completed.

The author is also appreciative of the tireless efforts of the staff of the Ergonomics Laboratory of the University of Wisconsin – Milwaukee, among them: Jay Kapellusch, Bradley Schworer and Phillip Vasquez for assisting in data collection, analysis and report preparation.

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ABSTRACT

The primary objective of this study was to reduce injuries to health care workers resulting from manual lifting and transferring of patients. The “zero-lift programs”, using employee-management advisory teams (participatory-team approach), were implemented in seven nursing homes and one hospital. The eight facilities varied in number of beds (mean = 145, range = 85-253) and number of nursing personnel (mean = 94, range = 57-136). All eight facilities had a large number of acute care patients.

The “zero-lift programs” were implemented by replacing manual lifting and transferring of patients, with modern, battery operated, portable hoists and other patient transfer assistive devices. Ergonomics committees with nearly equal representation from management and employees selected the equipment and implemented the “zero-lift programs.” Injury statistics were collected during post-intervention for 51 months (range = 36 – 60 months) and were compared with pre-intervention data for 37 months (range = 30 – 54 months). The number of injuries from patient transfers decreased by 62% (range = 39% - 79%), lost workdays by 86% (range = 50% - 99%), restricted workdays by 64% (96% decrease to 17% increase), and workers’ compensation costs by 84% (range = 53% - 99%). Overall, the eight facilities experienced decreases of 32% in all injuries, 62% in all lost workdays, 6% in all restricted workdays, and 55% in total workers’ compensation costs.

The program produced many intangible benefits including improvements in patient comfort and safety during transfers and patient care. The nursing personnel perceived their backs were less sore and they were less tired at the end of their shifts. More pregnant and older workers were able to perform their regular duties and stay on the job longer.

1. INTRODUCTION

Several studies have documented a high prevalence of low back pain among nursing personnel (Cust et al. 1972, Dehlin et al. 1976, Stubbs et al. 1983a,b Klein et al. 1984, Videman et al. 1984, Biering-Sorensen 1985, Jensen et al. 1989, Personic 1990, Garg and Owen 1992, Bureau of Labor Statistics 1994, Guo et al. 1995). Also, within the nursing personnel group, nursing assistants in long-term care facilities are at greatest risk for back injuries (Klein et al. 1984, Valles-Pankratz 1989, Personic 1990, Bureau of Labor Statistics 1993). Based on workers' compensation claims for back injuries, nursing aides and practical nurses were ranked fifth and ninth, respectively among all occupations (Klein et al. 1994, Bureau of Labor Statistics 1994). These studies also reported that the nursing aides are at a higher risk for back injuries than construction laborers, lumbermen, material handlers and non-specific laborers. Further, the injury and illness incidence rate for nursing home workers increased from 10.7 in 1980 to 18.2 in 1992 (Bureau of Labor Statistics 1994). Some nurses believe that low-back pain is an inevitable part of nursing practice (Owen 1987).

Lifting and transferring of patients have been reported to be the most common causes or precipitating factors for low back pain (Ferguson 1970, Bell et al. 1974, 1979, 1984 Dehlin et al. 1976, Stubbs et al. 1981, Jensen et al. 1985, 1990, Harber et al. 1986, Venning et al. 1987, Owen 1985, 1987, Owen and Garg 1989, Estrya-Behar et al. 1990, Personic 1990, Garg et al. 1992, Fuortes et al. 1994, Yassi et al. 1995, Smedley et al. 1995, Garg 1996, Knibbe and Friele 1996). Workers' compensation records show that more than 73% of the back strain/sprain cases are reportedly triggered by these tasks (Jensen et al. 1985). Based on data from three different nursing homes over a three year period, Garg (1995) reported that manual lifting and transferring of patients accounted for 84% of reported injuries, 86% of all lost and restricted workdays, and 81%-93% of workers' compensation costs. Other studies using questionnaires have reported even higher percentages for patient handling as the primary cause for back pain (Stubbs et al. 1981, Owen 1987). Also, nurses and nursing aides believe that, of all the tasks performed by them, patient handling activities are most likely to result in low-back pain (Harber et al. 1989, Owen and Garg 1989, Garg et al. 1992). Owen and Garg (1989) and Garg et al. (1992) reported significantly higher ratings of perceived exertion for patient transfers than for non-transfers.

A few studies have reported high levels of biomechanical stresses induced by patient lifting and transferring tasks (Stubbs et al. 1983, Torma-Krajewski 1986, Gagnon et al. 1986, Garg et al. 1991 a,b, Garg and Owen 1992, 1994, Garg et al. 1992, Marras et al. 1999). Indeed, Bell 1984, Videman et al. 1984, Harber et al. 1985, Stubbs et al 1986, Lloyd et al. 1987, Jensen 1990, Garg and Owen 1992, Standard Association of Australia Vasiliadou et al. 1995, Garg 1996, Knibbe and Friele 1996 have concluded that the primary approach for reducing low back pain should be reducing back stresses to nursing personnel.

Often nursing personnel, and nursing aides in particular, lift and move patients whose weights range from 37 kg to over 100 kg (Carlson 1989, Garg et al. 1992). These weights are considerably greater than the physical strength of most female workers (Carlson 1989, Garg and Owen 1991 a, b; Snook and Cirrello 1991, Garg et al. 1992, Waters et al. 1993,

Garg and Owen 1994) (Table 1). In addition, lifting of these patients produces high compressive forces on low back (Gagnon et al. 1986, Garg and Owen 1991a,b, Garg et al. 1992, Garg and Owen 1994; Marras et al. 1999) (Table 2). Further, patients can be combative, heavily contracted and/or uncooperative (Carlson 1989, Garg et al. 1992). Some patients are unpredictable and may suddenly resist movement, grab the nursing aides and throw them off balance during the transfer. This produces sudden and unexpected stresses to the body. Shape of the load (patient) is awkward for lifting and often optimum body postures cannot be assumed due to space limitations, equipment interference, and unadjustable chairs, commodes and beds, etc. Patients are not compact objects, weight is not evenly distributed, and they are difficult to grasp. These realities prevent nursing personnel from always using the ideal body mechanics they have been taught. Figure 1 summarizes the problem faced by nurses and nursing aides when lifting and transferring patients. Most programs for prevention of back injury to nursing personnel tend to focus on proper lifting techniques, body mechanics and back care (Hollis and Waddington 1975, Iveson-Iveson 1979, MacMillan 1979, Owen 1980, Raistrick 1981, Fletcher 1981, Scholey 1984, Greenwood 1986, Garg et al. 1991 a, Lagerstrom et al. 1998). However, there is lack of consensus on proper lifting techniques. Often methods acceptable in one health care institution are not considered appropriate in others (Standard Association of Australia 1982, Venning 1988). While there is intuitive appeal and widespread use of such techniques, effectiveness has not been demonstrated in nursing practice (Dehlin et al. 1976, Buckle 1982, Stubbs et al. 1983, 1986, Owen 1985, and Garg et al. 1992). Consequently, some experts believe that training in proper body mechanics and patient handling procedures should not be relied upon as the only or the primary component of a back injury prevention program (Figure 2) (Dehlin et al. 1976, Buckle 1982, Stubbs et al. 1983 b., Owen 1985, Lloyd et al. 1987, Wood 1987, Venning 1988, Garg et al. 1991 a, b, Garg and Owen 1992, Garg et al. 1992, Garg 1996, Garg 1999).

Many researchers have recommended an ergonomics approach for reducing stresses to the low back for jobs requiring lifting and transferring of patients (Dehlin et al. 1976, Bell 1984, Harber et al. 1985, Stubbs et al. 1986, Videman et al. 1984, Lloyd et al. 1987, Owen 1987, Jensen 1990, Garg et al. 1991 a, b, Garg et al. 1992, Garg and Owen 1992, Garg 1996). Ergonomics approach, instead of focusing on the behavior of workers, seeks to design and modify work so the physical and mental demands of the tasks are within the capabilities of the workers. Indeed, a few studies have shown the effectiveness of ergonomics approach in reducing both incidence and severity of low-back pain among nursing personnel (Garg and Owen 1992, Knibbe and Friele 1996, Garg 1996). For example, Garg and Owen (1992) reported that with the implementation of a zero lift program the back injury incidence rate decreased from 83 to 47 and there were no injuries resulting in lost or restricted workdays during the last four months of the post-intervention. However, the authors recommended large-scale studies should be performed involving different nursing homes to confirm their findings.

Table 1: Maximum acceptable weights for female and male workers (Snook et al. 1991)

Percent Capable Population	Maximum Acceptable Weights (lbs.)	
	Females	Males
90%	31	51
75%	35	68
50%	39	86
25%	46	103
10%	51	121

Table 2: Estimated compressive force on low back for transferring residents from wheelchair to bed (Garg et al. 1992)

Patient Weight (Percentile)	Estimated Compressive Force (lbs.)
25 th	993
50 th	1084
75 th	1143
90 th	1252

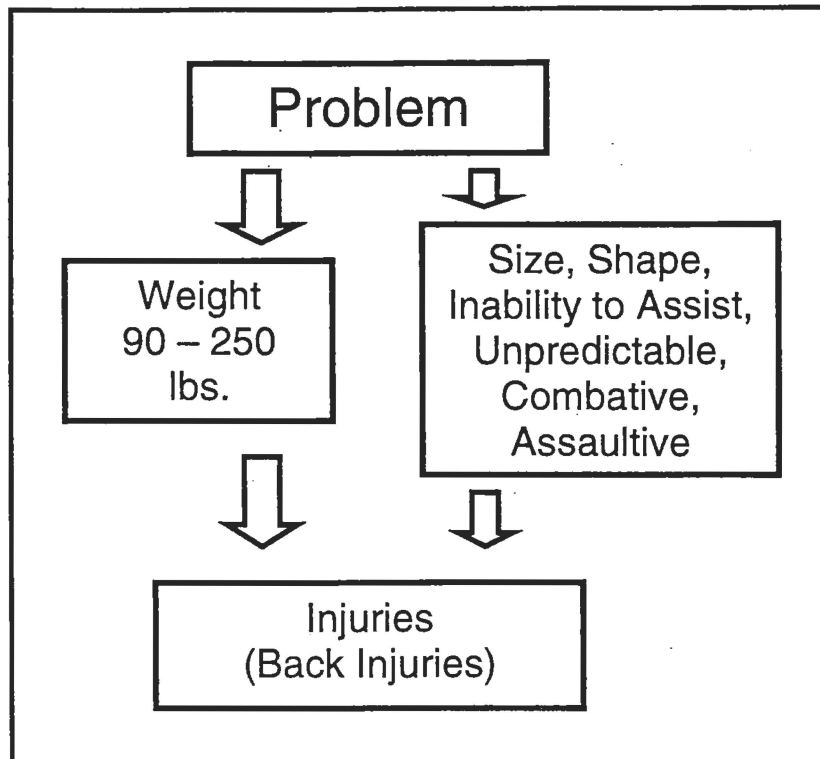


Figure 1: Object weight, size, shape and unpredictability make patient transfer tasks much more difficult (Garg 1999)

- Good body mechanics reduces stresses on the back.
- However, if the job is intrinsically unsafe, no amount of training on “safe lifting techniques” will make the job safe.

Figure 2: Why body mechanics is not enough (Garg 1999)

The objective of this study was to demonstrate the effectiveness of participatory approach in preventing musculoskeletal disorders among health-care workers. In particular, the objective was to determine the effectiveness of the participatory approach in implementing ergonomics controls to reduce overexertion injuries from manual lifting and transferring of patients experienced by nurses and nursing aides employed by long-term health care facilities and hospitals. The primary ergonomics controls focused on creating a manual lift-free environment – where modern patient transferring and repositioning devices took the place of manual lifting. The hypothesis was that if used regularly and consistently, these devices would significantly reduce the number of injuries caused by patient transfer, the resulting lost workdays and the workers' compensation costs.

2. PARTICIPATORY APPROACH

The term “participatory approach” generally means worker involvement (Cohen 1994). The rationale for worker participation includes improved worker motivation and job satisfaction, added problem-solving capability, greater acceptance of change, and greater knowledge of work and organization (Cohen 1994). Levels and forms of participation include quality circles, labor-management committees, work teams and gain sharing (Cohen 1994). To address workplace hazards, companies have employed joint labor-management safety and health committees, work teams, direct worker input in hazard control, and worker participation in ergonomics problem-solving (Cohen 1994). Some of the factors that determine the effectiveness of worker participation include management commitment, management/worker training, composition of teams, information-sharing, activities/motivation and team evaluation.

When a group of workers is asked to change established routines, a reluctance to change is often encountered (Garg and Owen 1992, U.S. Dept. of Health and Human Services 1994). Their refusal to adopt a work procedure could reflect an unanticipated problem with the recommendation. For example, in some nursing homes where hoists, sliding boards and other patient transferring equipment were provided, they were seldom used (Bell 1984, Takala and Kukkonen 1987, Garg et al. 1992, Garg et al. 1992). No matter how sound engineering and/or administrative controls are, they will not be effective in reducing safety, health and ergonomics hazards if they are not used. Using an employee-management advisory team concept, Garg and Owen (1992) reported an acceptability rate of 81% to 96% for recommended ergonomics procedures in a nursing home.

Several studies have demonstrated that a participatory approach, i.e., worker involvement in decision making, information sharing and team-problem solving leads to greater acceptance of a change and reduces resistance to change (U.S. Dept. of Health and Human Services 1994). Key elements of worker participation are summarized in Figure 3. Employee-management participation in an advisory team improves communication (Moore and Garg 1994). An opportunity to provide input into decision making affecting their work methods leads to the perception of being an important part of the team and makes the work interesting and challenging to employees. Also, a participatory approach is recommended because often the employees have the most knowledge about their work and the associated problems; they can provide a relatively simple solution to resolve a seemingly difficult problem.

2.1 Participatory Approach in Nursing Homes

The two key elements of a successful ergonomics program are (i) management commitment and (ii) worker participation. Management commitment includes providing financial and organizational resources. Financial resources include providing a safe workplace, appropriate patient transferring devices and other equipment, as well as adequate staffing to manage the ergonomics programs. Organizational resources include providing an ergonomics coordinator; adequate staff; assigning responsibilities; training, monitoring, feedback to employees; injury investigation and medical management; etc. (Figure 4).

- Hazard identification
(Identifying most stressful tasks)
- Control evaluation
(Evaluation of solutions to problems, including patient transferring procedures and devices)
- Selection of controls
(Selecting most effective procedures and device)
- Control implementation
(Implementing the safety program)
- Injury investigation
- Equal partners
(Make employees take ownership of the program as much as possible)

Figure 3: Important aspects of worker participation in implementing an ergonomic program (Garg 1999).

Obviously, without management's commitment, ergonomics controls cannot be implemented. Figure 5 summarizes key aspects of management's role to improve worker participation. The following are some of the reasons why worker participation is important in a nursing home environment:

1. Worker participation in all phases of the program (problem identification; control development, evaluation and selection; training; control implementation and evaluation) reduces resistance to change. This is especially true in nursing homes as engineering controls (patient transferring devices) take longer to make a transfer (90 seconds) than manual lifting methods (12 seconds) (Garg et al. 1991a, b, Garg and Owen 1992). *This increased time has been mentioned as a major concern for non-compliance with engineering controls* (Bell 1984, Takala and Kukkonen 1987, Garg et al. 1991).
2. *The average turnover rate for nursing assistants is 80%* (Garg 1999). Thus, training the new staff is a major problem. The nursing assistants play a crucial role in providing ongoing training to the co-workers.
3. Employee-management advisory committees lead to much better communication between management and nursing aides. Without effective communication between administrative staff, nurses and nursing assistants, management is often not aware of problems encountered by the caregivers in implementing controls:
 - a. Under "Residents Rights" a resident has the right to refuse the use of a specific equipment or procedure for transfer. Often an employee-management team is needed to resolve this problem.
 - b. Patient's physical and mental conditions change from day-to-day and from morning to afternoon. This requires a change in equipment choices by the nursing assistants. Changes in transfer requirements can only be made by employee-management advisory team.
 - c. Often there is equipment breakdown. Without employee participation, maintenance departments are not aware of broken equipment and that creates an equipment shortage.
 - d. Nursing homes are short on space. Equipment storage and battery charging need to be addressed by employee-management advisory team members.

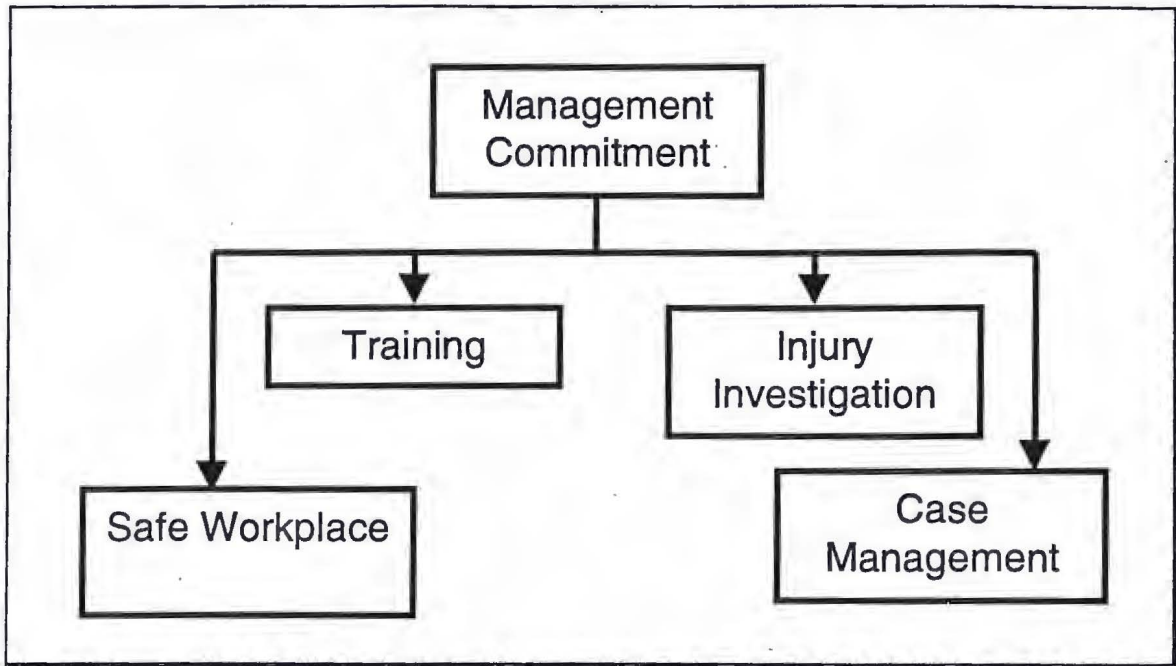


Figure 4: Required Management Commitment for participatory approach in nursing homes (Garg 1999).

- Encourage worker participation
If they feel confident, they will perform well.
Simple solutions to difficult problems
- Emphasize positive reinforcement.
Appreciate and respect them for achieving small goals.
- Seek workers' input prior to decision making.
- Communication
Provide information and feedback in a timely fashion
- Address workers' problems and concerns.

Figure 5: Management's role in worker participation
(Garg 1999)

4. *The program must provide ongoing training, monitoring, feedback and enforcement of safety rules.*
 - a. Transfers are generally made with doors closed to ensure patient privacy. There is a temptation to use a manual lifting method because it is faster.
 - b. Nursing aides are sensitive to patient likes and dislikes. They will often use a method that the patient likes, such as bear hug, even though it may be dangerous.
 - c. It takes time and frequent reminders to change old habits such as lifting in place of pulling with a walking belt.
5. There are always unforeseeable problems because the patient population is constantly changing. Some patients are very combative, some are highly spastic, some have very frail skin and some have severe deformities. While one person may not be able to solve a patient problem, a team usually finds a satisfactory solution.
6. Nursing assistants are reluctant to bring their problems to the attention of the management. An employee-management advisory committee provides a forum to discuss problems and share success.
7. When nursing aides encounter problems in implementing controls, charge nurses, if not involved in employee-management advisory teams may encourage them to forget the controls and use the old methods. Worker participation makes nurses and nursing aides aware of the program objectives and nursing aides are in a better position to say no to charge nurses.
8. About 95% of nursing aides are females employed in jobs with high physical and mental stresses. Wage rates are low, fringe benefits are few (generally no health insurance and pension plan), turnover rate is high (80%), and often there is a shortage of staff (unfilled positions). Most supervisory personnel are LPNs (2-year associate degree) with heavy workloads. Because of excessive patient care demands, generally safety and injuries to employees have low priority. In this environment a team approach to problem solving is probably the best practical solution.

3. PARTICIPATING NURSING HOMES AND HOSPITAL

In the fall of 1995 and early spring of 1996, seven nursing homes and one hospital were invited to participate in the study. All seven nursing homes and the hospital decided to participate in the study. All eight facilities were familiar with an earlier NIOSH study on nursing homes (Garg and Owen 1992). All the facilities already had (1) management commitment, (2) an established participatory-task force team, (3) recognized safety and health risks, and (4) developed and implemented ergonomics controls to reduce safety hazards especially from lifting and transferring of patients. This provided a longer post-intervention period to observe participatory-task force teams and collect injury data. A long post-intervention period was highly desirable, because (1) there is a large variability in injury statistics from year-to-year within a nursing home, (2) a few injuries in one year can substantially increase the lost workdays and workers' compensation costs, and (3) the program effectiveness can be determined after employees' initial excitement is over (Hawthorne effect).

All seven nursing homes were long-term care facilities. The hospital was a chronic care center. The eight facilities varied in number of beds and number of nursing assistants employed. The hospital was located in Canada and the seven nursing homes were located in four different states. The nurses and nursing aides were represented by a union in five out of eight facilities. Table 3 summarizes the eight facilities. Three (B, C and D) out of eight facilities were not-for-profit organizations and the remaining five were for profit organizations. In all facilities, resident (patient) mix included totally dependent, extensive assist, minimum assist, supervised and independent residents. All eight facilities, except A, employed full-time and part-time nurses and nursing assistants. In addition, they employed dietary workers, housekeepers, maintenance staff, and other personnel. The first four health-care facilities developed and implemented participatory task-force teams and ergonomics controls in-house, i.e., without seeking assistance from a consultant. The remaining four nursing homes used a technical consultant to develop and establish programs.

The investigators obtained consents of the participants, both management and employees. The investigators explained the study objectives to both management and employees. The investigators visited each facility two to ten times per year. They met with the participatory-task-force teams and attended the meetings. They learned how the tasks were targeted, teams were built, and controls were developed and implemented. The principal investigator took a tour of each facility with some of the team members. The team members identified the problems and the principal investigator discussed various solutions with the members. In addition, the principal investigator trained the team members on some of the more difficult patient transfers, answered their questions and concerns, and provided the team members with the information requested by them. During each visit the principal investigator met with the management (vice president, administrator, director of nursing, staff development coordinator, etc.). Each injury that appeared on OSHA 200 logs was discussed with management. In addition, injury statistics (OSHA 200 logs, employee incident reports, and insurance reports on workers' compensation costs) were obtained. Pre-intervention injury statistics were collected for at least 30 months and for longer periods wherever possible.

Table 3: Characteristics of the eight health-care facilities participated in the study.

Facility	Type	Union	Number of Beds	Total Number of Nursing Employees
A	Chronic care hospital	yes	124	136 ¹
B	Long-term care	no	125	90
C	Long-term care	no	120	87
D	Long-term care	no	85	76
E	Long-term care	yes	131	57 ²
F	Long-term care	yes	133	83
G	Long-term care	yes	189	100 ²
H	Long-term care	yes	253	125 ²

1. Registered and practical nurses. No nursing aides employed.
2. Nursing aides only. Data on number of nurses not available.

4. GENERAL OBSERVATIONS

4.1 Motivation for Establishing Participatory Task-Force Teams

The primary objective of all eight facilities was to reduce the number of injuries, lost workdays, and workers' compensation costs. Management of these health-care facilities believed that the employees should buy into health and safety program to be effective. They believed that the employees should be equal partners and should take ownership of the programs. They believed this would increase safety awareness among employees, improve communication between management and employees, have greater worker acceptance of ergonomics controls, make the program more effective, and focus on problems encountered by the employees. In addition, it would help in training and monitoring new and other employees in safe procedures.

4.2 Participatory Task-force Teams

In general, the participatory task-force teams consisted of 8-14 team members. About 50% of these members were nursing assistants representing different units and shifts. Some nursing homes had employees representing housekeeping, dietary and maintenance departments. The number of members and composition of the teams varied within a nursing home due to the high turn over rates of both employees and management. Changes in management philosophies and commitments at the local level affected participation and effectiveness of these teams. Often the administrator, director of nursing, staff development coordinator, and maintenance supervisor participated in the meetings. The teams usually met once a month for about one-hour. Written minutes of meetings were maintained.

4.3 Training of Team Members to Recognize Safety and Health Risks

The administrators, directors of nursing, persons in charge of health and safety, and senior nurses had attended various seminars on health and safety issues, including lifting and transferring of patients. In some nursing homes a few of the nursing assistants also attended seminars on lifting and transferring of patients. The staff in the eight health-care facilities did not receive any structured training on basic ergonomics because of this project.

4.4 Task Targeting

Both the management and the employees believed that manual lifting and transferring of patients were the most hazardous tasks in their facilities. This belief was confirmed by injury statistics (number of injuries, lost workdays and workers' compensation costs). The targeted tasks included lifting and transferring patients from bed to wheelchair (wc); wc to bed; bed or wc to toilet; toilet to bed or wc; lifting patients off the floor; bed or wc to bathtub, shower chair or gurney and back; weighing patients; and bathing. In addition, some nursing homes also targeted repositioning in bed and wheelchair.

In addition to patient transferring tasks, the participatory task-force teams discussed other hazards that were brought up in the meeting. Other hazards were discussed if either a committee member noticed an unsafe situation and brought it for discussion in the committee or there was a recent injury. These hazards included slips and falls, patient assaults, and unsafe conditions in dietary and housekeeping departments. However, as stated earlier, lifting and transferring of patients was by far the most frequent and most serious hazard in the nursing homes and the hospital.

4.5 Development and Implementation of Controls

All seven nursing homes and the hospital implemented a wide variety of engineering controls. The primary patient transferring devices used in the eight health-care facilities were different types of battery operated, portable total lift hoists both with and without weighing scales and sit/stand hoists. In addition, the hospital A and nursing homes E, F, G and H also had walking belts with handles, shower chairs, shower gurney, ramp-type weighing scales, and devices to reposition patients in beds. The hospital A also had a few ceiling mounted hoists. All nursing homes except D also had modern bathtubs. The eight health-care facilities used different manufacturers for patient transferring devices. Examples of total lift hoist, sit/stand hoist, walking belt with handles, shower chair, ramp type weighing scale, and repositioning devices are shown in Figures 6 to 10.

The nursing homes and the hospital invited different vendors to demonstrate their equipment. The participatory-task force teams evaluated these devices. In most cases, vendors for those devices that appeared to be promising were requested to temporarily provide the patient transferring devices for further evaluation by the participatory task-force teams. The evaluation period ranged from two to four weeks.

The vendors trained the participatory task-force team members in the use of selected patient transferring devices in hospital A and nursing homes B, C and D. The investigators provided training to the participatory task-force team members in nursing homes E to H. In addition, the investigators provided additional training on difficult patient transfers such as transferring patients out of a car to a wheelchair, transferring patients from low beds, repositioning in bed and wheelchair, and transferring patients with broken hips, etc. in nursing homes B and C. The investigators also assisted all nursing homes except A and D with health and safety problems in housekeeping and dietary departments.

The staff development coordinators and the members of the participatory task-force teams were responsible for training both new and all other nurses and nursing assistants in proper use of patient transferring devices. In general, the health-care facilities did not have a formal program for monitoring the use of these devices.

There were a few instances where a patient refused to be transferred using an assistive device. In these instances, a team of 3 to 4 nurses and nursing assistants approached the patient, calmed the patient down, explained the institution's policy on patient transfers, explained the advantages of using the patient transferring device to the patient, and transferred the patient with his/her approval on a trial basis. Practically all patients accepted to be transferred by appropriate patient transferring devices.

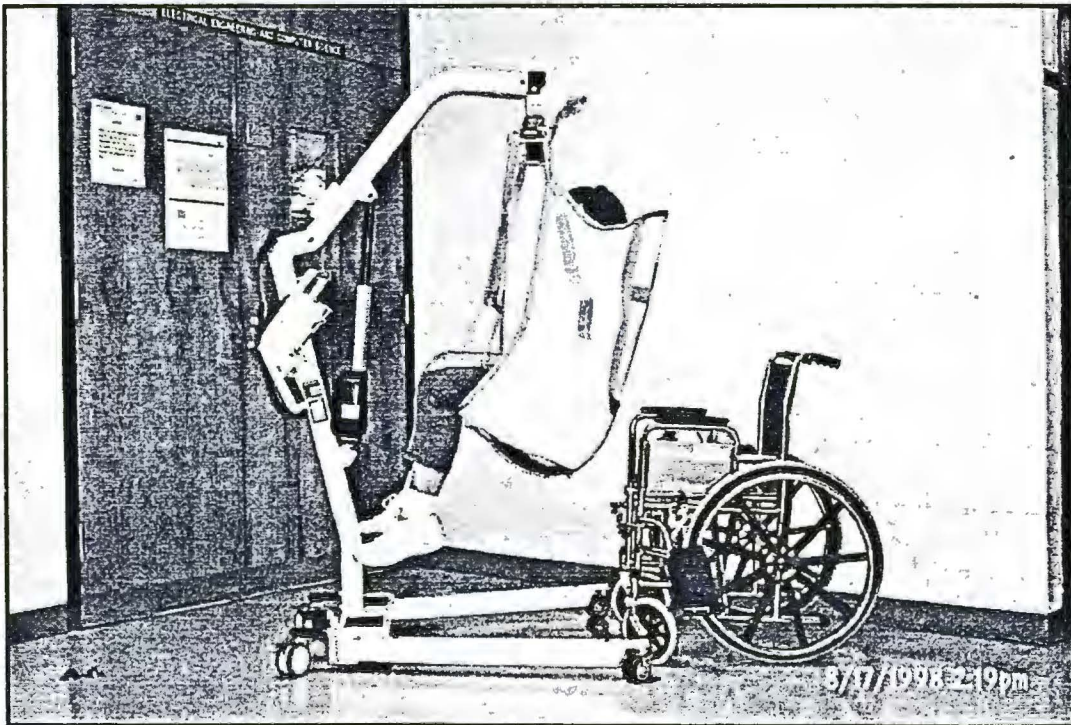


Figure 6: An example of a total lift hoist used by the nursing homes.

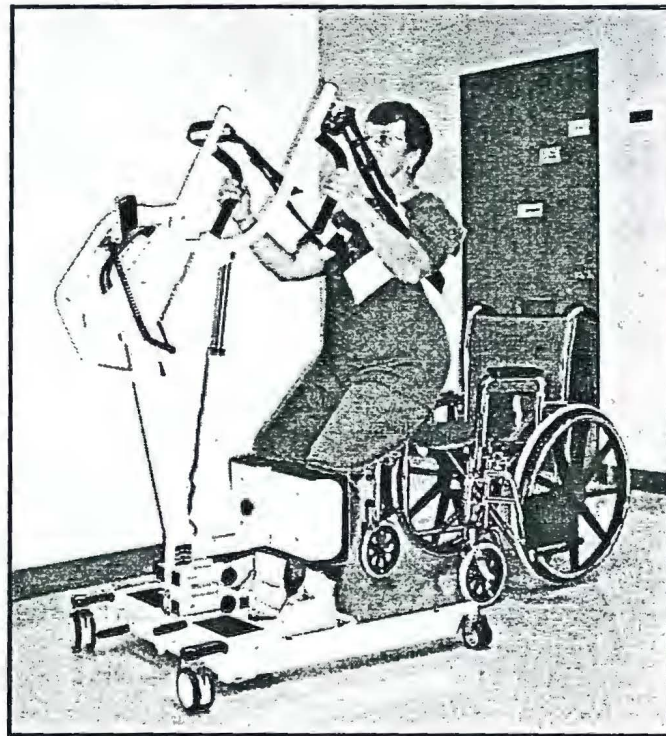
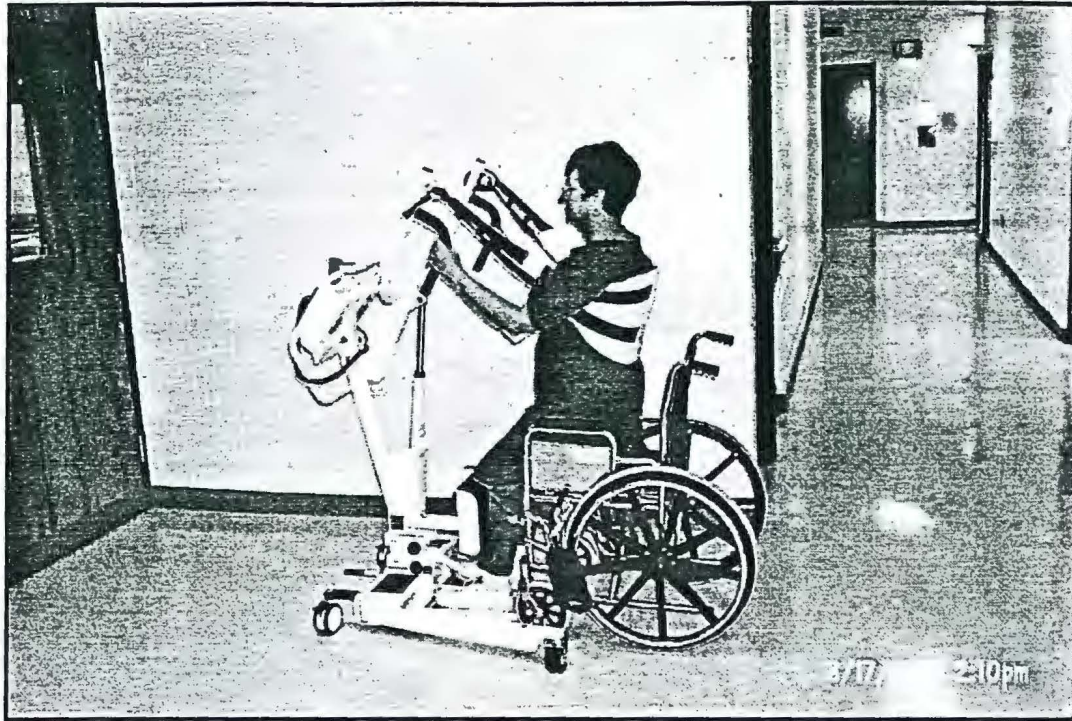


Figure 7: An example of a sit/stand hoist used by the nursing homes.

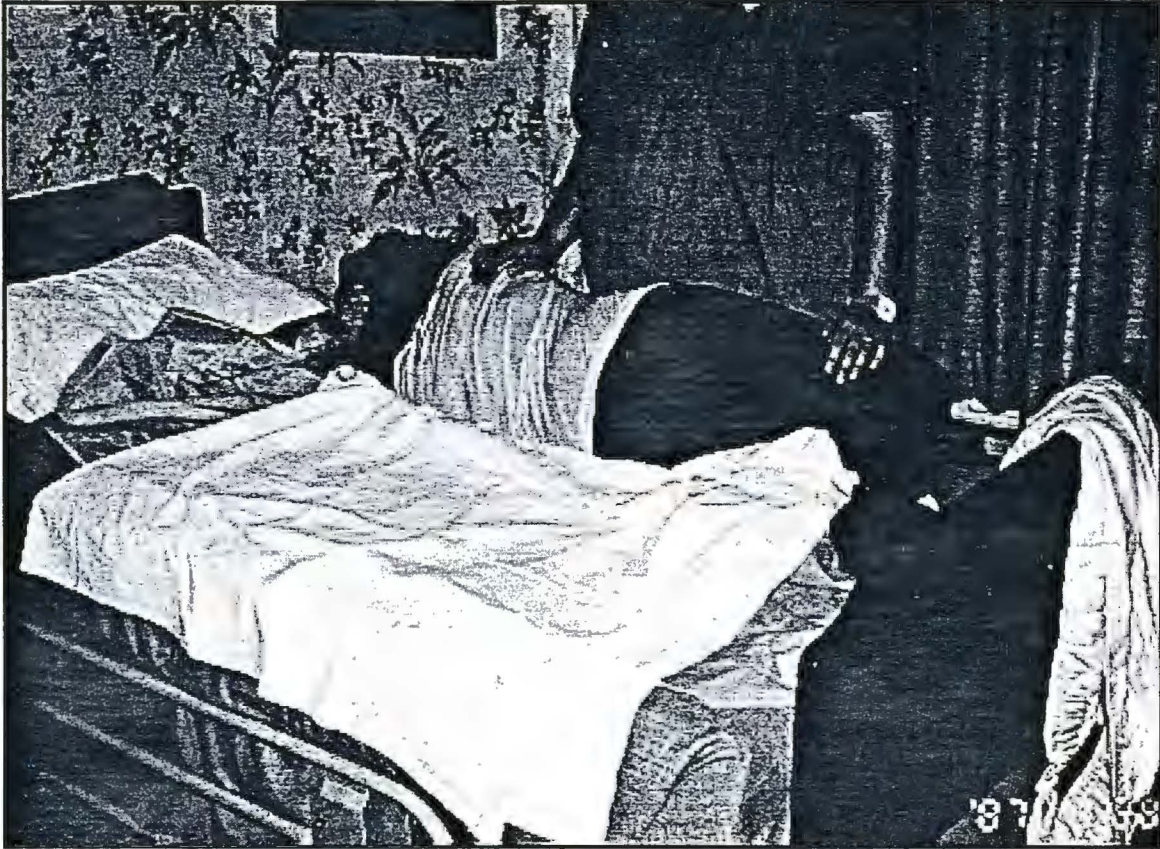


Figure 8a: Application of the device to re-position a patient in a bed



Figure 8b: continued, repositioning device to move patient up in the bed.

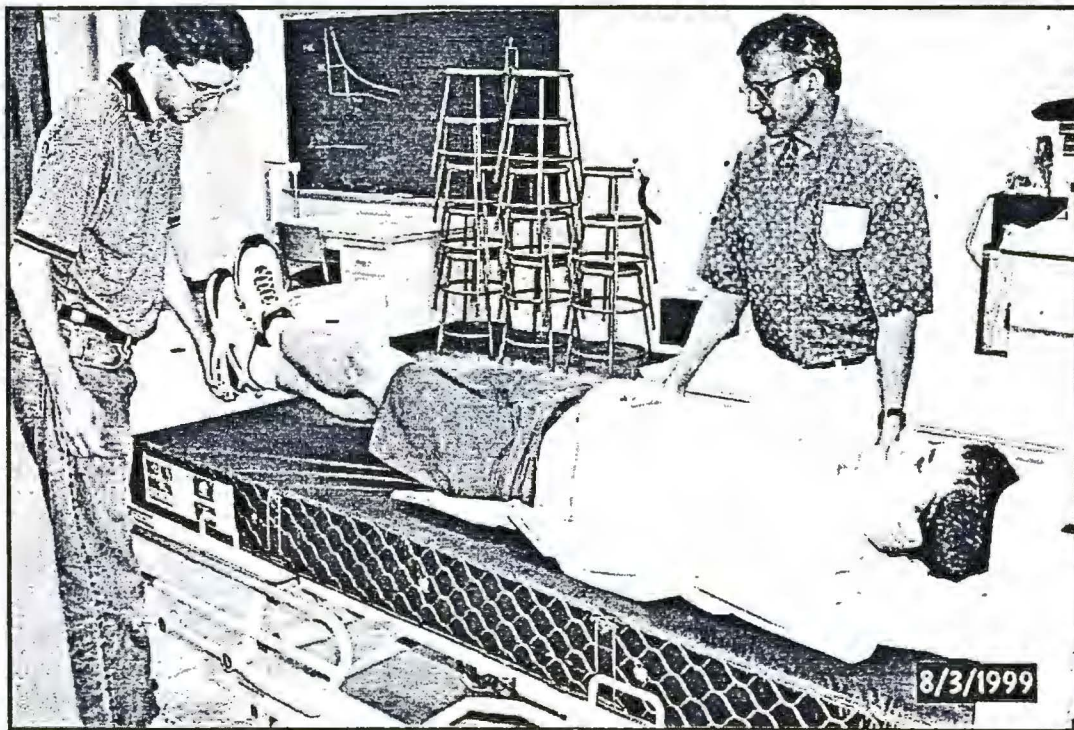


Figure 8c: continued to show use of repositioning device to straighten the patient in the bed.

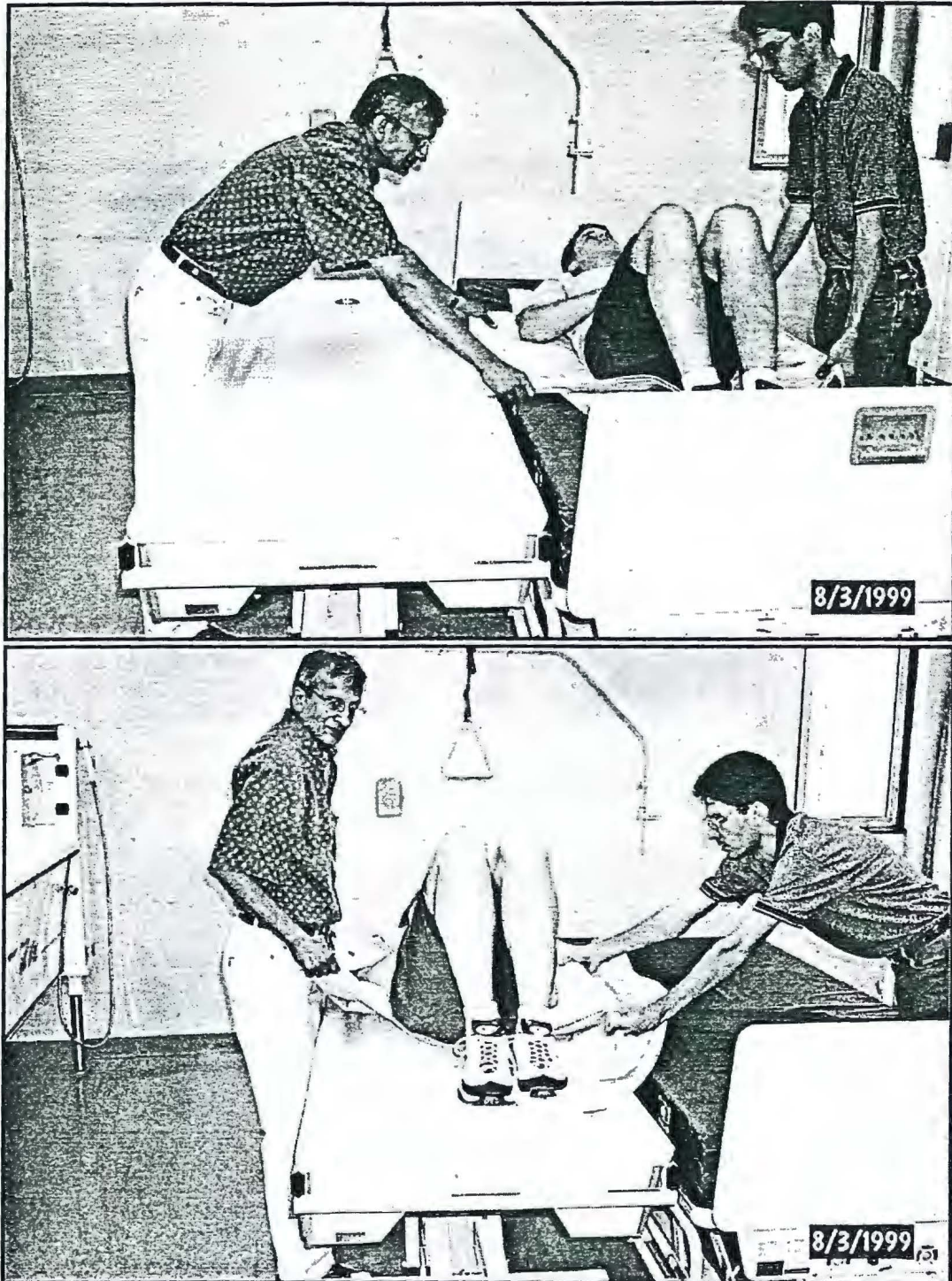


Figure 8d: continued to show use of repositioning device to transfer the patient from a bed to a stretcher.

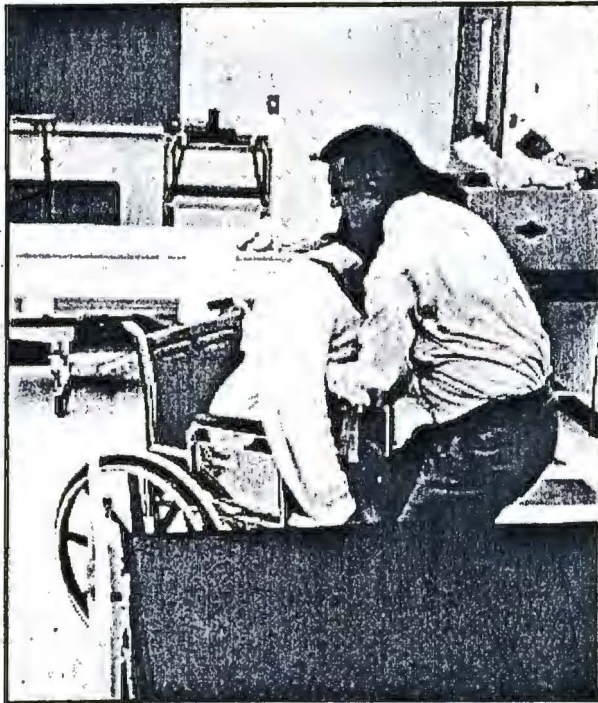


Figure 9a: Walking belt used by one person to transfer patient from wheelchair to bed.



Figure 9b: Walking belt used by two people to transfer patient from bed to wheelchair.

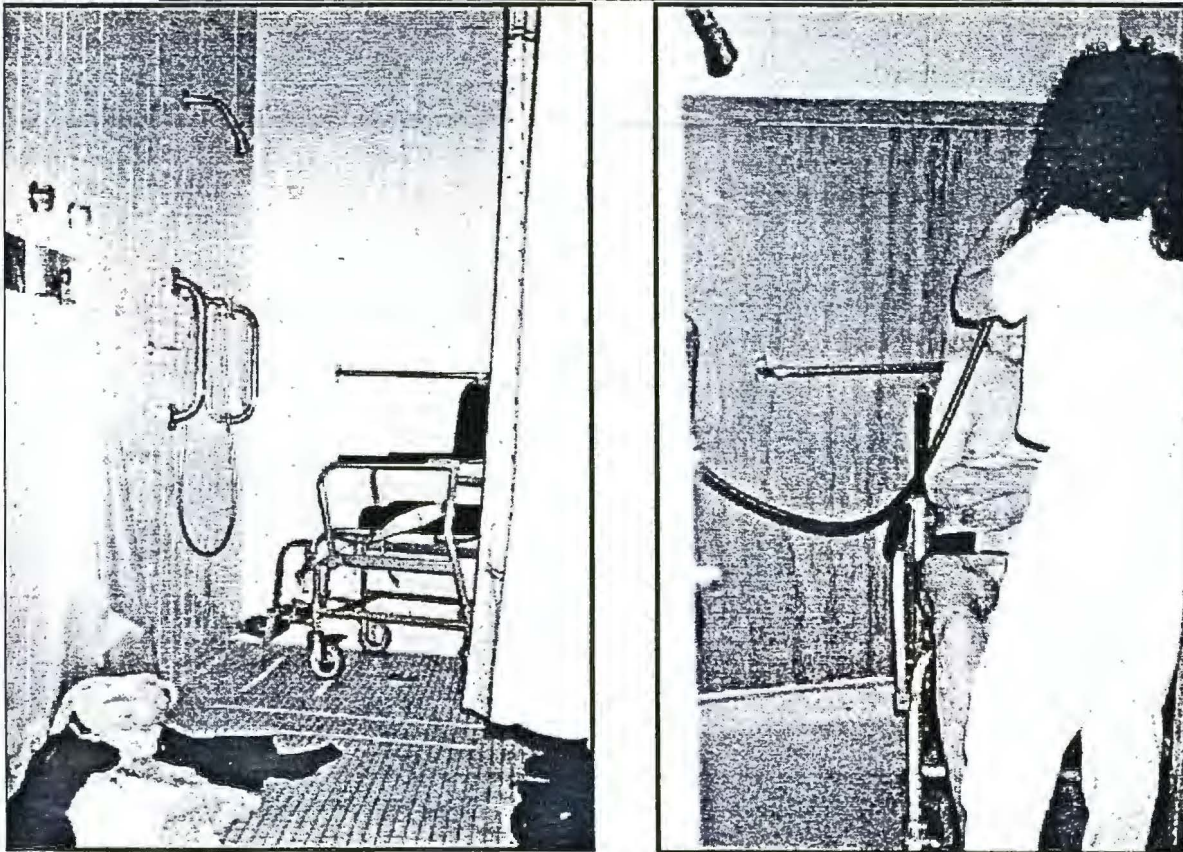
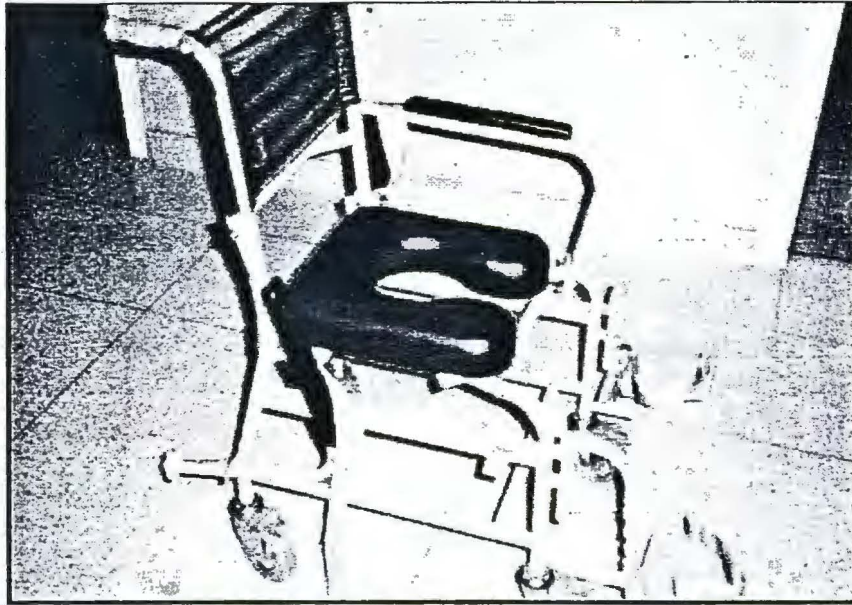


Figure 9c: Use of shower chair for bathing patients

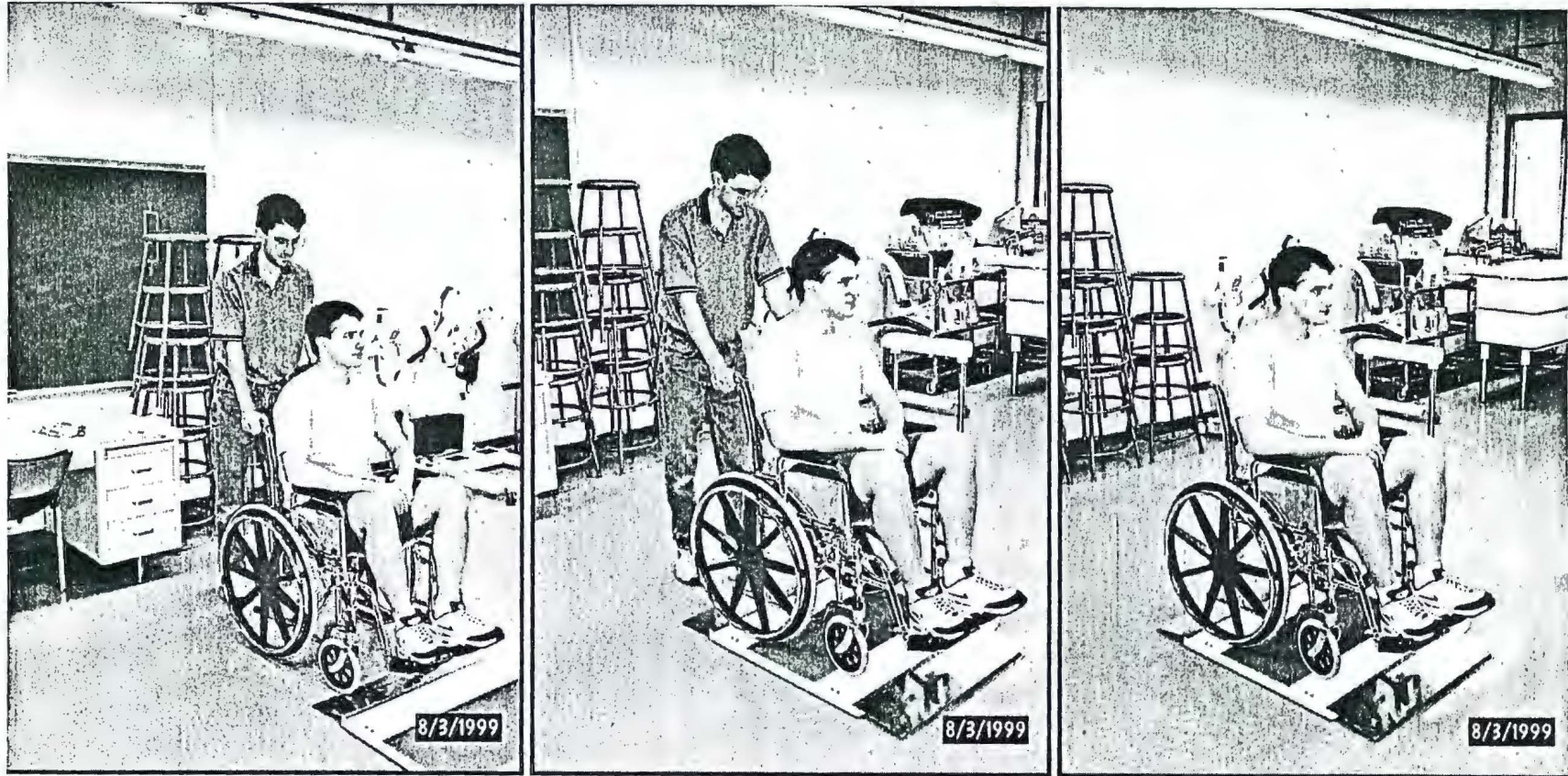


Figure 10: Ramp type weighing scale to weigh patient while in wheelchair

5. DEVELOPMENT OF ZERO-LIFT PROGRAM IN EIGHT HEALTH CARE FACILITIES

5.1 Hospital A

The facility, A, was a 124 bed chronic care hospital. The chronic care center in the hospital had 3 chronic care units with 102 beds and 1 rehabilitation unit with 22 beds. The vast majority of chronic care patients (102) needed to be transferred. The hospital employed 136 registered nurses and registered practical nurses (53 fulltime and 83 part-time). While the registered practical nurses performed the majority of patient transfers, both were involved in patient transfers. The hospital employed a total of 267 employees including fulltime and part-time. In March 1992 the hospital reformed the Back Care Team and developed a "State of the Art" Back Care Program. The team members developed an extensive policy/process and developed a "Train the Trainer" model. Even with all the education and training, there was an increase in overexertion/strain injuries from 1992 to 1993. The Back Care Team decided to follow an ergonomics approach to reduce stresses to the nurses using the University of Wisconsin-Milwaukee Study (Garg and Owen 1992). In the summer of 1994, the Back Care Team tried and evaluated several different patient transferring devices by arranging an "Equipment Fair." Seven companies displayed patient transferring devices and 100 people attended the fair (senior management, managers, staff, patients, and guests). As a follow-up, equipment trials were conducted in the summer of 1994. Both staff (nurses, physical and occupational therapists, occupational health personnel) and patients participated in the trials. Physical stresses associated with manual lifting and transferring of patients were rated "somewhat hard to hard" and with equipment "very light to light" (Borg 1962). The equipment was demonstrated to the Board of Governors and a proposal was submitted. On September 15, 1994, the Board of Governors accepted the proposal.

In-servicing was initially done by the vendors in the fall of 1994. The Back Care Team provided in-servicing as needed. The Back Care Team included occupational health nurse, registered practical nurses, physiotherapist, occupational therapist, assistant executive director of nursing, and representatives from housekeeping, maintenance, dietary and staff education departments. The equipment cost was \$62,000 (Canadian). This included portable, battery operated total lift hoists with weighing scales, sit/stand hoists, slide transfer sheets, slide turning sheets, transfer discs, transfer boards, roll boards, transfer belts, and ceiling mounted hoists.

Some noteworthy aspects of the ergonomics programs were that the employees were empowered in determining necessary equipment to improve quality of work life. Both employees and patients were involved in evaluation of equipment. The hospital demonstrated the commitment by a visible show of support from administration and the Board of Governors. The staff's reaction to the equipment was very positive. Some comments included: "reduced fatigue," "reduced stress," "equipment user-friendly," "improved patient care," and "the hospital does care about us and reducing injuries." The hospital was able to bring back three nurses with permanent impairment of the back. All three stated that they would not have been able to work without the equipment. Also, the employees indicated that they felt less fatigued after work. Management believed that there

was an improvement in patient care as well as patient safety. Some of the patients had said “how wonderful it is.”

5.2 Corporation B

Corporation B was a non-profit organization with over 1400 employees. It had four divisions: medical center (hospital with 1025 employees), physicians office practice (65 employees), parent company (27 employees), and long-term care (300 employees). The long-term care was divided into four units: child day care, Alzheimer’s boarding home, and two nursing homes (B and C). The two nursing homes employed 250 people. Most of the musculoskeletal injuries occurred in the two nursing homes. Therefore, the most ergonomics efforts were directed toward the two nursing homes and to a limited extent toward the hospital.

The nursing home B had 125 beds and C 120 beds. Both nursing homes were divided into three units. Both the nursing homes had Alzheimer’s, dementia, skilled care, psychiatric, Medicare and Medicaid patients. There were very few private-pay patients. The nursing home B had 90 nursing employees (72 FTE) and C 87 employees (75 FTE).

Safety began in 1990. The long-term care unit reinstated safety committee and started meeting on a monthly basis with the goal of decreasing accidents by a stated percentage. The management started preparing monthly reports and gathering statistics. The long-term care unit had safety walk through inspections performed by the State Bureau of Labor and the insurance company. The manager of employee health for the corporation implemented a new accident reporting system and began reviewing all accidents/illnesses with a corrective plan of action. The medical director started seeing injured employees on a weekly basis. A health and safety questionnaire survey was done for the long-term care as well as the medical center housekeeping. Physical and occupational therapists performed site evaluations for numerous employees. In 1991, the corporation expanded and implemented modified duty (light duty) program in many departments. A modified duty task list was developed for registered nurses, certified nursing assistants and housekeeping personnel. Employees returning to work after any lifting related injury received further instructions on back care and lifting techniques through physical therapy department at the medical center. Organizationally, the corporation began a self-insurance program (50%) in 1991 and became fully self-insured in 1992.

In 1992, the corporation formed a work site evaluation committee and began work site evaluations. The long-term care division organized a seven day safety program with a hands on component attended by the employee health manager, nursing home administrators, directors of nursing, and employees. At the end of the program, the management concluded that manual lifting of patients was hazardous. The employee health manager and other management personnel attended a seminar titled “An ergonomics approach for preventing back injuries in nursing homes and hospitals,” given by Arun Garg. The presentation lent credibility that (i) mechanical lifting devices were needed and (ii) employees must be involved. In 1993 the company spent 6-8 months on how to implement mechanical lifting devices and started investigating different lifting devices. The core group (4-5 certified nursing assistants and two administrators) of the safety committee evaluated every unit in

each shift in each nursing home and different patient transferring devices. They kept the devices for 3 months to learn and gain confidence. The employees and the management (including chief executive officer) held a community fundraiser and collected \$60,000 to purchase patient transferring equipment. The company set two goals: (i) reduce patient transferring incidents (short term goal) and (ii) create safe and healthy work environment through staff participation (long term goal). Finally, lifting devices and patient weighing scales were purchased in December of 1993 and all employees were given in-services by the safety committee in January 1994. New bathtubs were purchased in 1995. The assistive devices for repositioning in beds and for horizontal transfers in hospital (for example, bed to stretcher) were implemented in 1996.

In 1993, the state passed a new workers' compensation law. The employees were required to see a company designated physicians for the first 10 days. The injured employee could change physicians only twice per injury. Lastly, in case of litigation the injured employees had to pay for their attorneys even if the employer lost the case.

The long-term care unit improved the modified duty program in 1995. Management started putting employees on restricted duty even though the employee had not seen a physician. This was considered a preventive measure to avoid serious injuries.

The safety committee met once a month. The safety committee was divided into four subcommittees. These were: lifting committee consisting of 3 people from each nursing home, special project committee consisting of 5 people, recognition committee with 4 members, and a newsletter committee with 3 members. The newspaper was published once a month. The employee health manager played a very active role in the safety committee. The company had an ongoing agenda, which called for employee involvement in solving safety issues. Also, the company had a very major emphasis on prevention of injuries in the workplace.

5.3 Nursing Home D

Nursing home D was a non-profit, 85-bed facility. About 55-68 patients needed to be lifted and transferred. The nursing home had a total of 125 employees and 55 out of these were certified nursing assistants (FTE = 30). The total number of nursing employees was 76 (41.2 FTE).

The no lift program started in November 1992. In 1991, the director of nursing and two nursing assistants attended a presentation on reducing injuries in nursing homes by Arun Garg. The director of nursing and the nursing assistants were very impressed with the seminar. The nursing home was also expecting a critical shortage of nursing assistants. The existing nursing assistants were getting extremely tired and burnt out. The nursing aides were leaving, they could not be replaced, there was shortage of staffing, and everyone was having problems. The administrator and the director of nursing helped with patient care for 3 months due to the shortage of nursing aides. There were 19 nursing homes in a 25-mile radius.

Early in 1992, the administrator and director of nursing went out on the unit and worked with the nursing aides to see how much lifting they actually did. They were shocked to find that the nursing aides were doing between 30 and 60 manual lifts per day. The management asked themselves “what can we do to make their job not so strenuous?” Further, the patient population had changed over the last three years from intermediate care to more skill care. Management realized that the injuries were occurring because the nursing aides were tired. They started to see some mysterious injuries in the second shift. According to the management, these incidents were probably reported because employees wanted to take a few days off.

Early in 1992, the nursing home decided to pilot a “No Manual Lifting Program” when approached by the insurance company. Before deciding to proceed, however, the program was discussed in detail with the nursing aides. The administrator stated “I felt that if they weren’t going to support it, then implementing the program would be very difficult. We also made it clear that if we went into the program, we’d stick with it.” Meetings were also held with patients (residents) and their families to get their acceptance. The nursing aides, the patients and their families were very receptive and supportive of the program. However some patients were very resistive and did not want the equipment. With a lot of conversation they understood the need and were willing to go along. They realized that patients did not have the right to put employees at risk (residents’ rights versus employees’ safety). The nursing home lost 3-4 nursing aides when the program was initially implemented. The use of the patient transferring equipment was not an option and they did not want to use it. Initially nurses were made in charge of the program. The management soon realized that the nurses either did not have expertise or did not want to manage the program. They could not respond to nursing aides requests, for example, a change in patient transferring equipment for a patient. Therefore, a core group of nursing aides called “key operators” was made in charge of the program. The nursing aides felt they were a part of the program. The administrator and the director of nursing met with the key operators once a week for the first 8 weeks, then once a month for the first year. Later on, the meetings with the key operators were held once every 2-3 months. All new admissions were assessed by the key operators. The key operators were responsible for training new employees. For the first five days all new employees worked with one of the key operators. At least two key operators had to approve a change in transferring needs of the patient. If nurses or nursing assistants had questions, or had problems with a patient transfer they had to go to one of the key operators. A list of key operators was posted in each hallway and bathroom. Patients, patient roommates and co-workers monitored compliance with the use of patient transferring devices. They would inform the management or the key operators if the devices were not being used.

The nursing home surveyed nursing aides about the program one year after implementation. All but two of the facility’s nursing aides said the program was worthwhile. Perhaps the most telling indication of the program’s benefits was its impact on turnover. Before implementation of the program turnover rate was 150%. After implementation it dropped to 40%. For patients, no manual lifting resulted in fewer skin tears and bruises. According to both the management and employees use of the mechanical lifts had also been helpful in transferring combative patients.

The nursing home invested \$50,000 in the mechanical lifts. According to the administrator, “we figured out that, conservatively, it cost us \$300 to find and train a new nurse aide, at that kind of cost, if you’re turning over 100 people a year, as we were, you’ve pretty much paid for the equipment. You’ve also paid for the equipment if you prevent just one injury.” Before the implementation of “No Manual Lift Program,” the insurance premiums were \$170,000 per year. The premiums for 1995 and 1996 were \$76,000 and \$55,000, respectively. The experience modifier decreased from 1.3 to 0.6.

The equipment supplier helped assess the number and type of lifts needed and provided equipment at 0% interest loan. The equipment supplier also provided initial training in the proper use of the equipment.

5.4 Nursing Home E, F, G, and H

Nursing homes E, F, G and H were owned by a large corporation that operated approximately 160 nursing homes. The corporate office controlled all financial decisions and policies including patient transferring devices. The corporation was self-insured and an insurance company managed the workers’ compensation claims. The four nursing homes were located in two different states. The employees were represented by a union. The four nursing homes had a very high turnover rate for nursing personnel, staff development coordinators, directors of nursing, and administrators. The average turnover rate for nursing personnel was 80%. Three out of four nursing homes had three different administrators each over a four-year post-intervention period.

Nursing home E had 131 beds on three floors. It had a total of 71 full-time and 87 part-time employees. There were 21 full-time and 36 part-time nursing aides. It had Medicare, Medicaid, Alzheimer’s and stroke patients. About one-third of the patients were non-weight bearing, one-third weight bearing, and one-third were independent. Patient rooms and bathrooms on 2nd and 3rd floors were small and it was difficult to maneuver patient transferring equipment. There was very heavy reliance on recommendations from physical and occupational therapists for injury prevention (body mechanics, lifting technique, and use of gait belts).

Nursing home F had 133 beds distributed in five different units. There were a total of 137 employees (75 full-time and 62 part-time). Out of these, 83 were nursing personnel (62 certified nursing aides: 32 fulltime and 30 part-time). About 7% of the patients were ambulatory, 50% weight bearing, and 43% non-weight bearing. The vast majority of patients (80%-90%) required skilled or intensive care. In general, the patients were heavy, combative and resistive who intentionally stiffened up during transfers. Some patients suffered from Alzheimer’s disease or dementia. In addition, there was pressure from family members on nursing aides, i.e., their relatives should be cared first. Methods used to transfer patients were based on their likes and dislikes. For example, a number of patients refused to be transferred using an old mechanical lift because they were fearful of the equipment, and/or it was not considered to be a dignified method.

Nursing home G had 189 beds distributed in three units. There were a total of 143 full-time equivalent employees. Including 99 full-time equivalent nursing personnel. There were 100 certified nursing aides (56 full-time and 44 part-time). About 56% of the patients were totally dependent (couldn't bear weight), 10% required extensive assist (could bear weight), 8% limited care, and the remaining 26% were either supervised or independent. Some patients suffered from Alzheimer's disease; some were combative, unpredictable, and/or confused.

Nursing home H had a total of 253 beds on four floors. There were a total of 230 employees (190 FTE). Out of these, 125 (55 part-time and 70 full-time) were nursing aides. About 35% of the patients were totally dependent, 25% required extensive assistance, 15% limited assistance, and 25% were supervised or independent. One of the floors had young adult patients with head trauma, patients suffering from Huntington's, Lou Gehrig's or cardiovascular diseases. Most of these patients were in a permanent vegetative state. Another floor was a secured unit for patients with Alzheimer's or dementia. One floor was a geriatric unit. The nursing aides were initially trained by sales people. The existing nursing aides trained new nursing aides. No one was formally responsible for training. There were some injuries to patients. A couple of patients had slid out of the old mechanical lifts during transfers. There were bruises around ribs from gait belts. Two patients had fractured hips when they fell from toilets. The patients did not like to be transferred using the old mechanical lifts. They requested a particular method of transfer and the nursing aides often complied.

In all four nursing homes beds did not adjust. The head or foot of the bed could be raised manually. In general, the beds did not lock. All four nursing homes had old mechanical lifts, which were seldom used. Other patient transferring devices included gait belts, draw sheets (for turning and repositioning patients in beds), and chair lifts for transferring from wheelchair to bathtubs. Two nursing homes (G and H) had ramp type weighing scales to weigh patients and shower gurneys. One nursing home (H) had a modern battery operated lift. However, it was seldom used. The reasons included: lack of responsibility for charging the lift, scale malfunctioning, lack of training and non-availability of slings. The most commonly used methods for transferring patients were gait belts, under arm lift and bear hug. A few patients had experienced injuries (femur fracture, broken ribs, bruises, etc.) when transferred using mechanical lift or gait belt. Nursing aides worked independently and called for help whenever they needed it. Several patients requested particular methods for transferring and the nursing aides often went along with their requests.

In 1993 the corporate risk management approached the principal investigator. The corporation was concerned about rising workers' compensation costs and potential OSHA citations. They were aware of an earlier NIOSH study (Garg and Owen 1992). They asked the investigator to visit seven nursing homes selected by the corporate staff and make recommendations. Finally, nursing homes E, F, G and H were selected by the corporation for ergonomics intervention. The site visit recommended the following:

- a. The management must make commitment for safety and health of the employees both at the corporate and nursing home levels.
- b. The management should provide modern patient transferring devices in each unit of each nursing home.
- c. Each nursing home should form an ergonomics committee. The committee should meet at least once a month and should have written minutes. The committee should have 10 – 12 members with equal representation from management and union.
- d. A senior nurse (director of nursing, assistant director of nursing, staff development coordinator) should be made in-charge of the ergonomics program in each nursing home (ergonomics coordinator). This individual should be allowed to allocate 25% - 50% of her time to the ergonomics program.
- e. The ergonomics committee should be responsible for training all employees in the proper use of patient transferring devices, random monitoring of these devices, providing feedback to employees, enforcing safety procedures and rules, promptly addressing problems, questions and concerns as they arise, good record keeping, and maintaining communications at all levels. The ergonomics coordinator should assign different responsibilities to different individuals.
- f. Bathrooms should be modified to allow maneuvering of patient transferring devices. Ventilation in bathrooms and kitchens should be improved to minimize slippery conditions.
- g. Provide space for equipment storage. A given piece of equipment must be easily accessible and stored at the same place every time.
- h. Crank handles on beds and locks on beds and wheelchairs should be repaired.
- i. All patients should be assessed by the designated persons (preferably ergonomics committee members) for transfer needs.

Once the corporation decided to incorporate the ergonomics program in the four nursing homes, ergonomics committees were formed in each of the four nursing homes. Several vendors were invited to demonstrate their patient transferring equipment and leave it with the nursing homes for further evaluation. The ergonomics committee members from the four nursing homes participated both as care givers and patients. They rated each piece of equipment for patient safety, patient comfort, stresses to the lower back, stresses to the whole body, ease of use, ease of maneuvering (pushing/pulling, opening/closing base, etc.), ease of applying and removing slings, and overall preference. Using this information, each nursing home selected and ordered patient transferring devices. The ergonomics committee members were trained in the proper use of equipment by the principal investigator. Photographs were taken and a videotape was prepared showing both proper and improper

use of equipment. These photographs and videotapes were used for training other employees. The patient transferring devices included battery operated total lift hoists with weighing scales, sit/stand hoists, walking belts with handles, a device to reposition patients in bed, shower chairs, ramp type weighing scales, and shower gurneys.

The ergonomics committee members assessed the needs of each patient for transfers, prepared a patient transfer card for each patient (Figure 11), laminated it, and placed the card in the closet of the patient's room. The patient transfer card was periodically updated. Anytime a new patient was admitted he/she was assessed for patient transferring needs and a patient transfer card was prepared. The entire nursing staff (all certified nursing aides, nurses, staff development coordinator, assistant director of nursing and director of nursing) were trained in the proper use of patient transferring equipment. The training included videotape demonstration as well as hands on practice. During the training the employees were asked to raise their questions and concerns.

The ergonomics committee assigned responsibilities for charging equipment, storing equipment, sling inspection, and periodic equipment inspection. The principal investigator met with the ergonomics committees 4-10 times per year. Safety issues, injuries and corrective actions in all departments (nursing, housekeeping, dietary and maintenance) were discussed. The major issues were financial support, training, compliance, non-work related injuries and case management. The corporation had spent about \$50,000 per nursing home to buy the patient transferring equipment. It was reluctant to spend additional resources to hire an ergonomics coordinator or provide release time to a nurse to monitor the ergonomics program, renovate bathrooms and kitchens, or purchase other equipment. At times there were problems with providing appropriate training to new nursing personnel and monitoring compliance with the established procedures. Some of the reasons for this included shortage of nursing staff, high turnover rate, lack of responsibility, and other commitments and emergencies. Due to high turnover rate and lack of interest, sometimes prevention of injuries was not a high priority for some administrators and directors of nursing. At times the committee members were frustrated with those injuries that appeared to be non-work related and the insurance company managing the workers' compensation insurance was unwilling to investigate these injuries. In one case, a community health nurse claimed permanent disability from rheumatoid arthritis, which she claimed was caused by walking. In another case, a nursing aide stayed off the work for four months because of low back pain. She was often seen roller skating in a park and further medical examination found no problems with her back. A nurse claimed she hurt her back when she bent down to open a drawer. She stayed off work for several months. Later on it was found that she was involved in a car accident and hurt her back. In another case a nursing aide claimed serious injury to her knees while walking in a clean, dry and non-slippery hallway. In another case, a nurse sought compensation for carpal tunnel syndrome within one week of being hired. There were many cases of these types of injuries, which did not appear to be work related and/or the committees felt helpless to assign causes and take appropriate corrective actions.

In spite of these problems, most of the ergonomics committee members and other employees were highly supportive of the ergonomics program and patient transferring devices. Some of them believed there would be fist fights if for some reason patient transferring devices

Transfer	Total Hoist	Sit/Stand	Walking Belt	Repos. Device	Shower Chair	Ramp Scale
Bed-WC		X				
WC-Toilet		X				
Off floor	X					
Repos. In Bed				X		
Weighing						X
Etc...						

Figure 11: An example of patient transfer card used by the four nursing homes (Garg 1999).

were taken away from them. They wondered, how did they function prior to these devices. Comments like: "I go home without my back being sore." " We are a lot less tired at the end of the day." "I am pregnant, without this equipment there was no way I could continue to work." "The resident was so large that we did not have muscle strength to move. With the repositioning device, it was very easy." were made frequently to the investigators.

6. RESULTS

In a given nursing home, there was variability in injury statistics both during pre-intervention and post-intervention phases. During the post-intervention phase, some of the injuries, associated with lost workdays and workers' compensation costs appeared to be non-work related and no specific cause could be assigned. Some were true accidents. In some cases, employees had a pre-existing condition such as degenerative spine disease and reported pain during the post-intervention phase. Also, for certain years, injury data were available only for part of the year. For example, if intervention began on July 1, 1994 and ended on June 30, 1998, only 6 months of pre-intervention data were available for 1994 and 6 months of post-intervention data for 1994 and 1998. This required extrapolation for computing number of injuries, lost workdays and workers' compensation costs per year. Therefore, program effectiveness was determined by comparing mean number of injuries per year, lost workdays per year and workers' compensation costs per year during post-intervention with those during the pre-intervention phase. The effectiveness was defined as follows:

$$\% \text{ Decrease in injuries} = \frac{\text{Mean number of injuries per year during post-intervention} - \text{Mean number of injuries per year during pre-intervention}}{\text{Mean number of injuries per year during pre-intervention}} \times 100 \quad (1)$$

The same procedure was repeated for lost workdays, restricted workdays, and workers' compensation costs. Mean number of injuries per year during pre- and post- intervention phases were determined using the following formulas:

$$\text{Mean injuries per year during pre-intervention} = \frac{\text{Total number of injuries during pre-intervention}}{\text{Observation period in years during pre-intervention}} \quad (2)$$

$$\text{Mean injuries per year during post-intervention} = \frac{\text{Total number of injuries during post-intervention}}{\text{Observation period in years during post-intervention}} \quad (3)$$

Mean restricted workdays per year, lost workdays per year and workers' compensation costs per year were determined in similar fashion. Two types of injury statistics are presented:

those associated with patient transfers and those that occurred in the entire facility. Patient transfer injuries were defined as those injuries that occurred during the act of transferring a patient, preparing a patient for transfer (for example, trying to prevent a patient from falling from bed, wheelchair or toilet), or repositioning a patient in a bed or wheelchair. Injuries that occurred in the entire facility included all reported injuries that occurred in a health care facility, i.e., any injury to any employee working in any department (nursing, housekeeping, dietary, maintenance, administration) irrespective of cause of injury.

Number of injuries was obtained from OSHA 200 logs. There were some injuries that were not reported on OSHA 200 logs but resulted in medical payments. These were included. Restricted and lost workdays were obtained from OSHA 200 logs. Workers' compensation costs were obtained from company's insurance records. Workers' compensation costs include amount paid plus amount reserved for anticipated future expenses as determined by the facilities' insurance companies. Three types of payments were included in the workers' compensation costs. These were medical payments, indemnity payments and other expenses (legal, travel, etc.). In most cases, actual number of injuries, lost and restricted workdays, and workers' compensation costs are reported rather than the above statistics per 100 workers per year (incidence rate, severity rate). This is because the actual number of hours worked each year could not be accurately determined and this would have introduced an error. Secondly, it could not be accurately determined what nurses and administrative staff were involved in patient transfer, due to the high turnover rate.

6.1 Hospital A

Both pre- and post- intervention injury statistics were available for 3 years. Figures 12 and 13 compare the number of injuries, lost workdays and workers' compensation costs associated with patient transfer from the post-intervention phase with those from the pre-intervention phase. There were significant decreases in injuries, lost workdays and workers' compensation costs in the post-intervention phase. For all practical purposes, there were no lost workdays associated with patient transfer injuries and the workers' compensation costs were negligible during the post-intervention phase (Figures 12 and 13). On the average, the number of injuries decreased by 56%, lost workdays by 99.6% and workers' compensation costs (both actual and NEER costs) by 99.8%. NEER costs were defined as follows:

NEER costs	=	A + B + C
Where, A	=	payments to the worker + medical payments
B	=	projected future costs
C	=	administrative costs
NEER costs	=	New Experimental Rating Costs

Figure 14 shows number of injuries and lost workdays in the entire hospital. Both number of injuries and lost workdays were substantially lower in the post-intervention phase than in the pre-intervention phase. On the average, number of injuries decreased by 55% and lost workdays by 76%. Figure 15 shows the modified cost for the entire hospital. Modified cost was defined as the money paid to those injured employees who were on the modified duty. There was substantial improvement in the modified cost in post-intervention. The average modified cost per year during the pre-intervention phase was \$64,300. It reduced to \$2,333

per year, a 95% improvement. The lost workdays in 1992, both for patient transfer and the entire hospital, were lower than those in 1993 and 1994. This was because the hospital was emphasizing prevention in 1992. Most injured workers were not being placed on lost work time. They were being returned to extended modified work, in some cases even for 1 to 2 years.

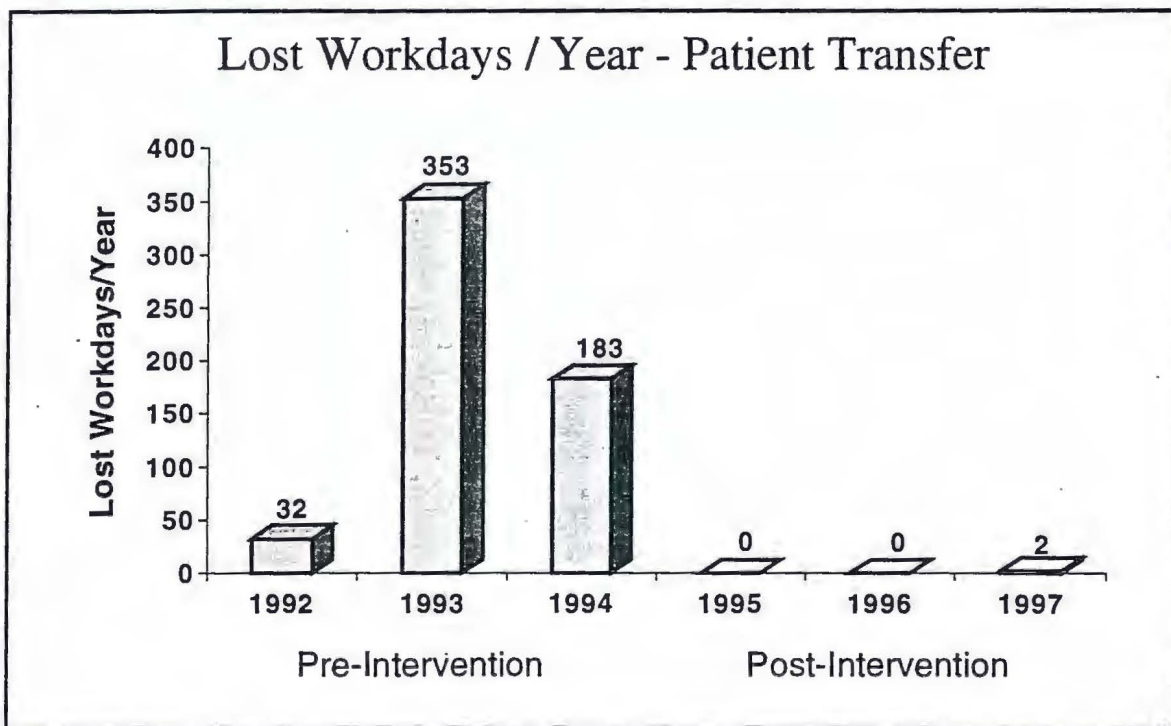
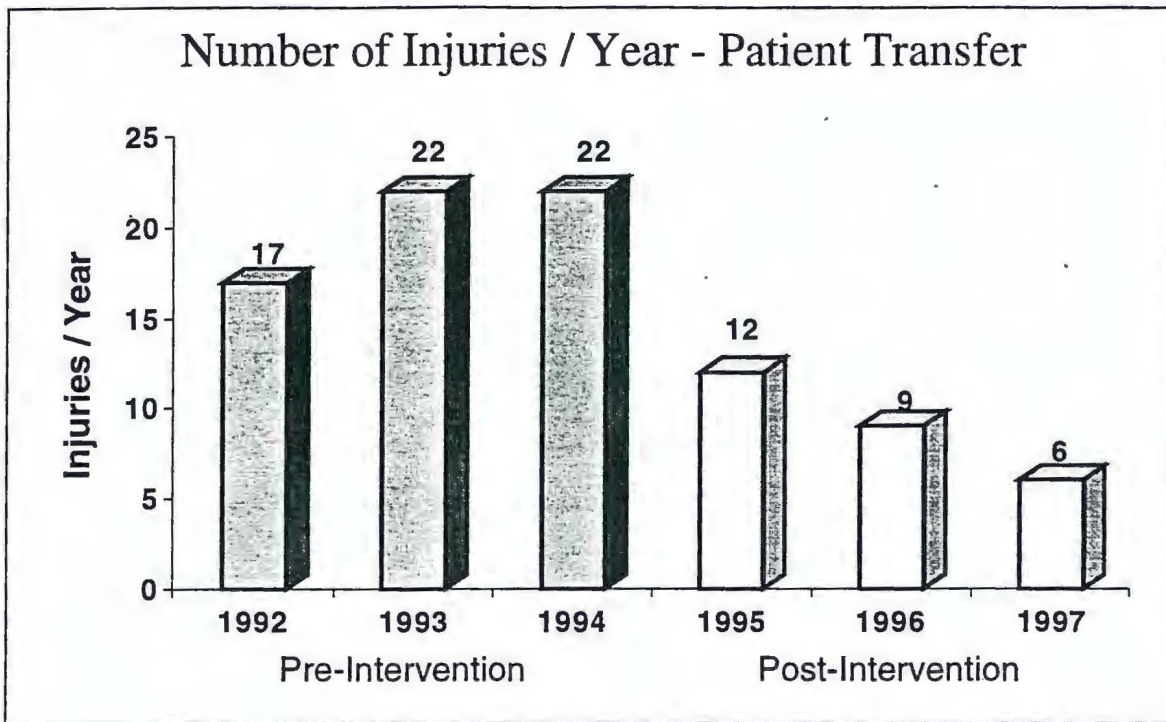


Figure 12: Number of injuries and lost workdays from patient transfers for hospital A.

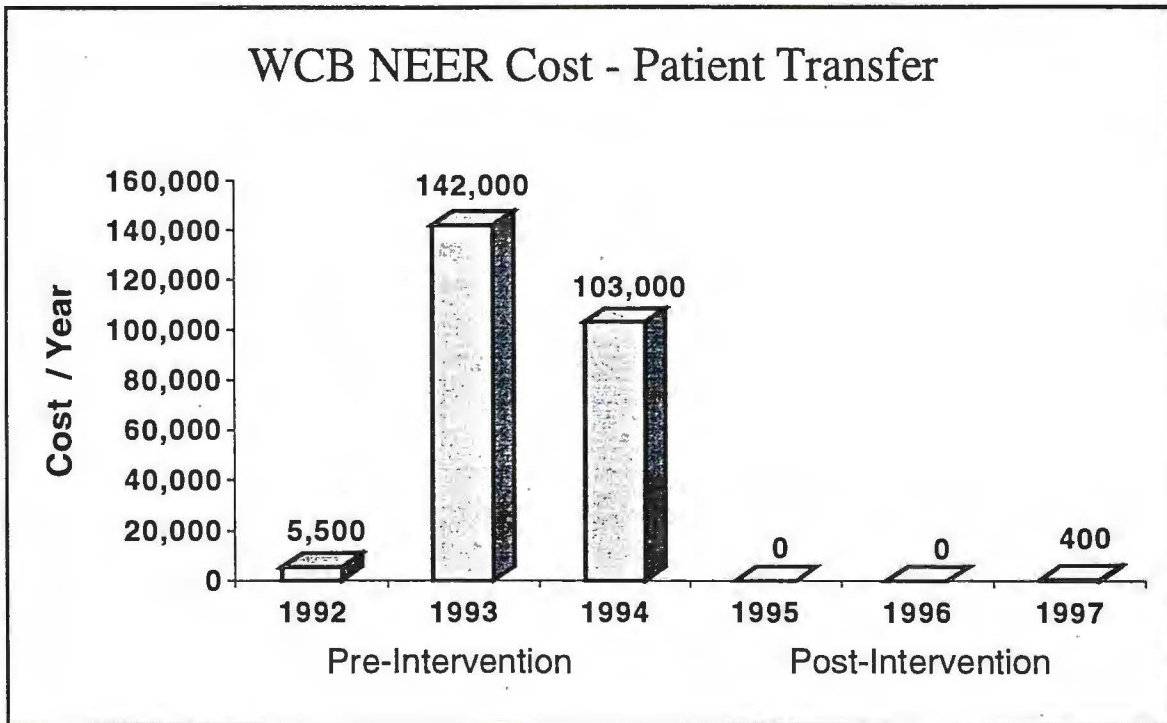
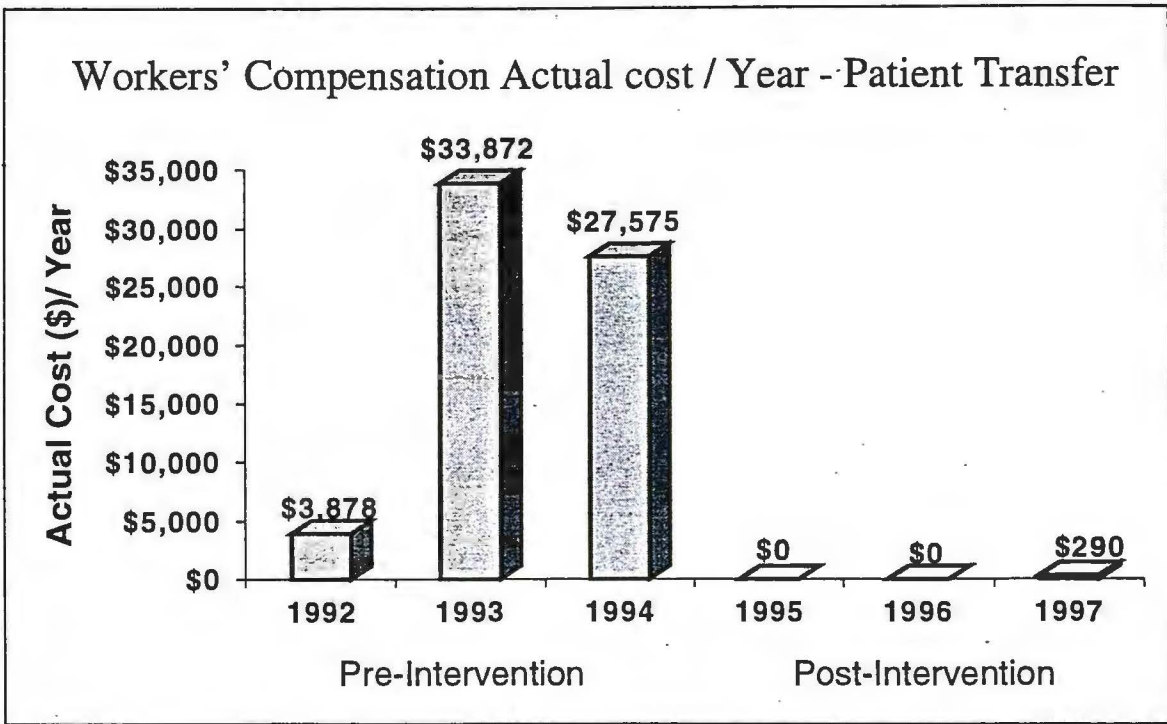


Figure 13: Actual and NEER costs from patient transfers for hospital A.

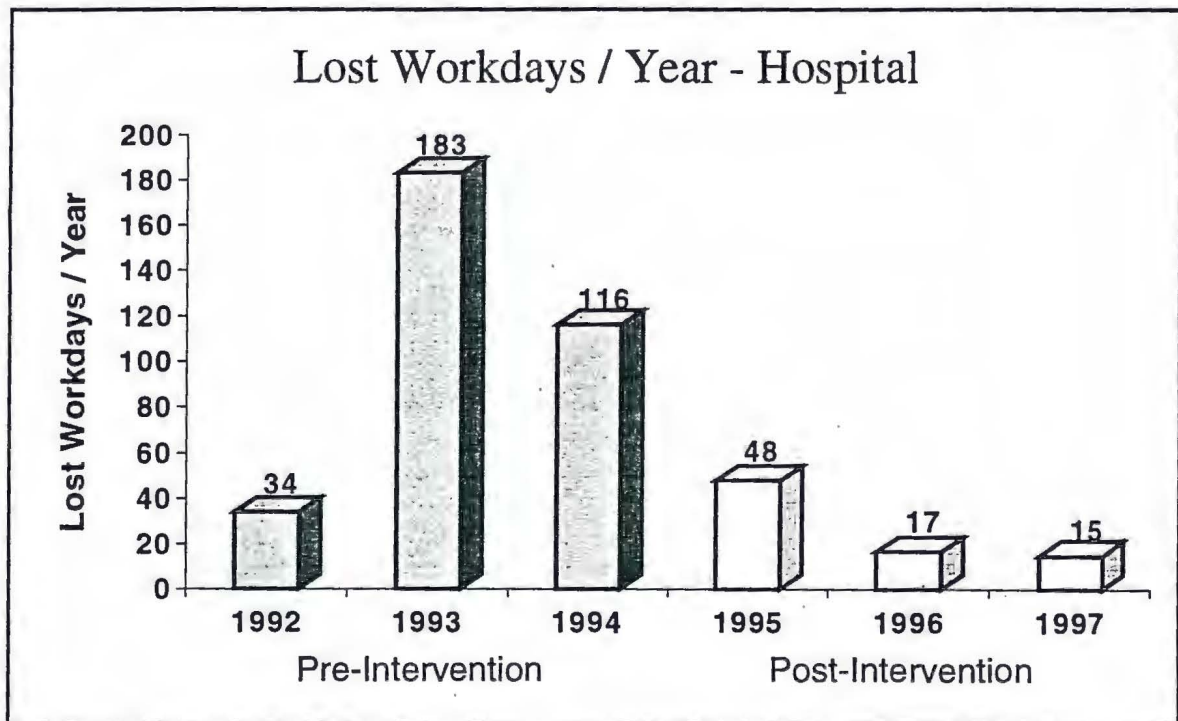
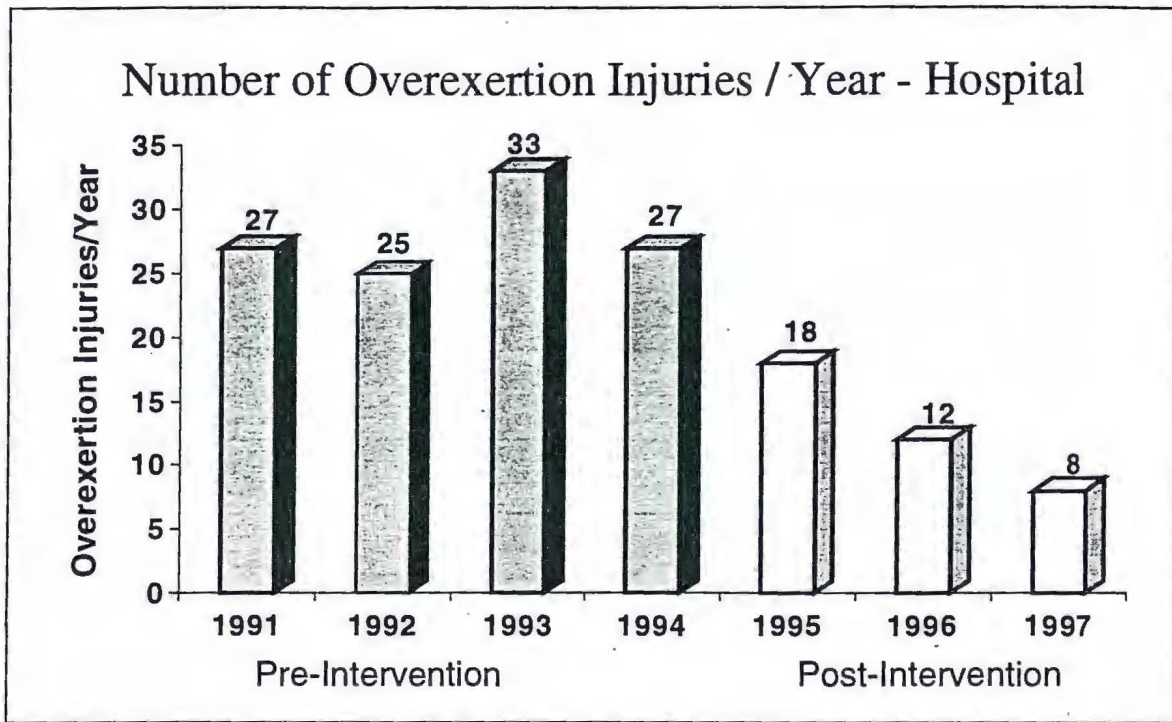


Figure 14: Number of injuries and lost workdays in hospital A.

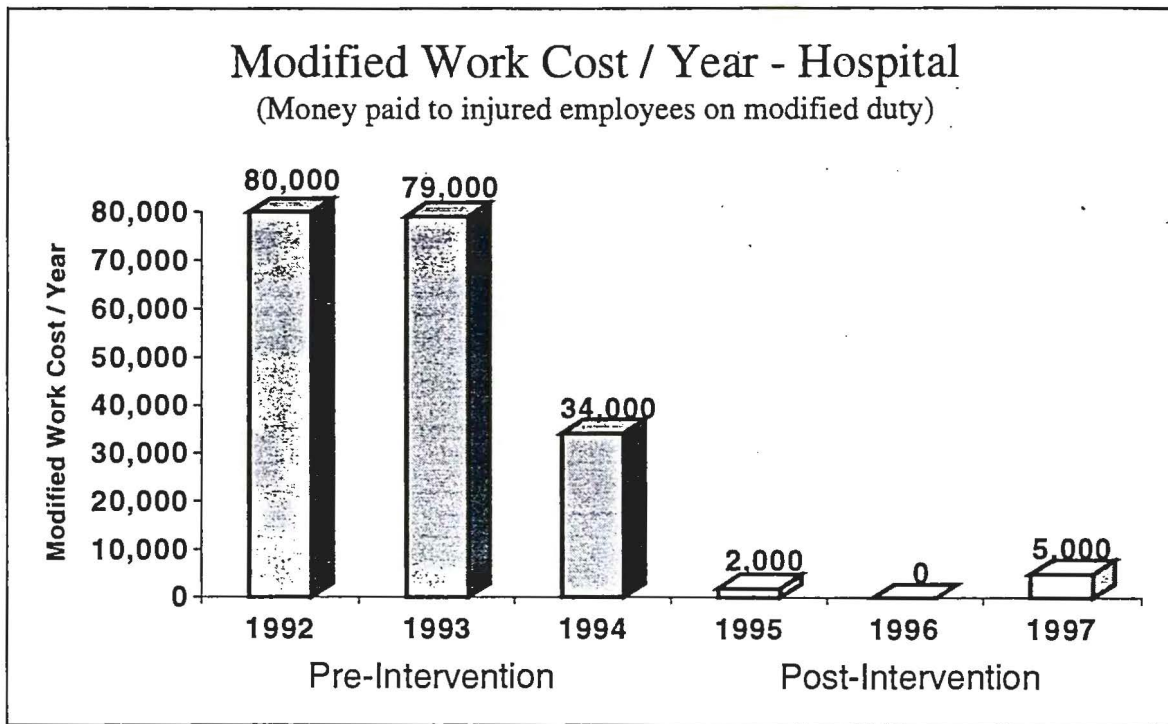


Figure 15: Workers' compensation cost paid to employees on restricted duty in hospital A.

6.2 Corporation B and Nursing Homes B and C

Both the workers' compensation modifier and the insurance premium for the entire corporation showed continuous improvements after implementation of the safety program primarily in the two nursing homes (Figure 16). The workers' compensation modifier decreased from 1.8 to about 0.7 and the insurance premium from \$1,560,000 per year to \$713,000 per year (Figure 16). While both showed some improvements before the implementation of the "zero-lift program," the major improvements occurred after the implementation of the program. Similarly, the workers' compensation costs and lost workdays for the entire corporation showed significant improvements after implementation of the "zero-lift program" (Figure 17). Pre- and post-intervention injury statistics for the entire corporation are summarized in Table 4. On the average, the workers' compensation modifier decreased by 53%, insurance premium by 42%, workers' compensation costs by 60%, lost workdays by 85%, and restricted workdays by 15% (Table 4).

The average turnover rates per year in nursing homes B and C were about 130% (Table 5). Implementation of the safety program and the "zero-lift program" did not affect the turnover rate (Table 5). However, injury statistics showed marked improvements in both nursing homes. There were significant reductions in number of injuries, lost workday injuries, lost workdays, restricted workdays, and workers' compensation costs (Figures 18-20). Among these statistics, lost workdays, lost workday injuries and workers' compensation costs showed the most improvements (Figures 18-20). On the average, lost workdays decreased by 89%, lost workday injuries by 70% and workers' compensation costs by 50%. The number of injuries decreased by 38% (Figure 18). The restricted workdays showed a small improvement of 10% (Figure 19). In 1993, one year prior to implementation of the "zero-lift program," the nursing homes had initiated an aggressive modified duty program. The management started placing employees (who filed an accident report) on modified duty as a preventive measure even though these employees had not seen a physician. Table 6 summarizes the injury statistics for nursing homes B and C from pre- and post-intervention phases of the study.

Figure 21 shows the number of injuries and lost workdays from patient transfers. The average number of injuries from patient transfers decreased by 39% and lost workdays by 86% (Figure 21). These decreases were comparable to those observed for the entire nursing homes (Table 6).

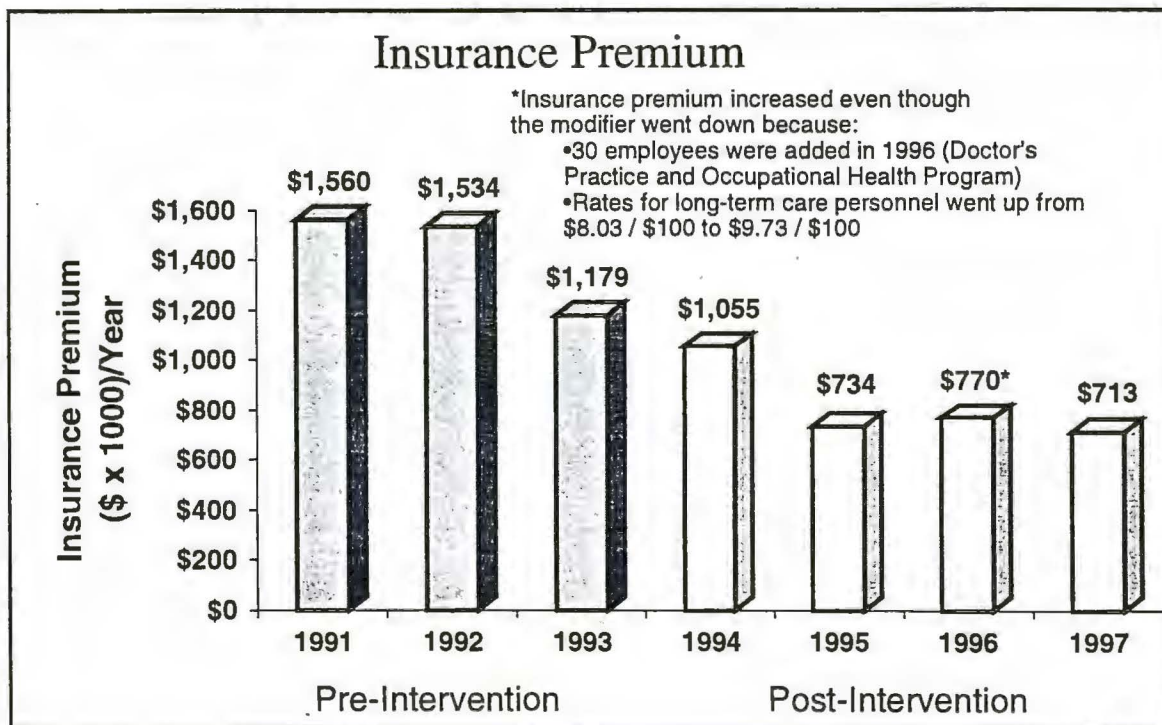
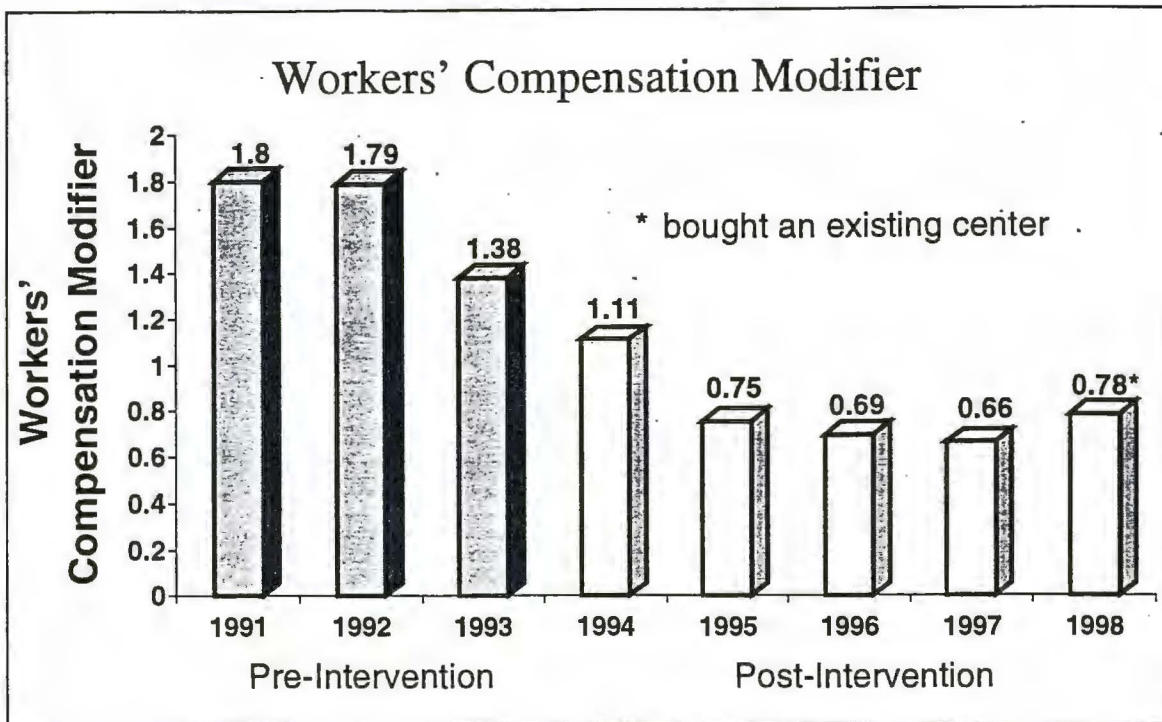


Figure 16: Workers' compensation modifier and insurance premium for the entire corporation B.

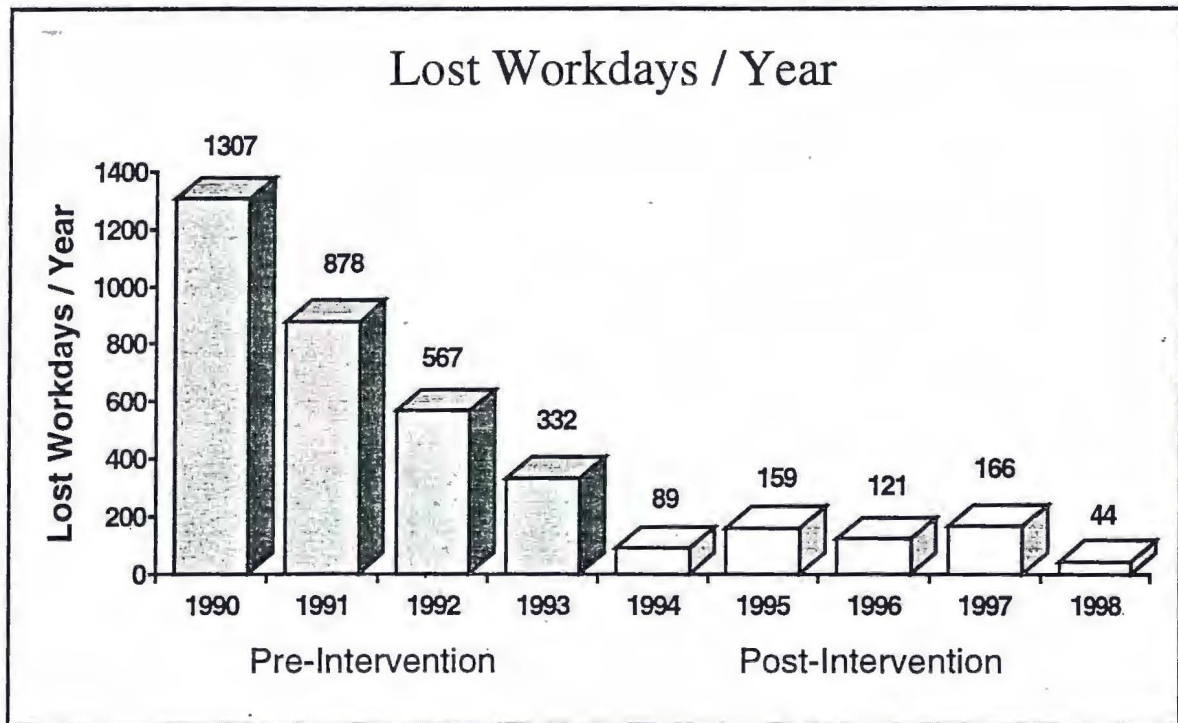
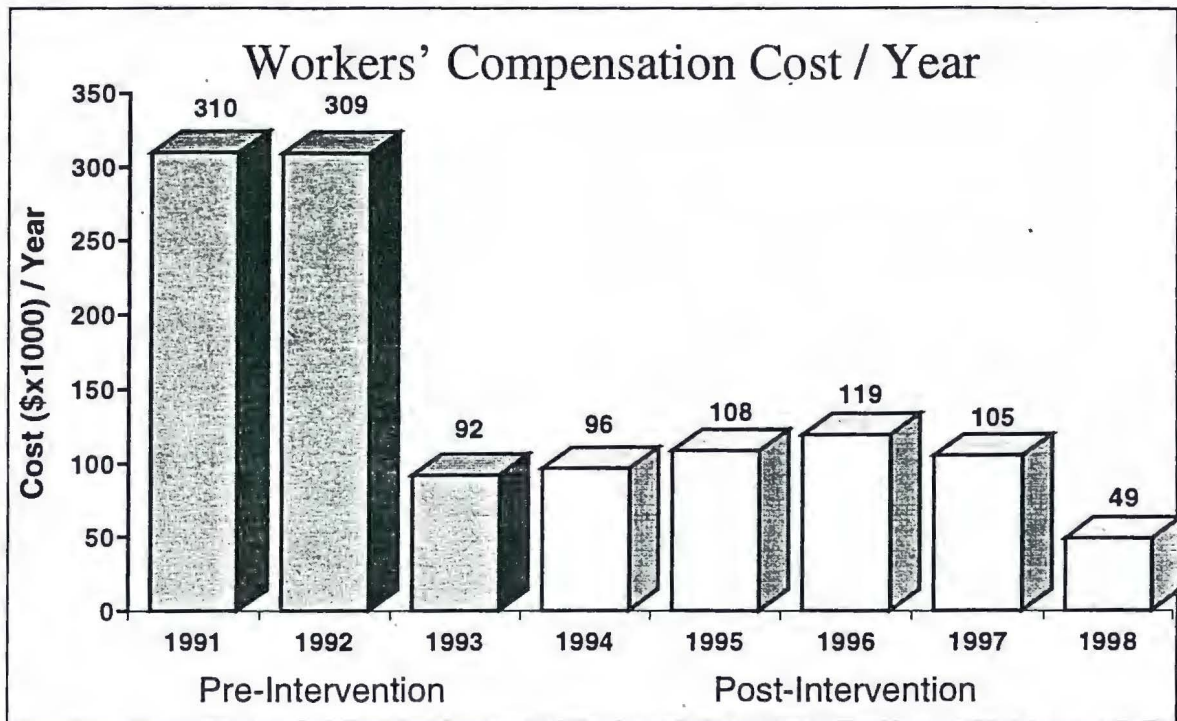


Figure 17: Workers' compensation cost and the lost workdays for the entire corporation B.

Table 4: Summary of pre and post-intervention injury statistics for the entire corporation B.

Statistics/Year	Pre- Intervention	Post- Intervention	% Decrease
WC Modifier	1.7 ¹	0.80 ³	53%
Insurance Premium(\$M)	1.42 ¹	0.82 ⁴	42%
WC Cost (x \$1,000)	237 ¹	95 ³	60%
Lost Workdays	771 ²	116 ³	85%
Restricted Workdays	915 ²	774 ³	15%

¹ Pre-Intervention: 3 years

² Pre-Intervention: 4 years

³ Post-Intervention: 5 years

⁴ Post-Intervention: 4 years

Table 5: Turnover rate per year in nursing homes B and C

Year	Turnover Rate %	
	Nursing Home B	Nursing Home C
1991	123%	123%
1992	126%	124%
1993	126%	128%
1994	129%	135%
1995	127%	128%
1996	142%	124%

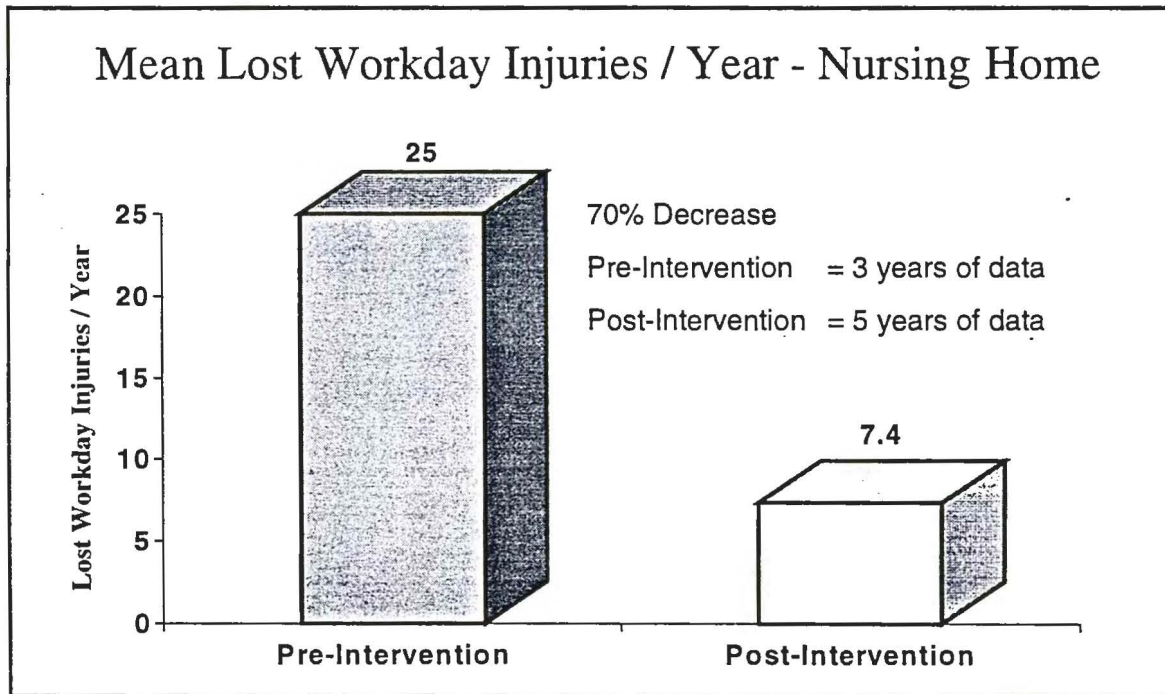
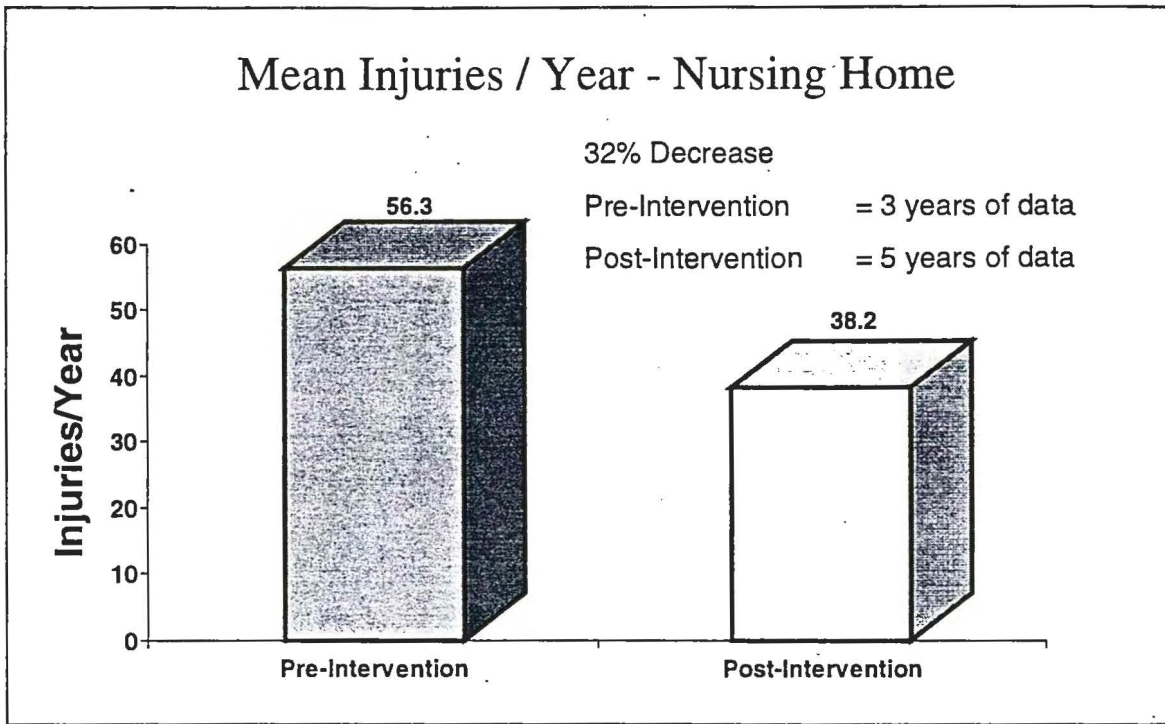


Figure 18: Number of injuries and lost workday injuries in nursing homes B and C.

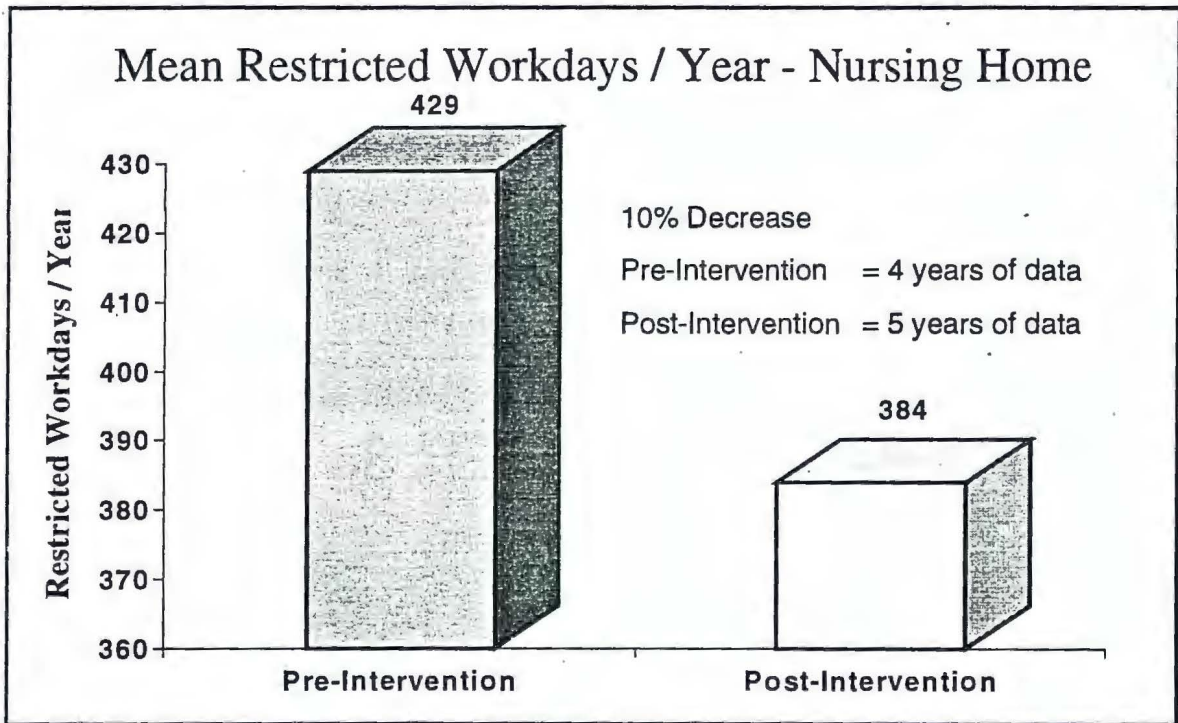
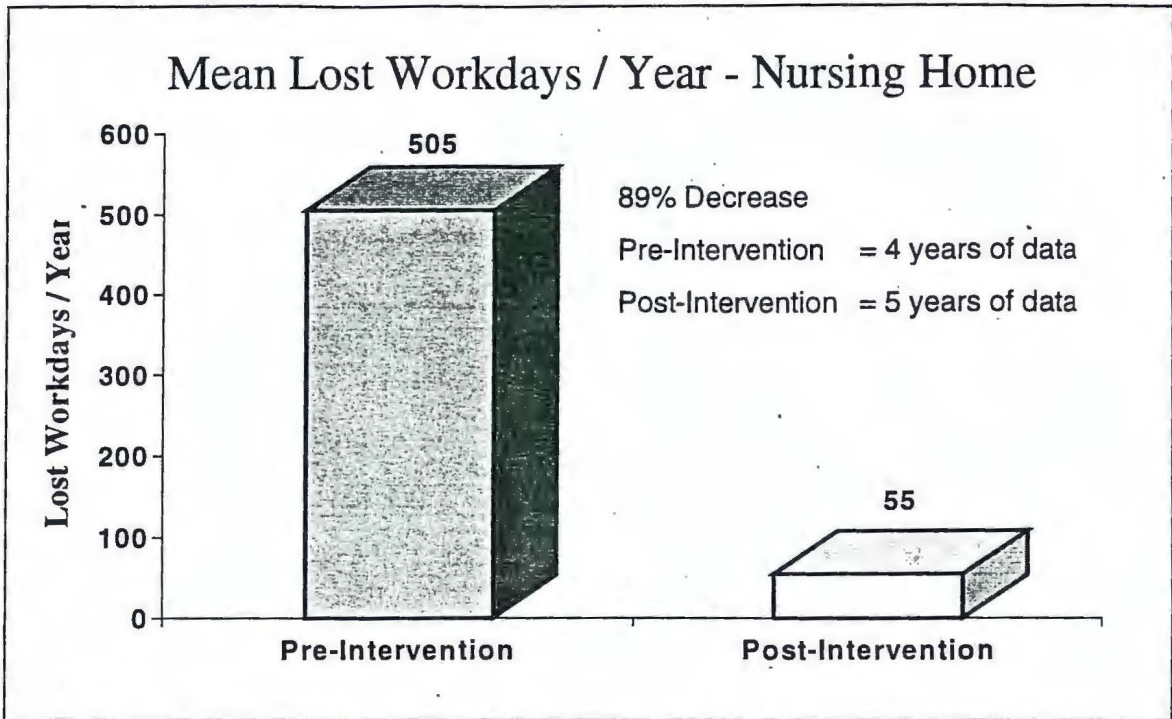


Figure 19: Lost and restricted workdays in nursing homes B and C.

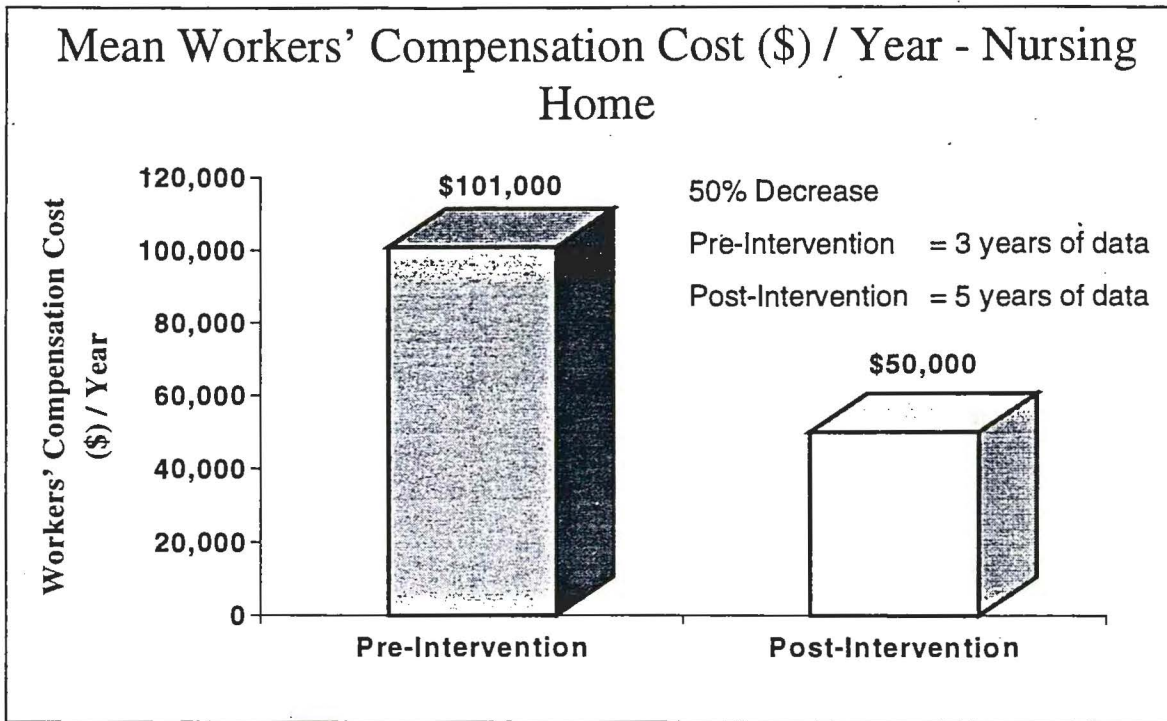


Figure 20: Workers' compensation cost in nursing homes B and C.

Table 6: Summary of pre- and post-intervention injury statistics for nursing homes B and C.

Statistics/Year	Pre- Intervention	Post- Intervention	% Decrease
Number of Injuries	56.3 ¹	38.2 ³	32%
Lost Workday Injuries	25 ¹	7.4 ³	70%
Lost Workdays	505 ²	55 ³	89%
Restricted Workdays	429 ²	384 ³	10%
Incurred Cost (x \$1,000)	101 ¹	50 ³	50%

¹ Pre-Intervention: 3 years

² Pre-Intervention: 4 years

³ Post-Intervention: 5 years

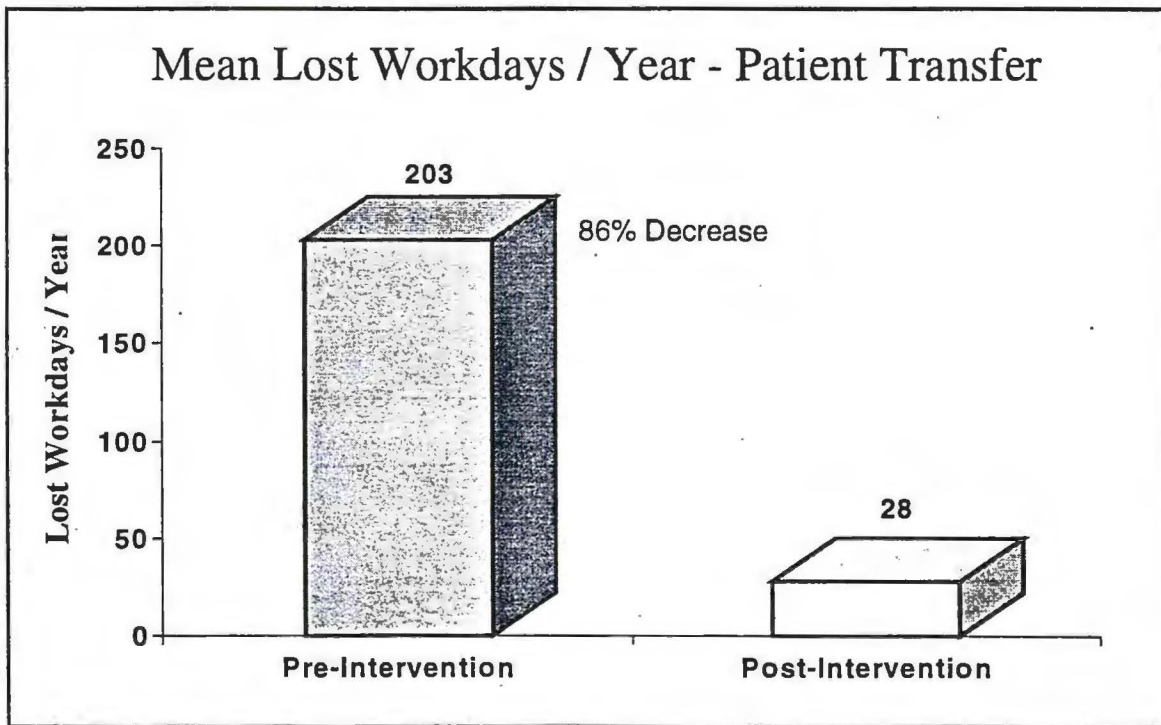
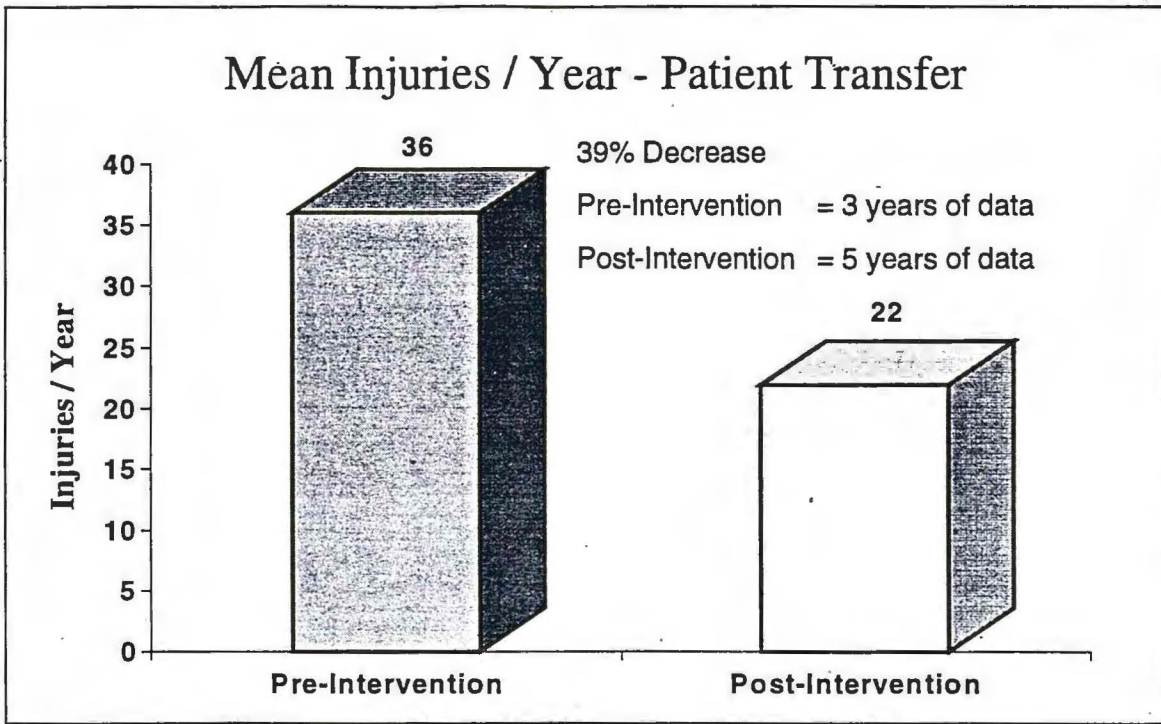


Figure 21: Number of injuries and lost workdays from patient transfers in nursing homes B and C.

6.3 Nursing Home D

The acuity level of patients in nursing home D was rising since intervention (Table 7). In other words, more sick patients were being admitted and required a higher level of medical care. All other nursing homes believed that the patients were getting sicker and required a higher level of care but did not have actual data to share with the investigators.

The turnover rate of nursing personnel decreased significantly with the implementation of the “zero lift program” (Table 8). While the management did not have actual numbers prior to 1991, it estimated that the turnover rate in previous years was over 80% to 110%. Between 1987-1991 there was an extreme shortage of nursing assistants.

Figures 22 and 23 show the effects of the “zero-lift program” on patient transfer injuries, lost workdays, restricted workdays, and workers’ compensation costs. All statistics except restricted workdays decreased after the implementation of the “zero-lift program.” On the average, patient transfer injuries decreased by 55%, lost workdays by 95%, and workers’ compensation costs by 66%. The nursing home had very low workers’ compensation costs prior to implementation of the “zero-lift program.” On the average, they were \$7,355 per year. The restricted workdays increased by 17% (Figure 23). This is because the nursing home had 0 restricted workdays for two years prior to the implementation of the “zero-lift program.” No reasonable explanation could be offered for the extremely low workers’ compensation costs and restricted workdays associated with patient transfers prior to the intervention.

Figures 24 and 25 show the effects of the “zero-lift program” on the entire nursing home. Number of injuries, lost workdays, and workers’ compensation costs showed marked improvements (Figures 24 and 25). On the average, the number of injuries per year decreased by 16%, lost workdays by 64%, and workers’ compensation costs by 40%. The restricted workdays dramatically increased, on the average, by 220% (Figure 25). Once again, there were no restricted workdays reported on OSHA 200 logs for one year and only 26 for another year prior to the ergonomics intervention.

The lost workdays and workers’ compensation costs would have shown much greater improvements except for one injury in 1995. A LPN reported pushing a medical cart off an elevator, which she claimed, was not level with the floor. She alleged that the cart got jammed and jarred her low back. Radiographic studies showed mild multilevel degenerative changes and subsequently she was diagnosed with focal disc herniation at L4-5, and underwent hemilaminotomy, disc excision and foraminotomy. This single injury resulted in \$57,156 in workers’ compensations cost and 476 lost workdays in 1995. The total workers’ compensation costs and lost workdays for the entire nursing home in 1995 were \$66,073 and 488 respectively.

The management believed that the patient care had improved significantly with the “zero-lift program.” For example, there was a decrease in skin tears (Table 9). Over the five years since the “zero-lift program” was implemented there were six falls involving patients (Table 10). Out of the six falls, one resulted in a fractured shoulder.

The “zero-lift program” had a major impact on pregnant and older workers (Table 11). According to the best estimates by the management, 5 out of 6 female employees continued to work to the term. Similarly, most nursing aides in fifties and sixties were able to continue their employment (Table 11). The management believed that the “zero-lift program” had resulted in several major benefits. These benefits are summarized in Table 12.

Table 7: Acuity level of residents in nursing home D

Year	Case Mix Index (CMI)*
1993	0.92
1994	0.88
1995	1.11
1996	1.11
1997	1.24

* 1.0 Average nursing home resident
< 1.0 Less medical care is required
> 1.0 Resident is more complex

Table 8: Yearly turnover rate of nursing personnel in nursing home D.

Year	Turnover Rate
1987 - 1990	80% - 110%
1991	69%
1992	38%
1993	42%
1994	67%
1995	51%

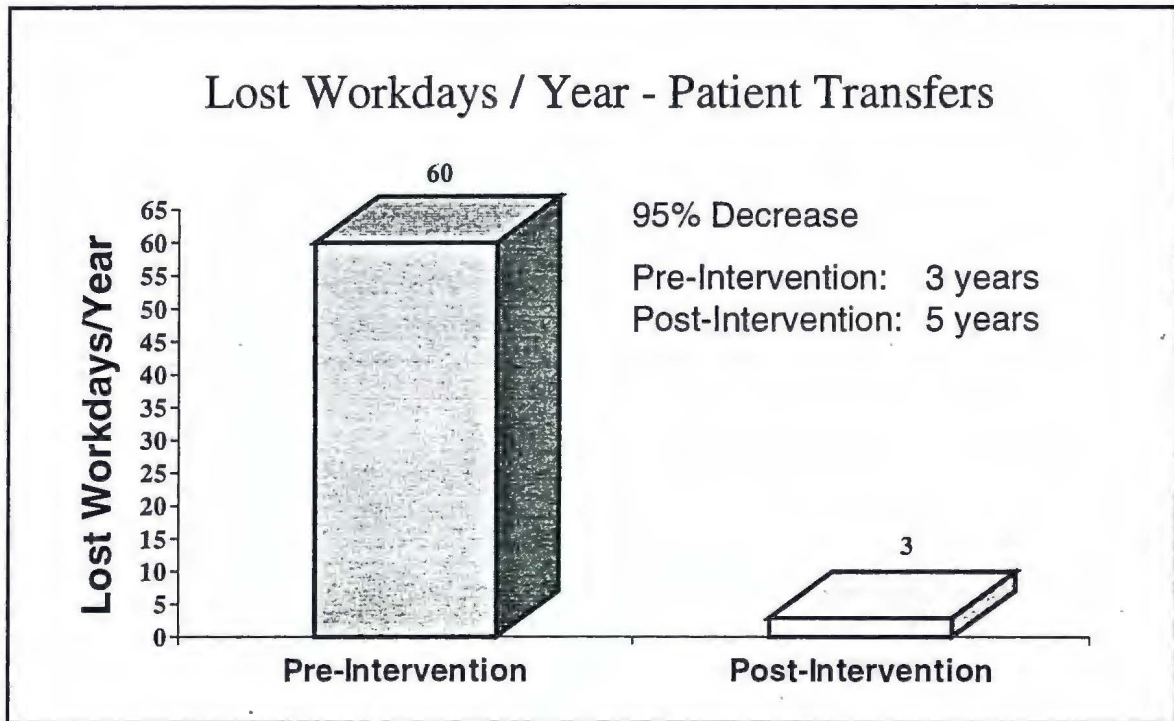
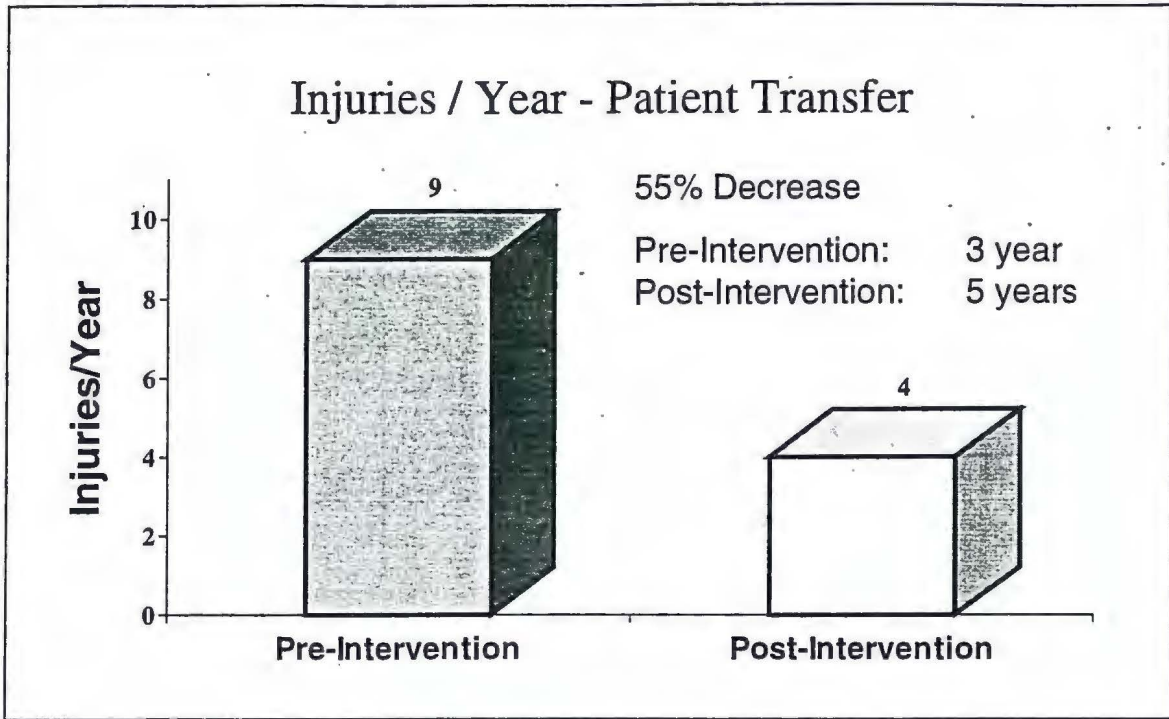


Figure 22: Number of injuries and lost workdays from patient transfers for nursing home D.

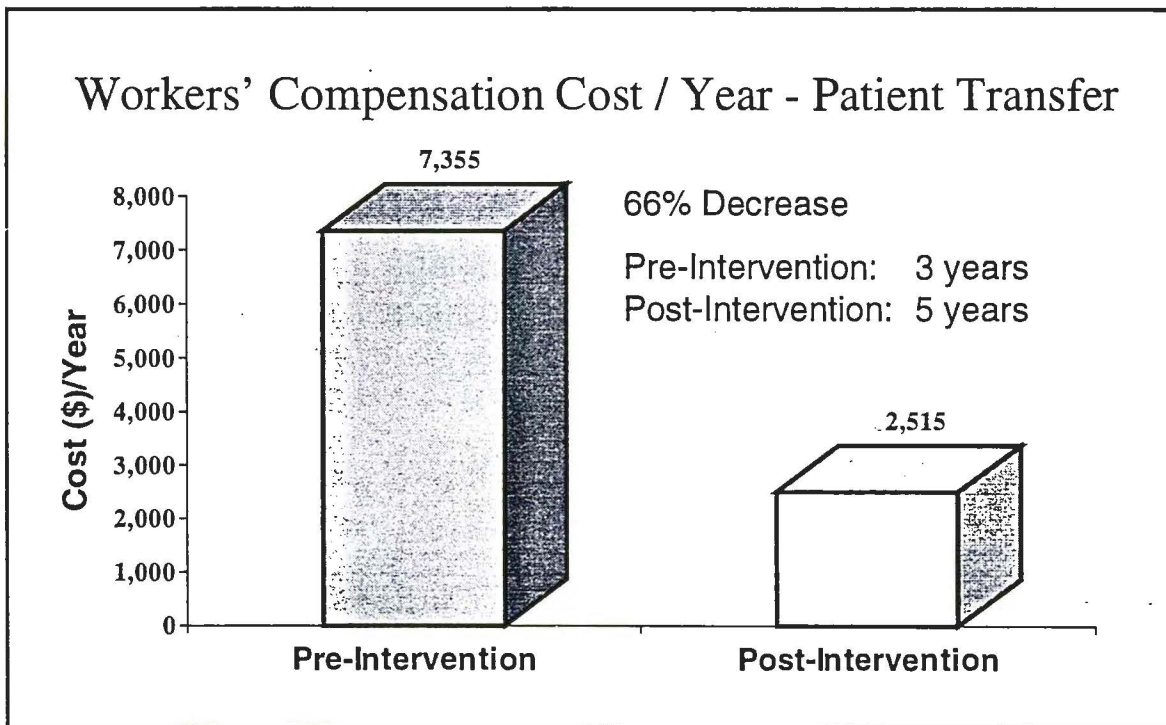
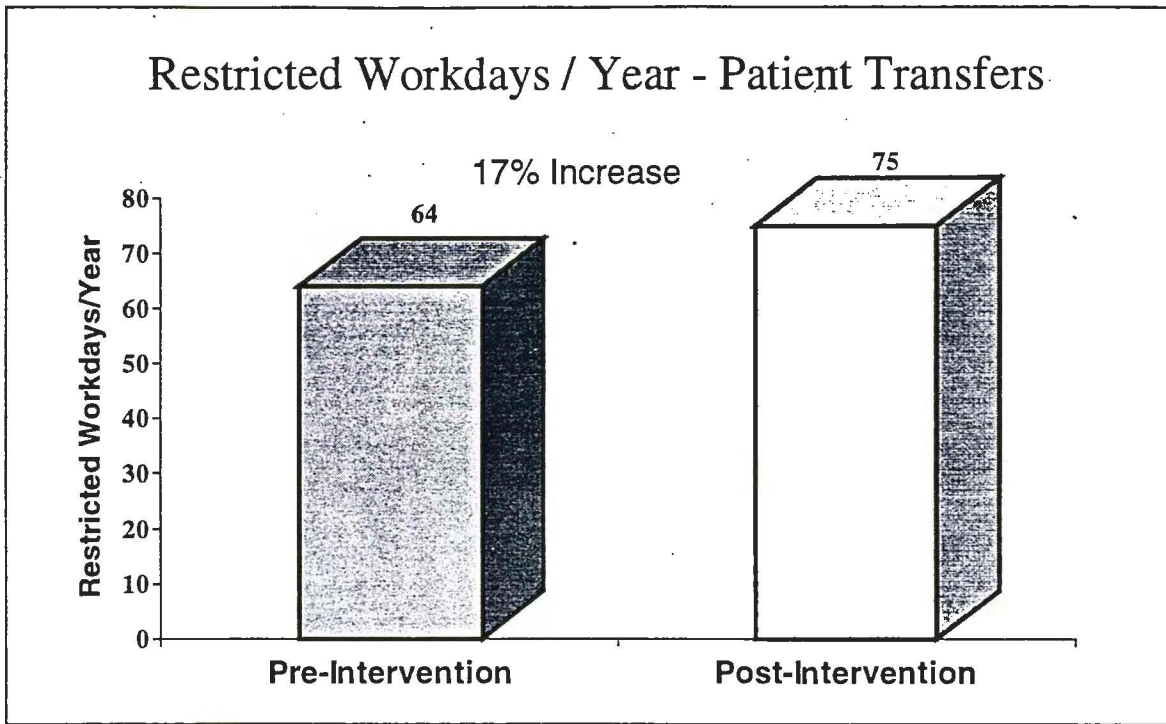


Figure 23: Restricted workdays and workers' compensation costs from patient transfers for nursing home D.

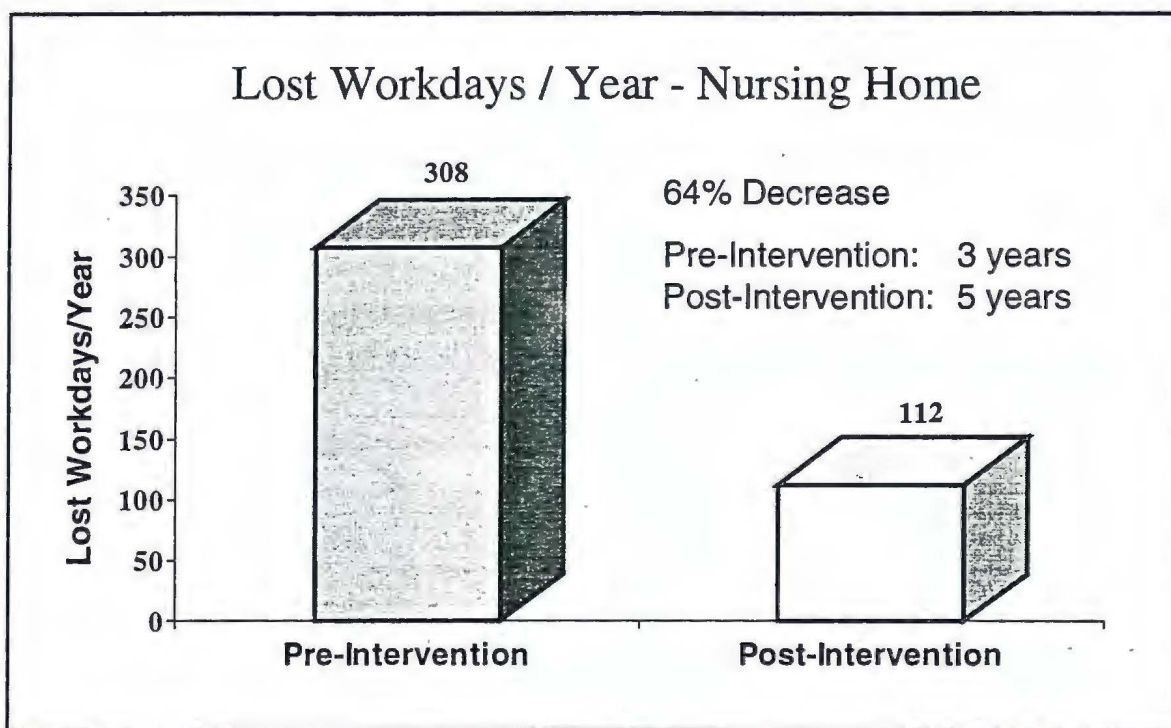
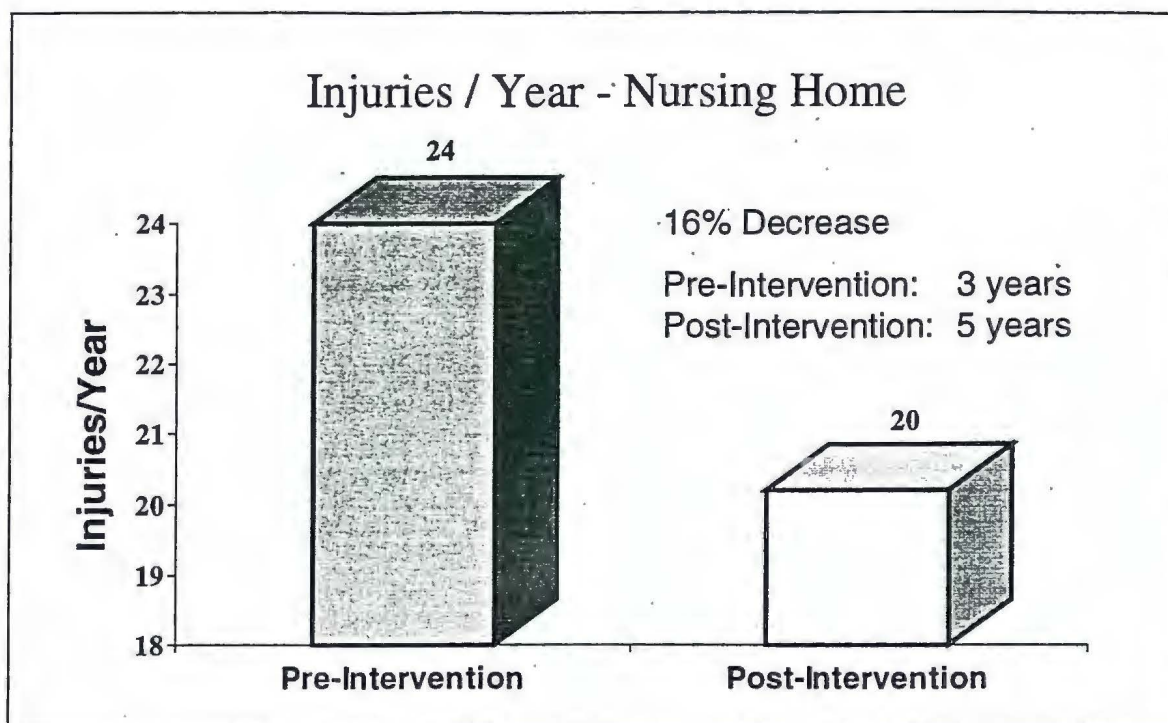


Figure 24: Number of injuries and lost workdays for the entire nursing home D.

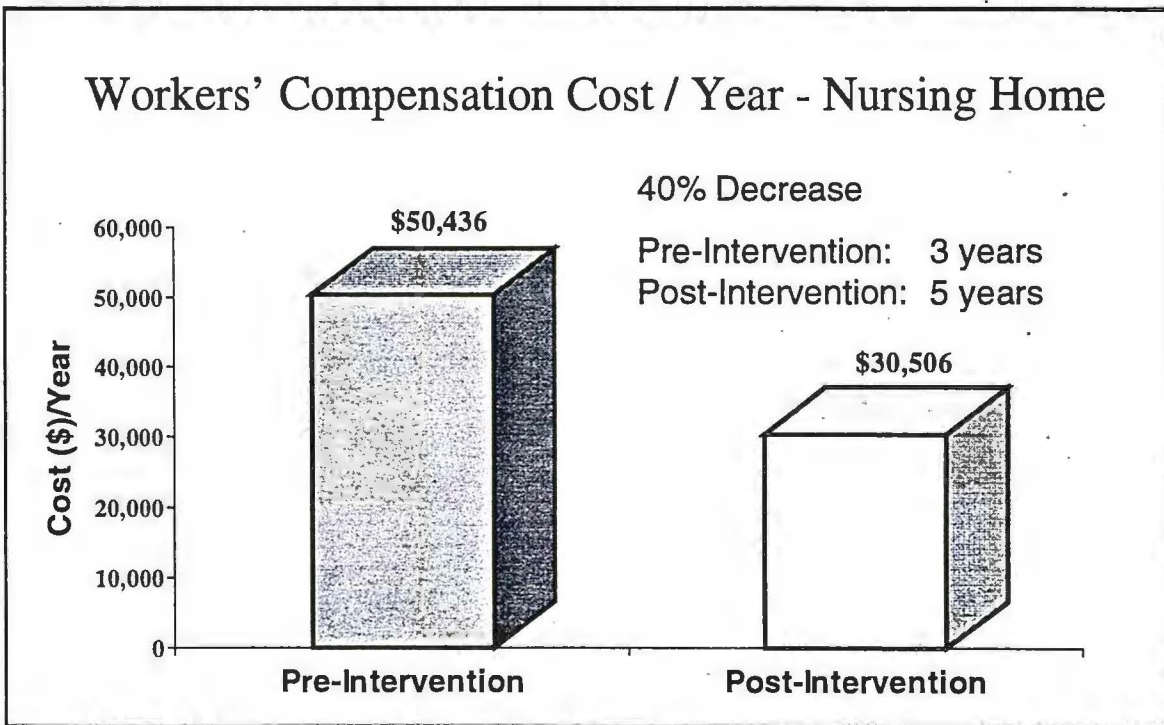
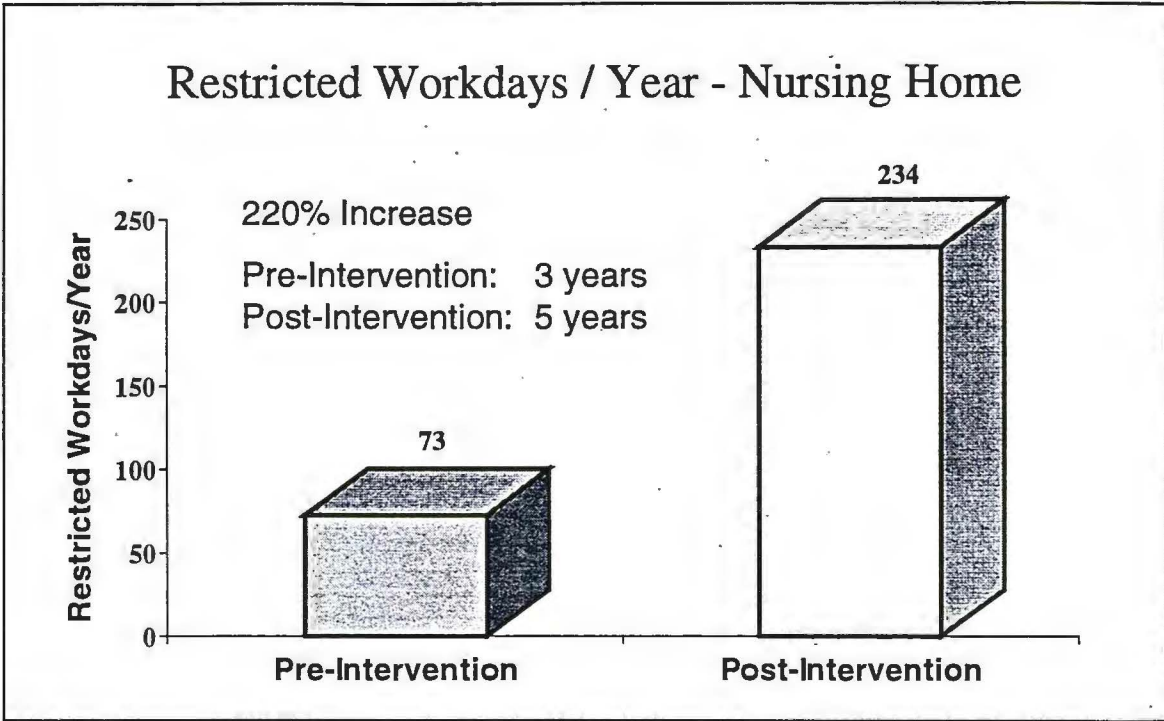


Figure 25: Restricted workdays and worker's compensation costs for the entire nursing home D.

Table 9: Skin tears per year in nursing home D.
(Numbers are for patients treated with
dressing or medication)

Year	Skin Tears
1991	16
1992	15
1993	17
1994	8
1995	5

Table 10: Injuries to residents since inception of the “zero-lift program” in nursing home D.

- Sit-stand lifts: 2 falls
 - One resulted in no injury
 - Other caused fractured shoulder

- Total lifts: 4 falls
 - All 4 falls because of defective equipment
 - None of the four resulted in any injury

Table 11: Effects of the “zero-lift program” on pregnant and older workers in nursing home D.

- **Pregnant Nursing Aides**
 - 5 employees in the 3 years worked to the term
 - 1 employee did not because of medical reasons

- **Older Workers**
 - 3 NAs are over 60 years (7%)
 - 11 NAs are over 50 years (25%)

Table 12: Benefits of the “zero-lift program” in nursing home D

- Reduced injuries (55%)
- Reduced lost workdays (95%)
- Reduced workers’ compensation cost (66%)
- Decreased turnover rate
- Reduced call off rate
- Improved employee morale
- Reduced skin tear
- Pregnant women continued regular assignment
- Older employees continued regular assignment

6.4 Nursing E

Figure 26 shows the number of injuries from patient transfers for three years prior to intervention and five years after intervention. The “zero-lift program” began in July of 1994. Therefore, both pre- and post-intervention injuries for 1994 were extrapolated to determine number of injuries per year. Similarly, injury data for 1998 were available only for 6 months and were extrapolated for full year. There was a significant decrease in the number of patient transfer injuries after implementation of the “zero-lift program” (Figure 26). Figures 27 and 28 compare the number of injuries, lost workdays, restricted workdays, and workers’ compensation costs from patient transfer after implementation of the “zero-lift program” with those before implementation of the program. The pre-intervention data were based on 29 months and post-intervention on 49 months of observation. Patient transfer injuries decreased by 79%, lost workdays by 50%, restricted workdays by 96%, and workers’ compensation costs by 53%. (Figure 27 and 28).

Figures 29 and 30 show the effects of the “zero-lift program” on number of injuries, lost workdays, restricted workdays, and workers’ compensation costs in the entire nursing home. On the average, the number of injuries in the nursing home decreased by 37%, lost workdays by 40%, restricted workdays by 81%, and workers’ compensation costs by 32%.

Some of the serious and expensive injuries after the implementation of the program did not appear to be work related. No reasonable cause could be assigned to these injuries. In some cases, nurses and nursing assistants had serious low back problems prior to implementation of the program. They had suffered serious low back injuries in the past either in this nursing home, on their previous jobs, in accidents, or during their leisure activities. In other cases, nurses and nursing aides did not use proper patient transferring devices and manually lifted and transferred patients. At times, training in safe patient transferring procedures and compliance with these procedures were an issue because of high turnover rates of administrators, directors of nursing, nurses and nursing aides. Some injuries were true accidents, for example, in 1995 a nursing aide earlier diagnosed with degenerative spine disease suffered a serious low back injury when a strap of a sling for the total lift hoist broke. This injury resulted in 132 lost workdays and \$91,329 in workers’ compensation costs. This single injury accounted for 63% of all workers’ compensation costs for that year. Prior to this injury, the same individual suffered non-specific low back pain without an assignable cause (nothing in particular) resulting in 18 lost workdays, 56 restricted workdays, and \$6,009 in workers’ compensation costs. In the same year, a nurse involved in a car accident hurt her low back. She claimed she suffered low back pain while she bent down to open a drawer. The cost for this injury was \$31,285. In the same year, another nursing aide manually lifted a patient from a Clinitron bed and hurt her shoulder. This resulted in 66 lost workdays, 21 restricted workdays, and \$4,312 in workers’ compensation costs. Together, these three individuals accounted for 76% of all lost workdays and 92% of total workers’ compensation costs for that year. All injury statistics were considerably higher for that year than any other year in this

nursing home. A new administrator and director of nursing were appointed that year. The “zero-lift program” and health and safety issues were not high priorities to them, and neither of them attended monthly ergonomics meetings most of the time.

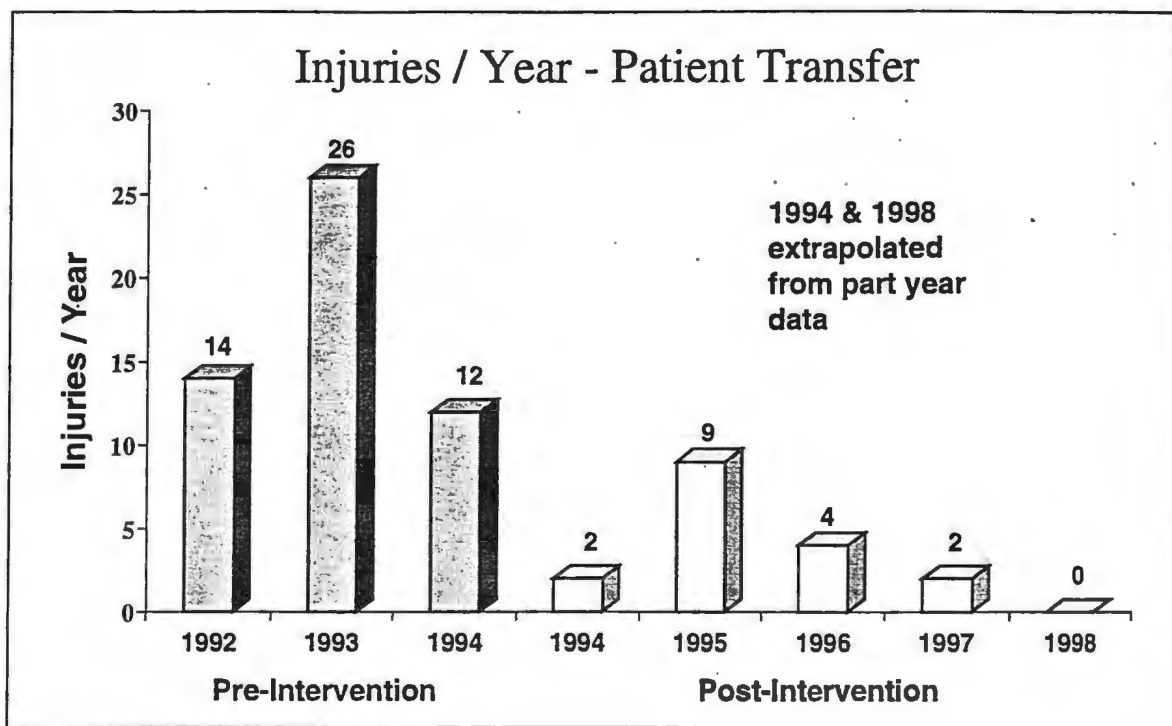


Figure 26: Patient transfer injuries in nursing home E.

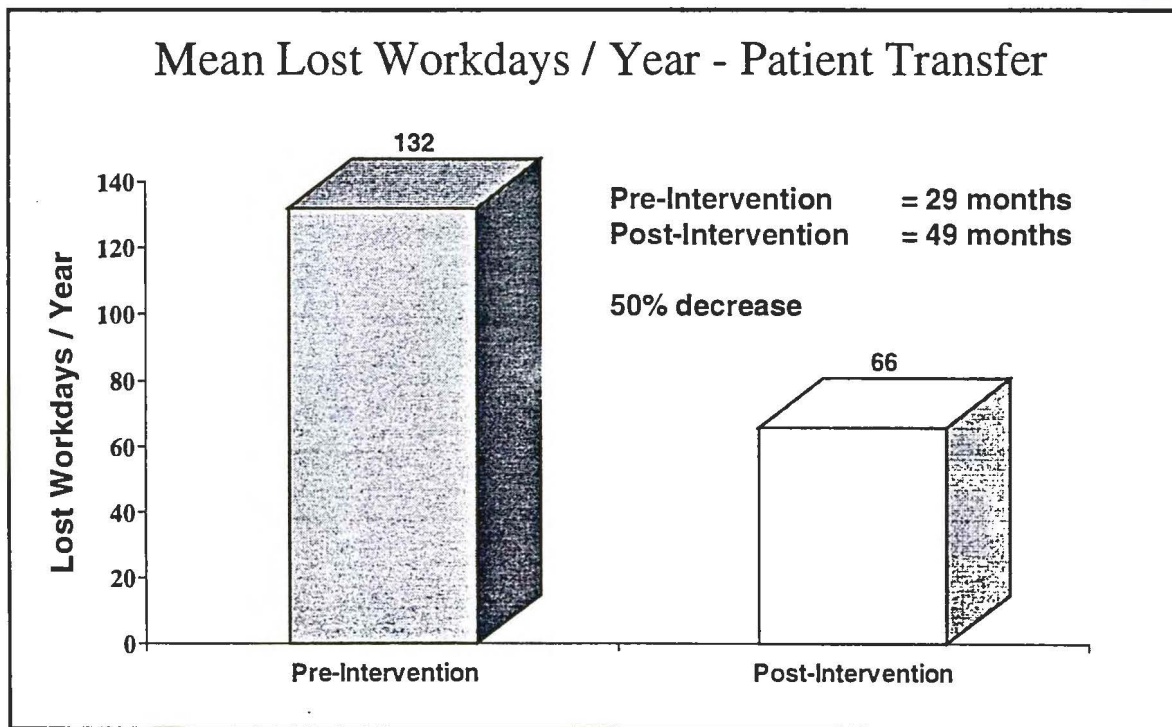
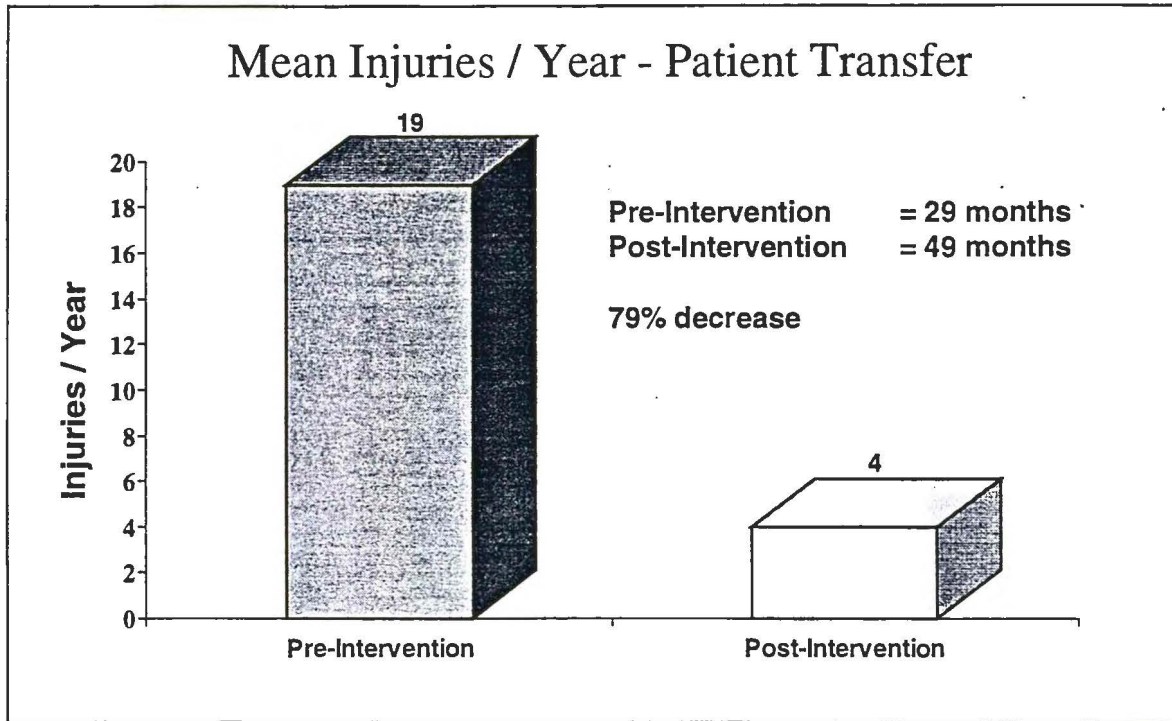


Figure 27: Number of injuries and lost workdays from patient transfers before and after implementation of the “zero-lift program” in nursing home E.

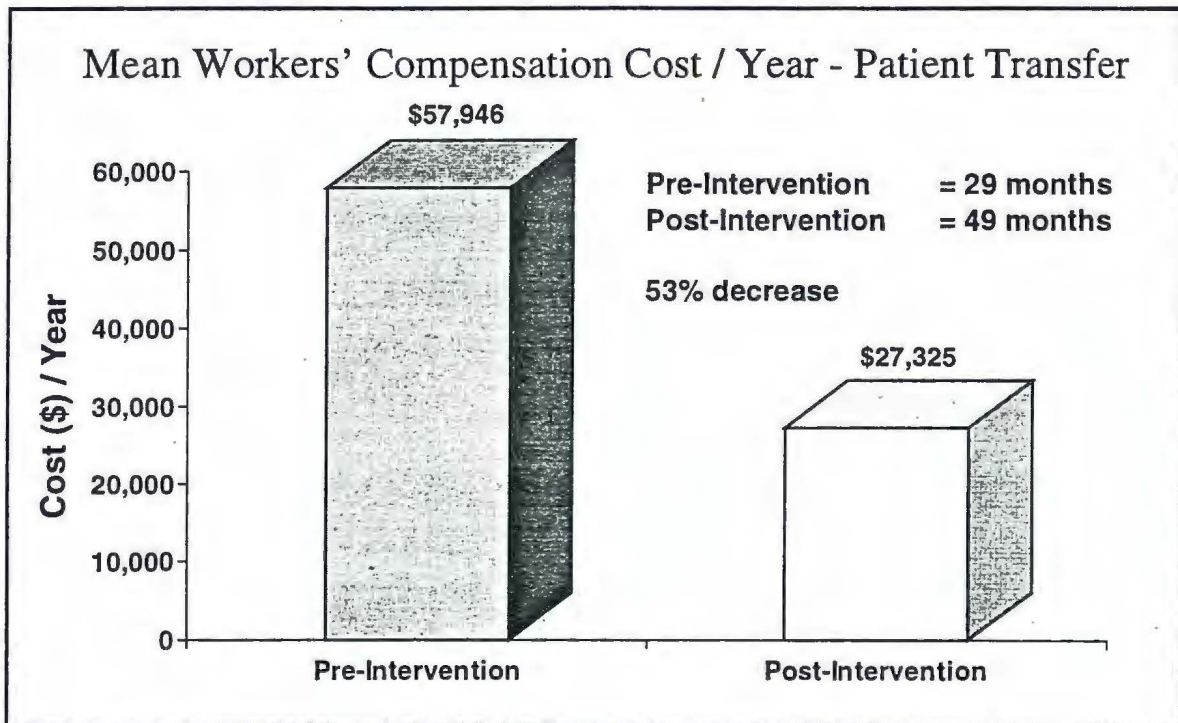
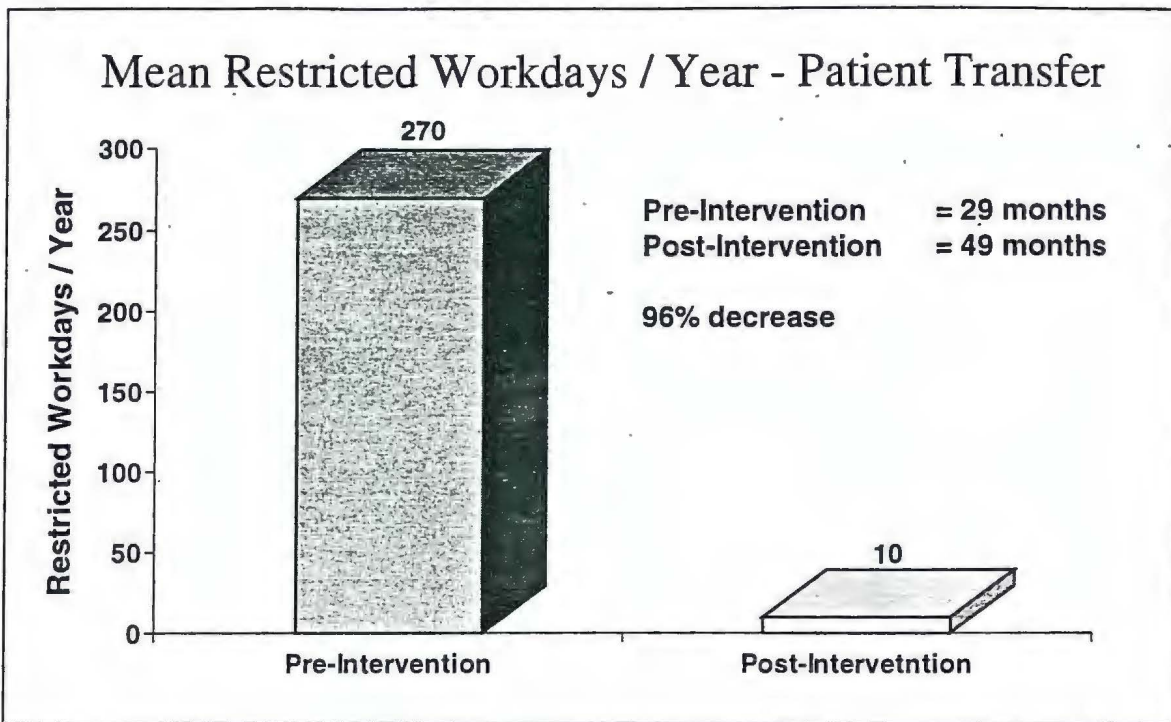


Figure 28: Restricted workdays and workers' compensation costs from patient transfers before and after implementation of the "zero-lift program" in nursing home E.

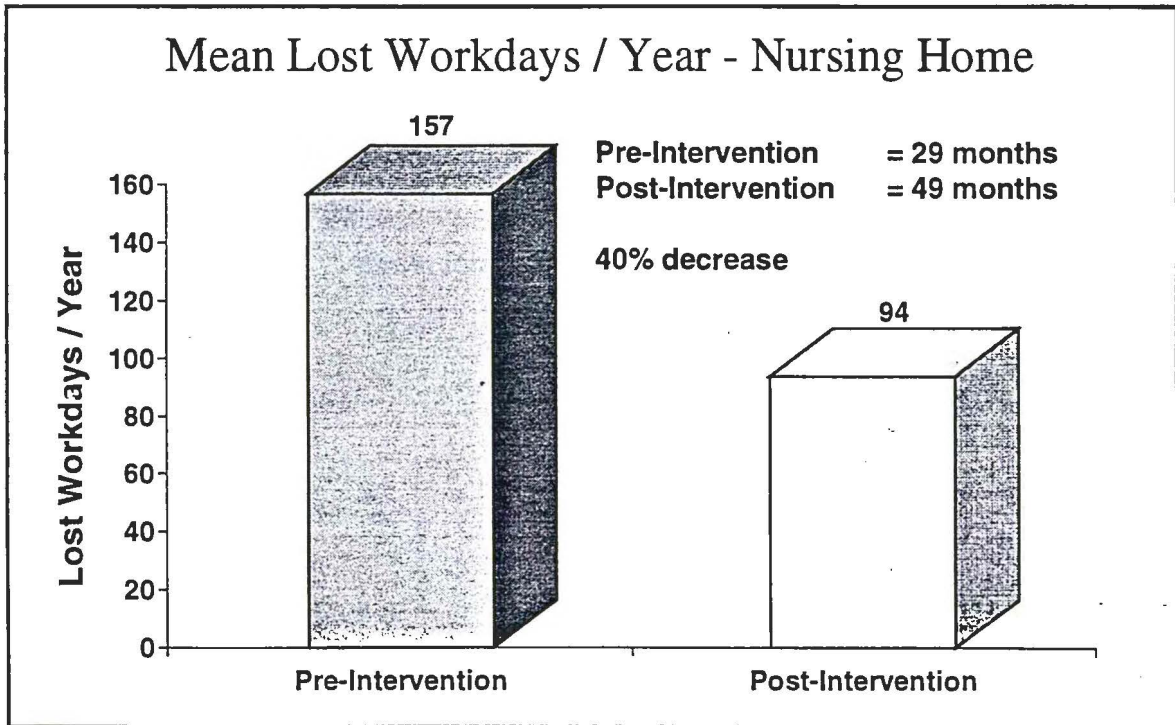
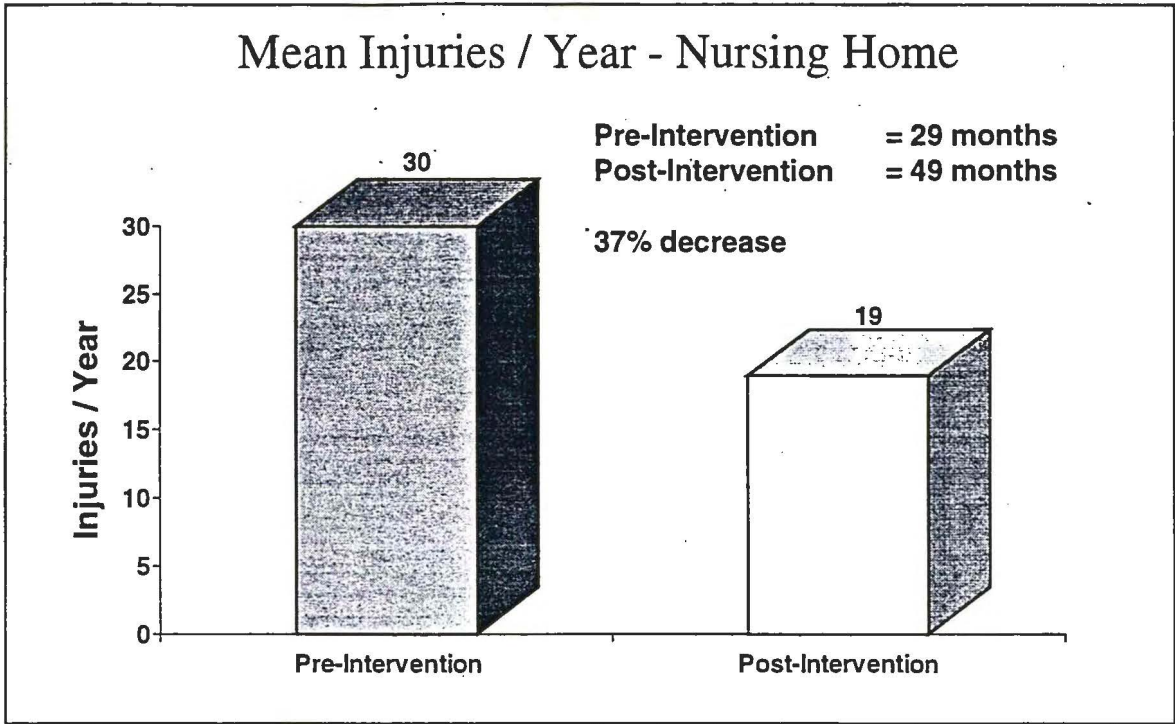


Figure 29: Number of injuries and lost workdays for the entire nursing home E before and after implementation of the “zero-lift program”.

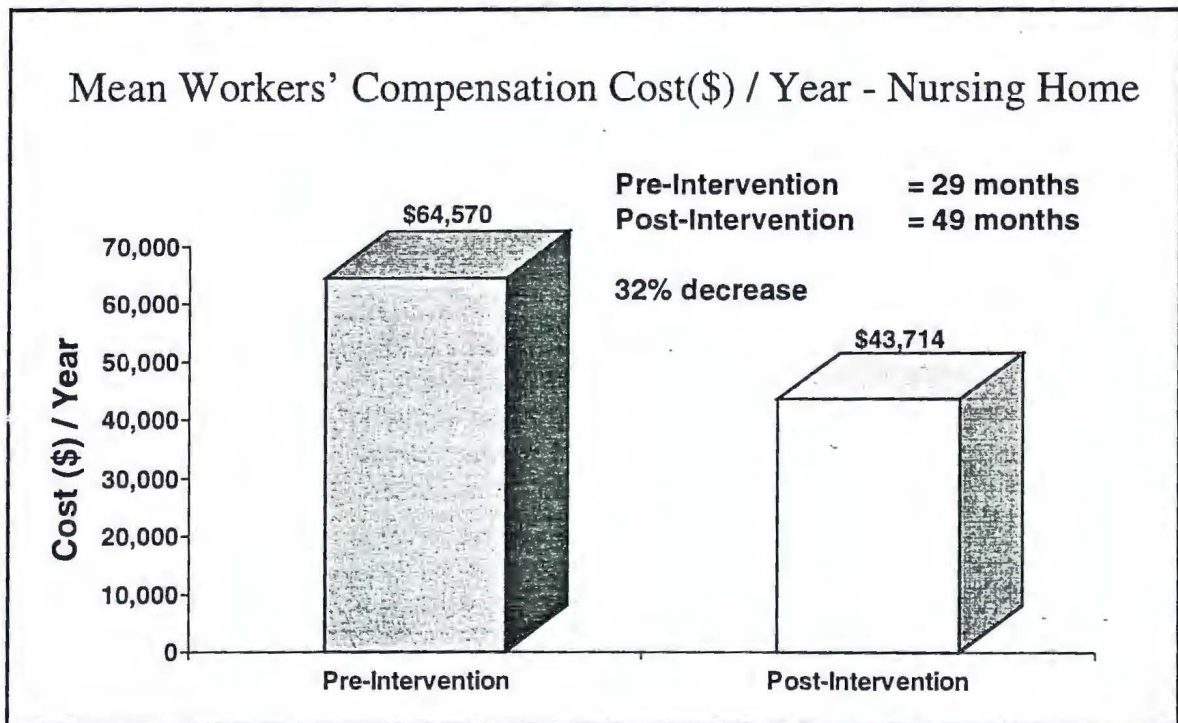
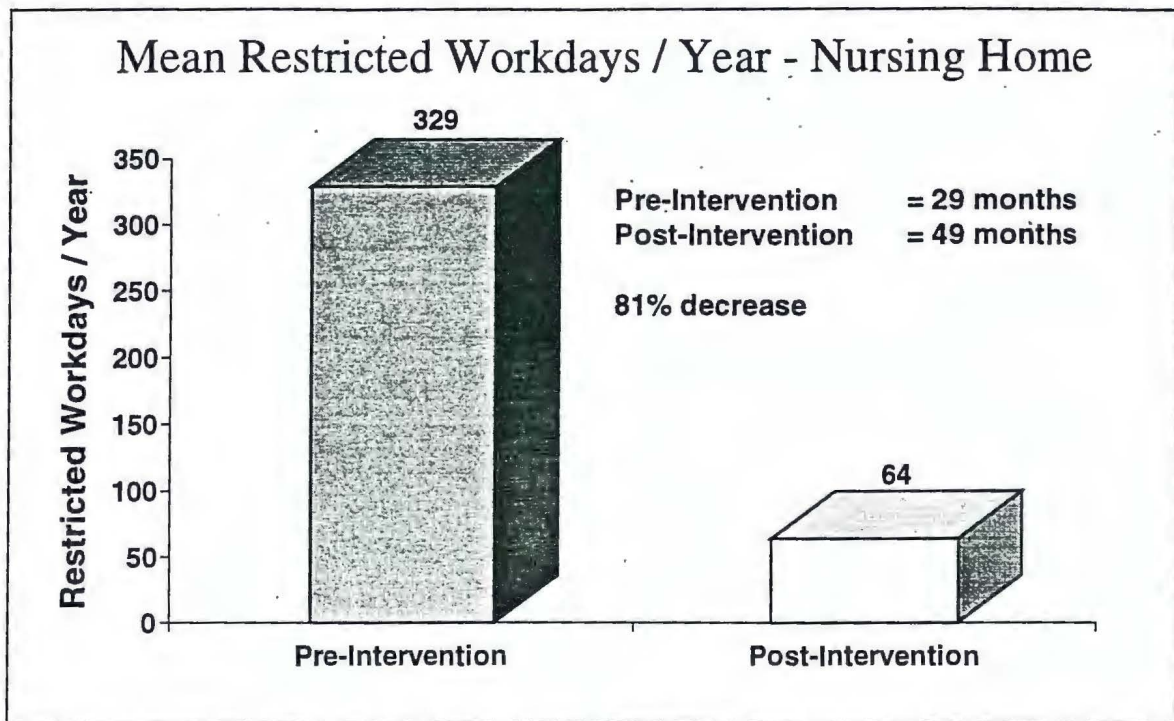


Figure 30: Restricted workdays and workers' compensation costs for the entire nursing home E before and after implementation of the "zero-lift program".

6.5 Nursing Home F

The “zero-lift program” in nursing home F was highly successful in reducing the number of injuries, lost workdays, restricted workdays, and workers’ compensation costs due to patient transfers. The patient transfer injuries decreased by 63% (Figure 31). More importantly, severity of these injuries, as measured by lost workdays, decreased by 94% (Figure 31). The associated restricted workdays decreased by 79% (Figure 32). After implementation of the “zero-lift program,” the workers’ compensation costs from patient transfer injuries were practically insignificant. On the average, they reduced to \$1,838 per year from \$102,396 per year, resulting in 98% improvement (Figure 32).

While injury statistics for the entire nursing home showed significant improvements, the decreases were not as pronounced as those associated with patient transfer injuries. The number of injuries for the entire nursing home decreased by 19% (Figure 33). The lost workdays for the entire nursing home decreased by 30% (Figure 33). The restricted workdays and the workers’ compensation costs showed greater improvements. These decreased by 48% and 62%, respectively (Figure 34).

One of the primary reasons why the nursing home was more successful in reducing patient transfer injuries than all injuries was a considerable increase in slip and fall injuries after implementation of the “zero-lift program.” The nursing home had a history of slip and fall injuries (Figure 35). In general, these used to be minor injuries resulting in a few lost workdays and involving relatively small amounts of workers’ compensation costs. However, these injuries became a major issue after implementation of the “zero-lift program.” The number of slip and fall injuries doubled after implementation of the program and the lost workdays increased from 0.4 per year to 30 per year (Figure 36). While there was no change in restricted workdays, the workers’ compensation costs associated with slip and fall injuries increased by 74% (Figure 37).

Slip and fall injuries were brought to the attention of the ergonomics committee by the investigator in 1994, immediately after implementation of the “zero-lift program.” In 1995, the nursing home had an epidemic of serious slip and fall injuries. There were 8 slip and fall injuries resulting in 65 lost workdays, 88 restricted workdays, and \$75,257 in workers’ compensation costs. In 1995, slips and falls accounted for 24% of all injuries, 92% of lost workdays, 62% of restricted workdays, and 92% of workers’ compensation costs for the entire nursing home. The reasons for slip and fall injuries included: urine in patient room (4 injuries), wet spot in a hallway, walking on ice over a window left in front of the back entrance, and ice in the parking lot. In early 1996, the ergonomics committee and the administrator decided to address slip and fall problems in the nursing home. The following actions were taken:

1. Identify the patient rooms with urine on the floor. These rooms and the care plans of these patients will be marked by blue dots to indicate possibility of water on the floor.
2. During the day shift, housekeeping will be responsible for frequently checking these rooms for liquid on the floor.

3. On the night shift, nursing aides will check these rooms for liquid on the floor.
4. Provide additional mops and buckets for cleaning up spills.
5. Make these mops and buckets easily accessible by storing them in central locations.
6. Provide flashlights at central locations, on linen carts and nursing carts.
7. Anyone that sees a spill is responsible for either putting a wet floor sign out, contacting a housekeeper, or cleaning it himself/herself.
8. Present all changes in the facility newsletter as well as inform the entire staff.

The slip and fall injuries decreased substantially in 1996, reappeared in 1997, and for the first 7 months in 1998 there were no slip and fall injuries.

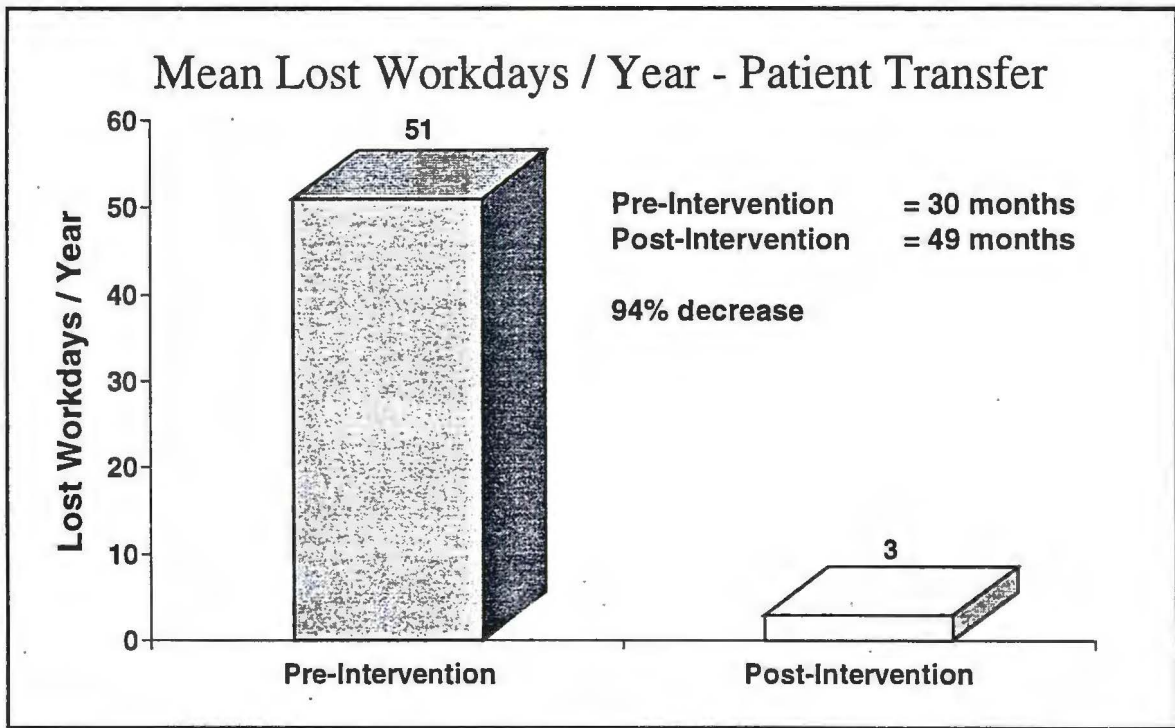
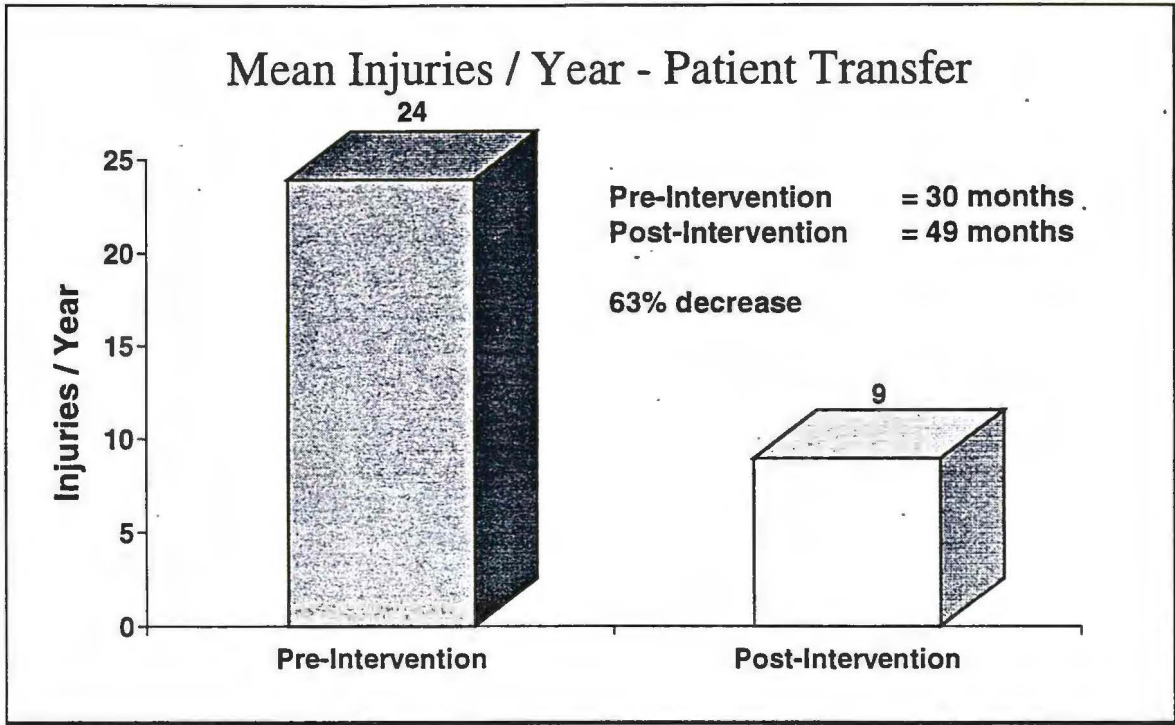


Figure 31: Number of injuries and lost workdays from patient transfers before and after implementation of the “zero-lift program” in nursing home F.

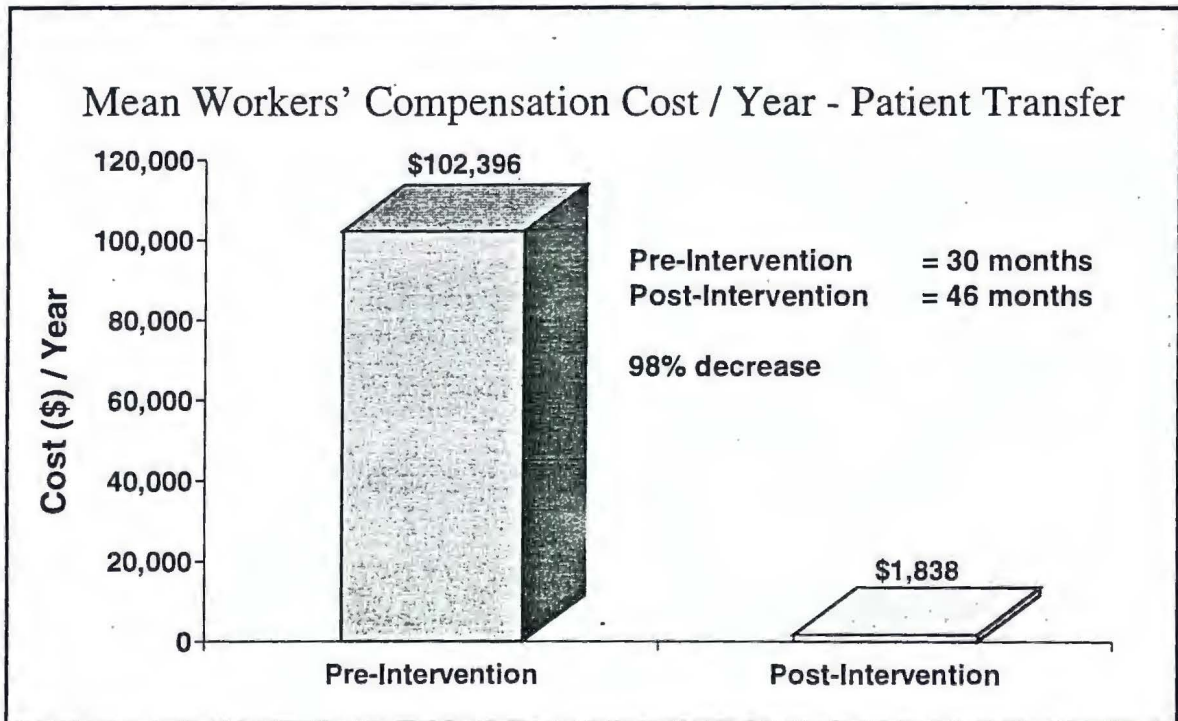
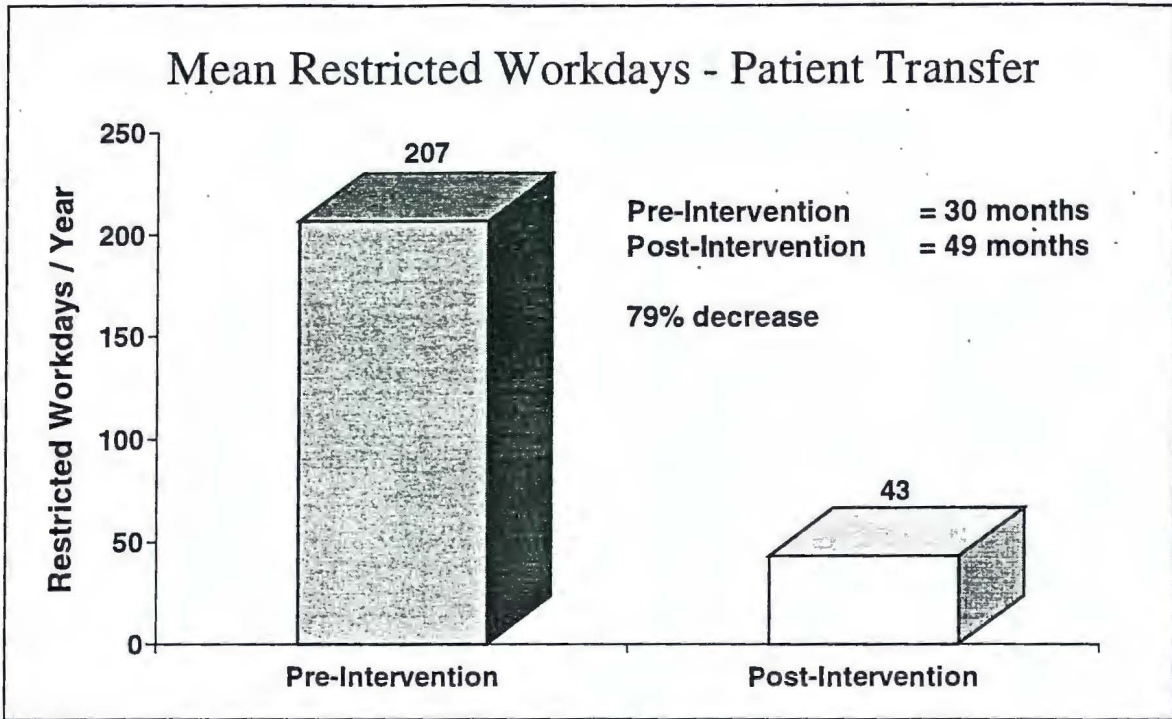


Figure 32: Restricted workdays and workers' compensation costs from patient transfers before and after implementation of the "zero-lift program" in nursing home F.

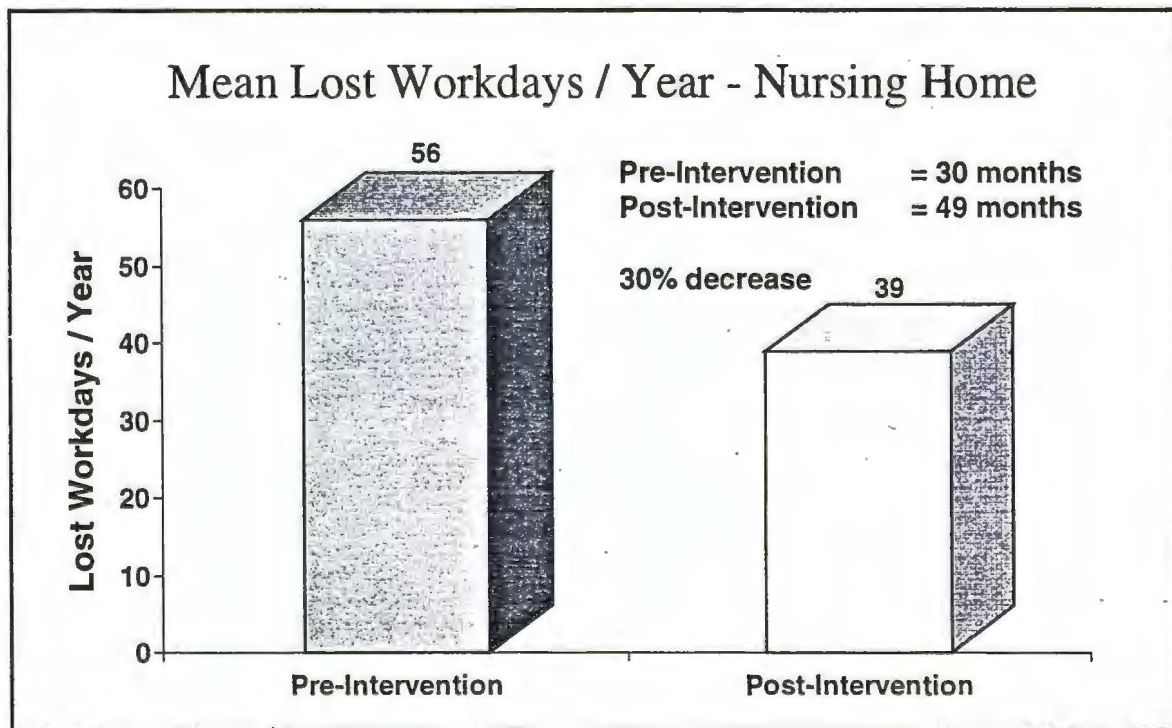
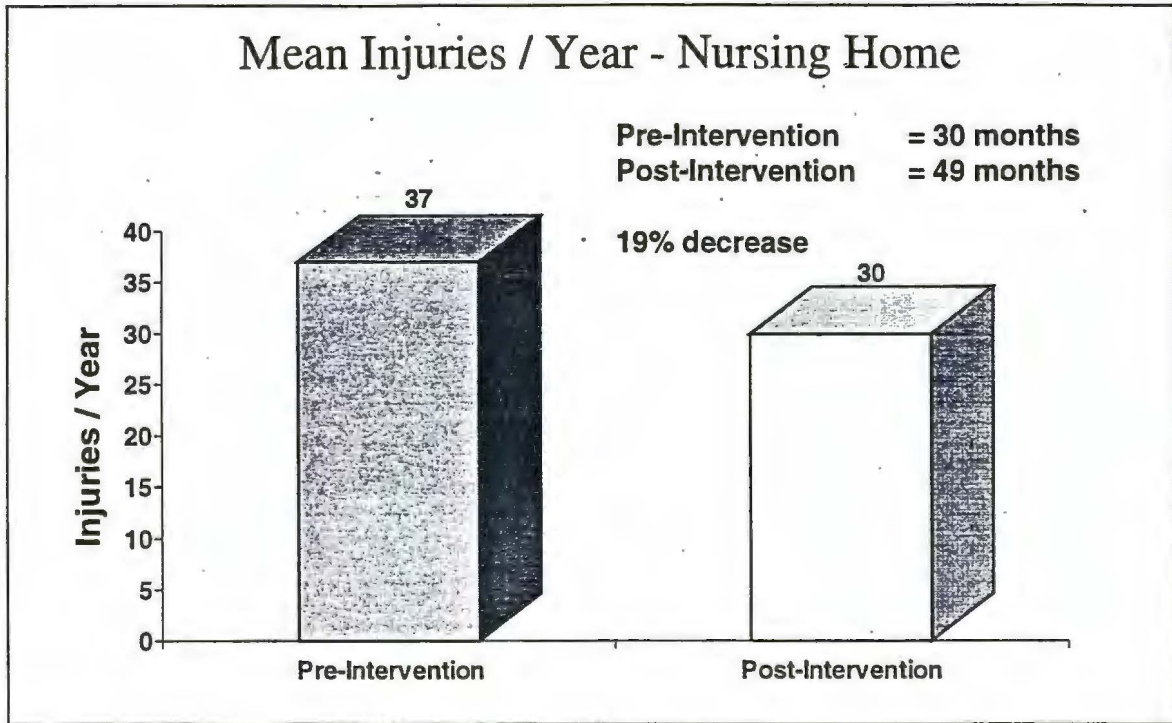


Figure 33: Number of injuries and lost workdays in the entire nursing home F before and after implementation of the “zero-lift program”.

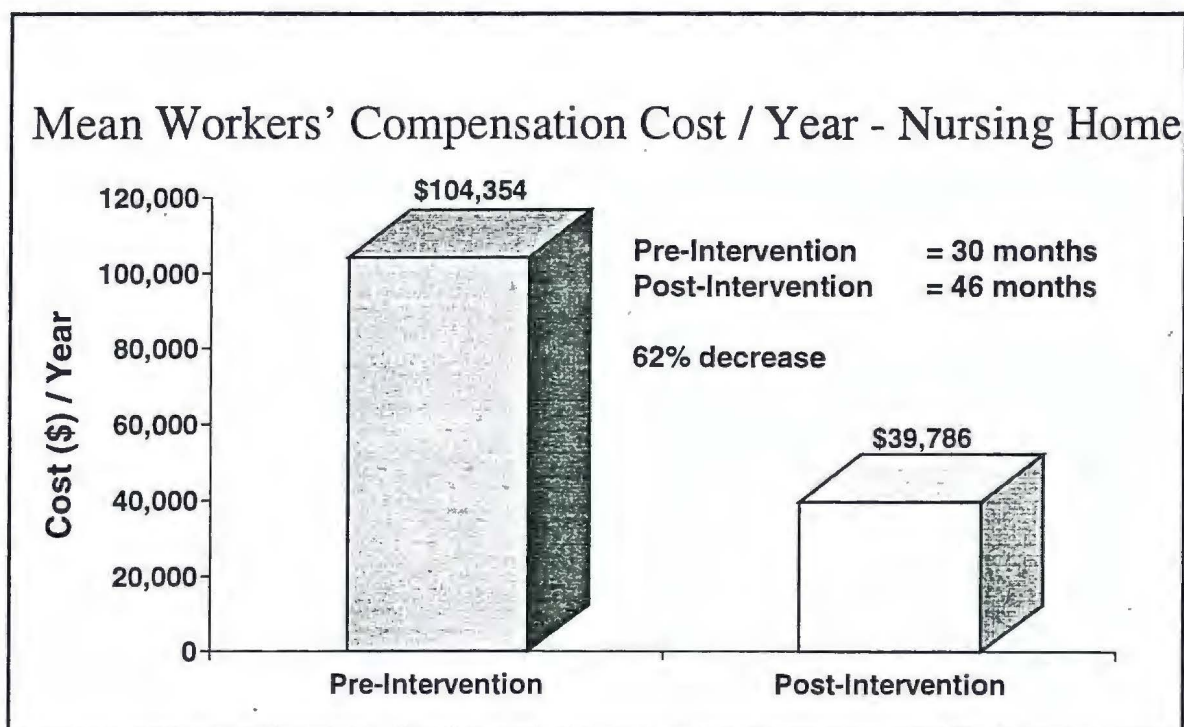
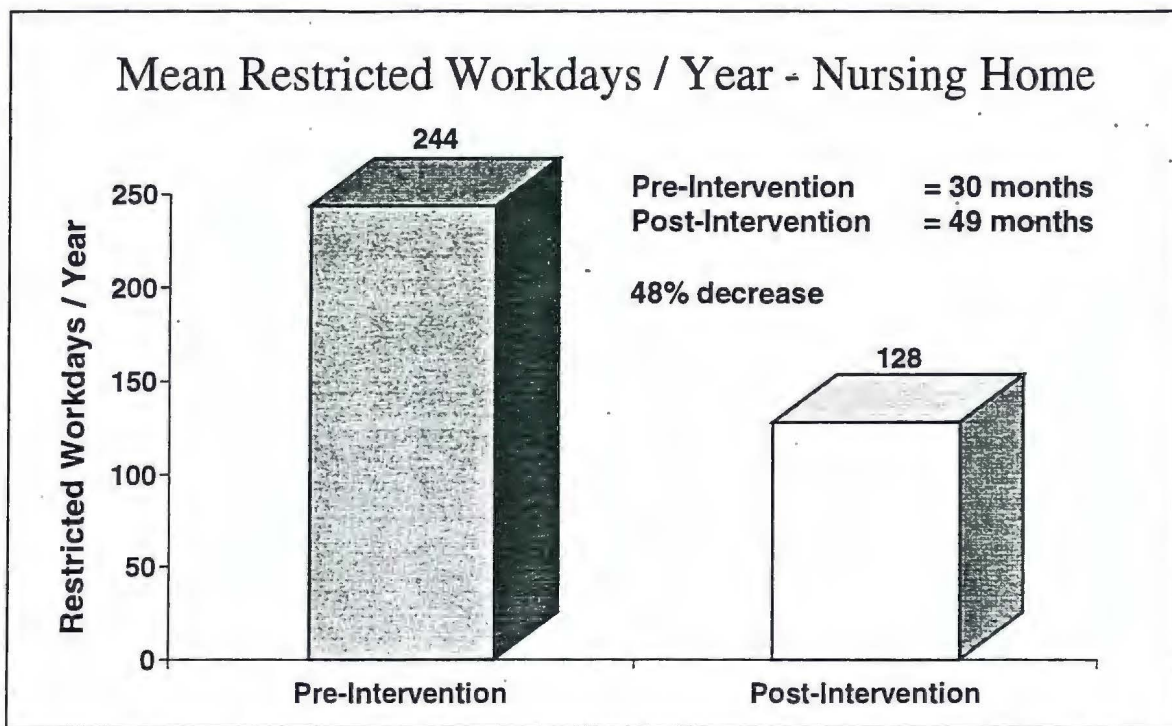


Figure 34: Restricted workdays and workers' compensation costs for the entire nursing home F before and after implementation of the "zero-lift program".

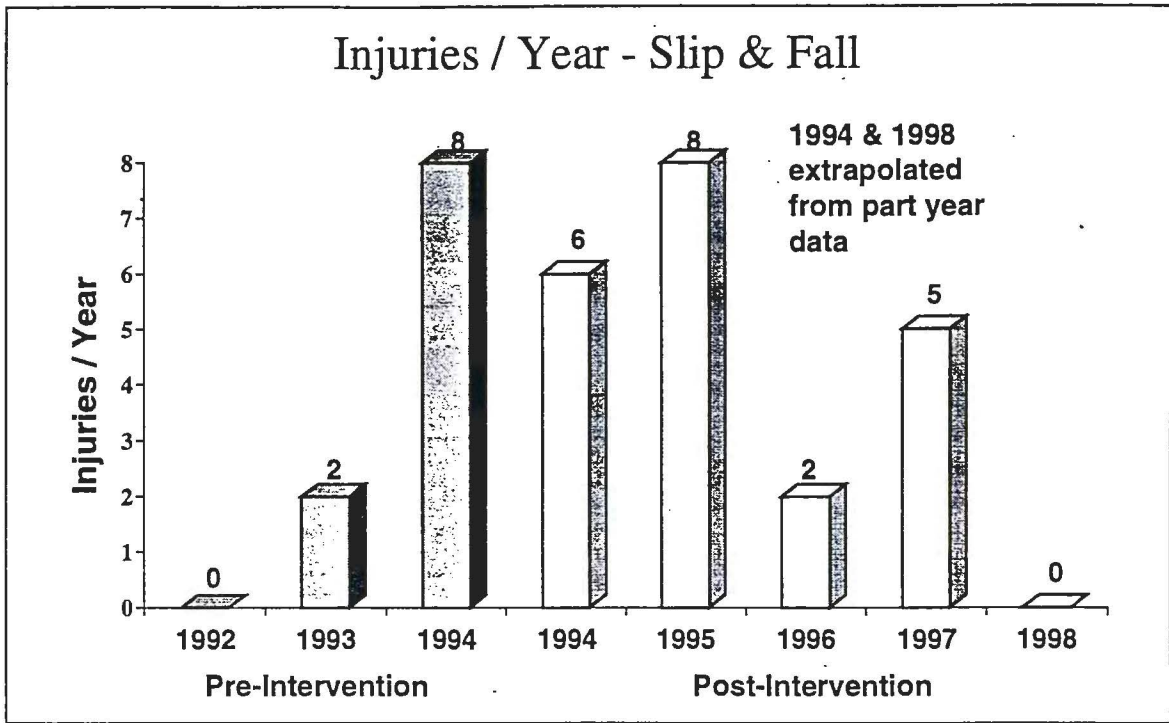


Figure 35: Slip and fall injuries in nursing home F.

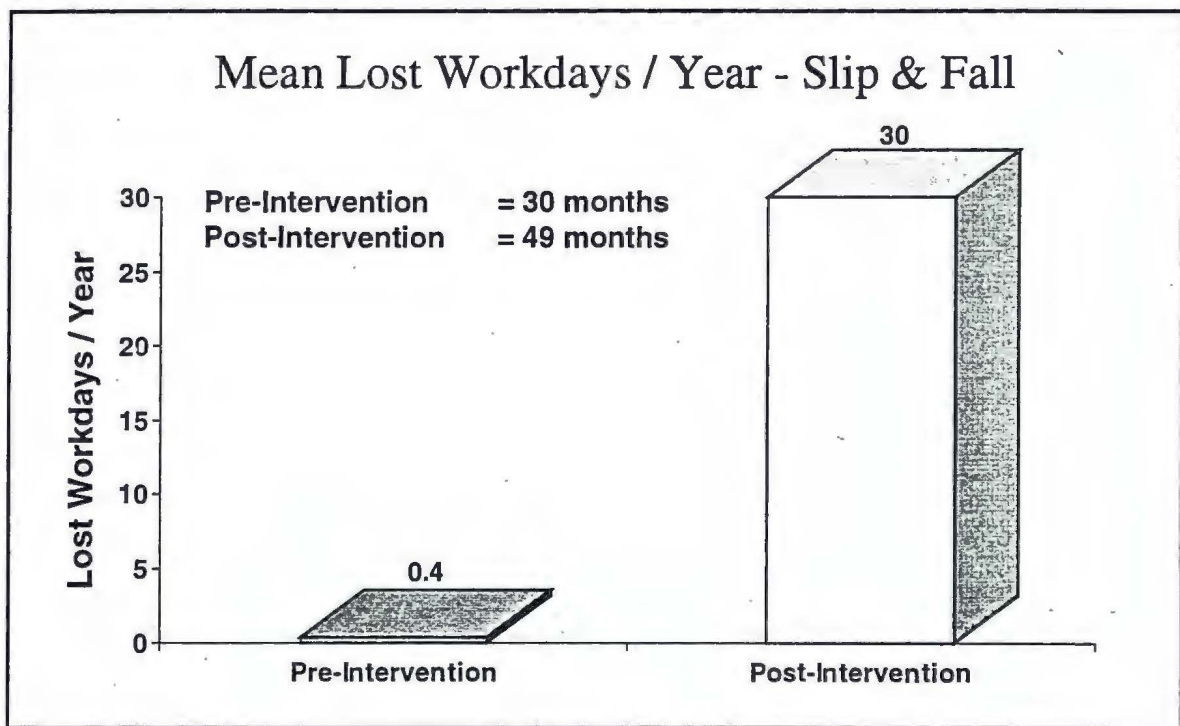
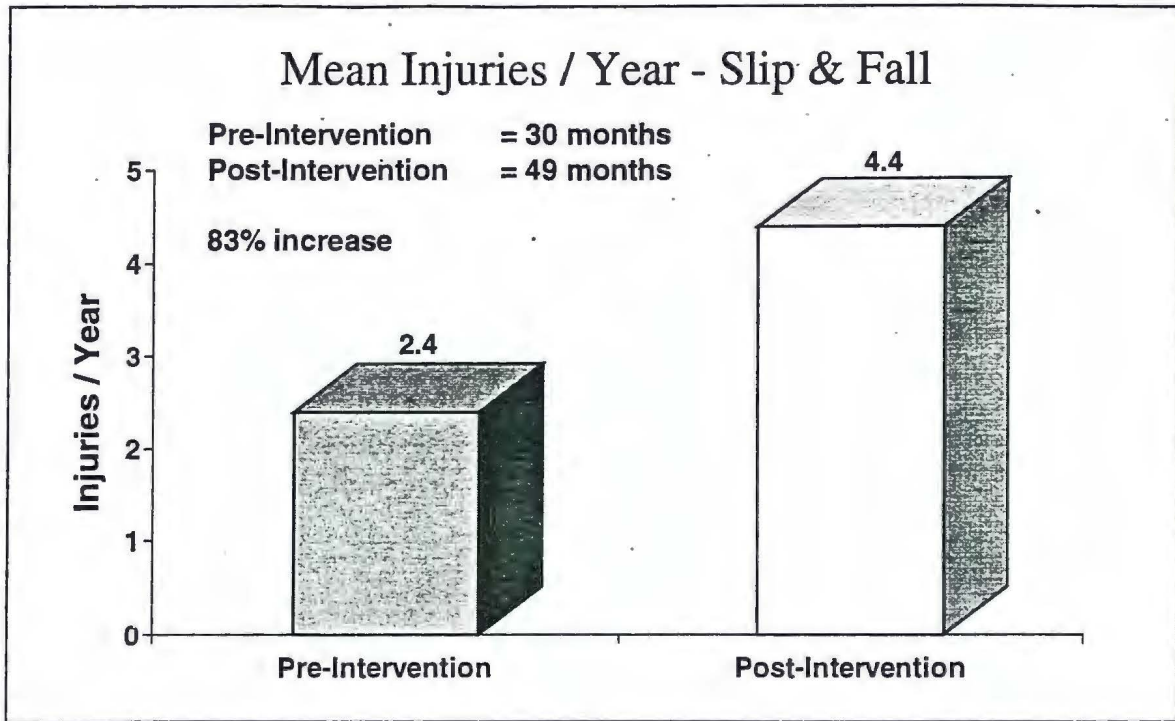


Figure 36: Number of injuries and lost workdays due to slip and fall in nursing home F before and after implementation for the “zero-lift program”

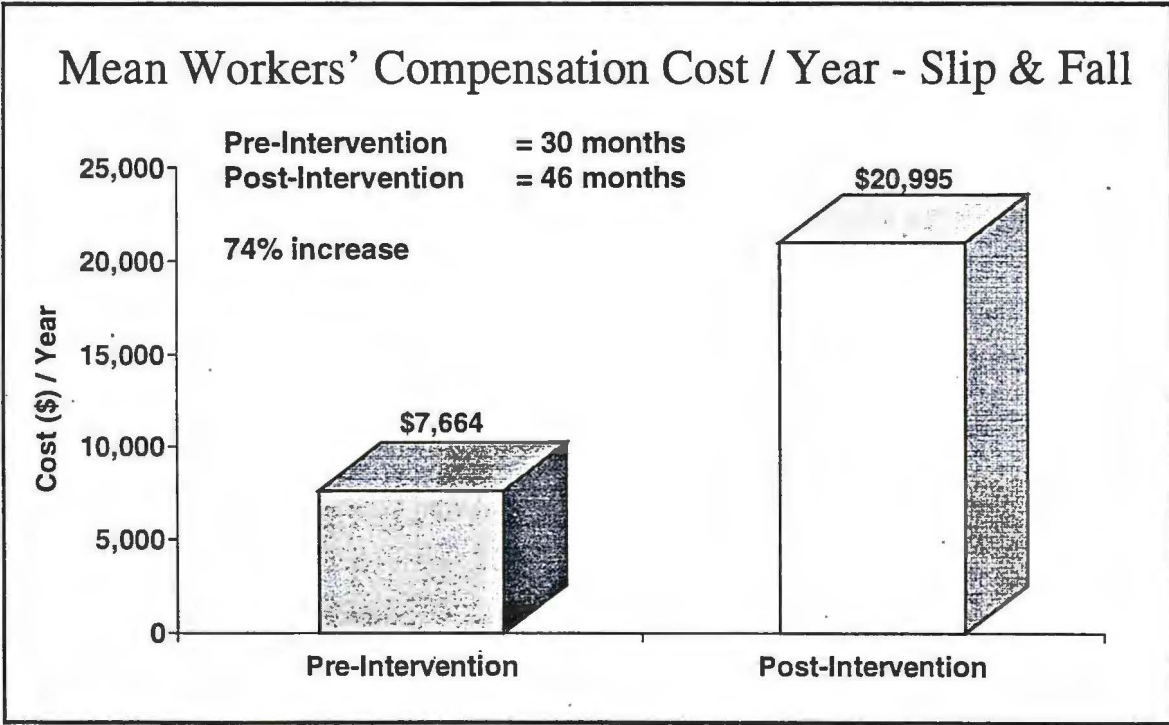
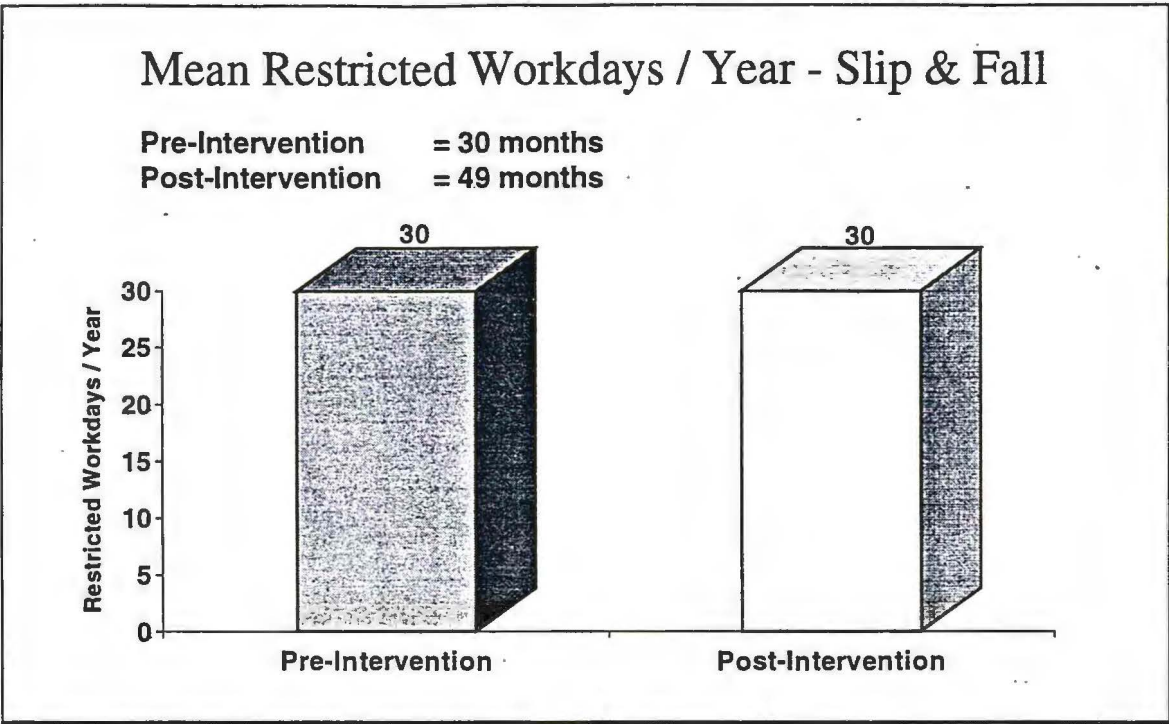


Figure 37: Restricted workdays and workers' compensation costs due to slip and fall injuries in nursing home F before and after implementation of the "zero-lift program".

6.6 Nursing Home G

The “zero-lift program” in nursing home G was highly successful and had a major impact on patient transferring injuries (Figure 38). The patient transfer injuries showed a marked improvement after implementation of the “zero-lift program” (Figure 38). On the average, the number of patient transfer injuries decreased by 78% (Figure 39). More importantly, these were minor injuries and most of them did not result in lost workdays. On the average, the lost workdays decreased from 217 per year to 3 per year (99% improvement) (Figure 39). The restricted workdays from patient transfer injuries decreased by 77% (Figure 40). Similar to the lost workdays, the workers’ compensation costs associated with these injuries showed the most improvement. It decreased from \$117,731 per year to \$1,093 per year (99% improvement) (Figure 40).

The ergonomics intervention also reduced injuries in the entire nursing home (Figure 41). Prior to the intervention, the injuries appeared to be on the rise (Figure 41). After the intervention, the injuries had a declining trend (Figure 41). The number of injuries in the entire nursing home decreased by 33% (Figure 42). Similar to the patient transfer injuries, the lost workdays showed greater improvement. On the average, lost workdays for the entire nursing home decreased by 56% (Figure 42). The restricted workdays for the entire nursing home decreased by 39% and the workers’ compensation costs by 79% (Figure 43). The nursing home had a small but well organized and active ergonomics committee. There was continuity of the committee members. There was a time when the nursing home was without a permanent administrator, but the committee members remained focussed.

One important finding was that a nursing aide had suffered a serious low-back injury from patient transfer prior to implementation of the “zero-lift program.” She was operated for a herniated disc and placed on permanent restrictions. These restrictions included no lifting of more than 40 lbs., no repetitive lifting, and no repetitive bending. There was no way she could perform her regular duties as a nursing aide without the ergonomics intervention. She returned to work right after the “zero-lift program” was implemented with permanent restrictions in her file. During the entire post intervention period of 48 months she performed all her duties as a nursing aide, including all patient transfers as if there were no restrictions. For all practical purposes, these restrictions had disappeared. Similarly, there were a few pregnant nursing aides during the post-intervention phase of the study, they all continued to work well into their pregnancies.

On the negative side, there were a few expensive injuries that did not appear to be work related. In 1995, a community health nurse complained of leg pain while walking to her car and carrying a tray of cookies in the nursing home parking lot. She did not slip, trip or fall down. She used to wear foot braces. Several years ago, in the nineteen eighties, she was diagnosed with rheumatoid arthritis. This claim resulted in 15 lost workdays, 27 restricted workdays, and \$3,900 in workers’ compensation costs. Later in 1996, the same individual claimed that her rheumatoid arthritis was caused by walking in the nursing home. This claim resulted in 235 lost workdays and \$64,500 in workers’ compensation costs prior to the settlement. This single claim in 1996, accounted for 95% of all lost workdays in the nursing home and 83% of all workers’ compensation costs.

A nursing aide suffering from degenerative spine disease suffered a herniated disc while dressing a resident in bed in 1995. This injury resulted in 4 lost workdays, 157 restricted workdays, and \$24,796 in workers' compensation costs. A dietary aide claimed radial fracture without any accident (1 lost workday, 53 restricted workdays and \$717 in cost). The bathrooms and kitchen areas were slippery due to high humidity and lack of ventilation. These were identified potential hazards and caused some slip and fall injuries. However, these problems could not be addressed due to lack of economic resources.

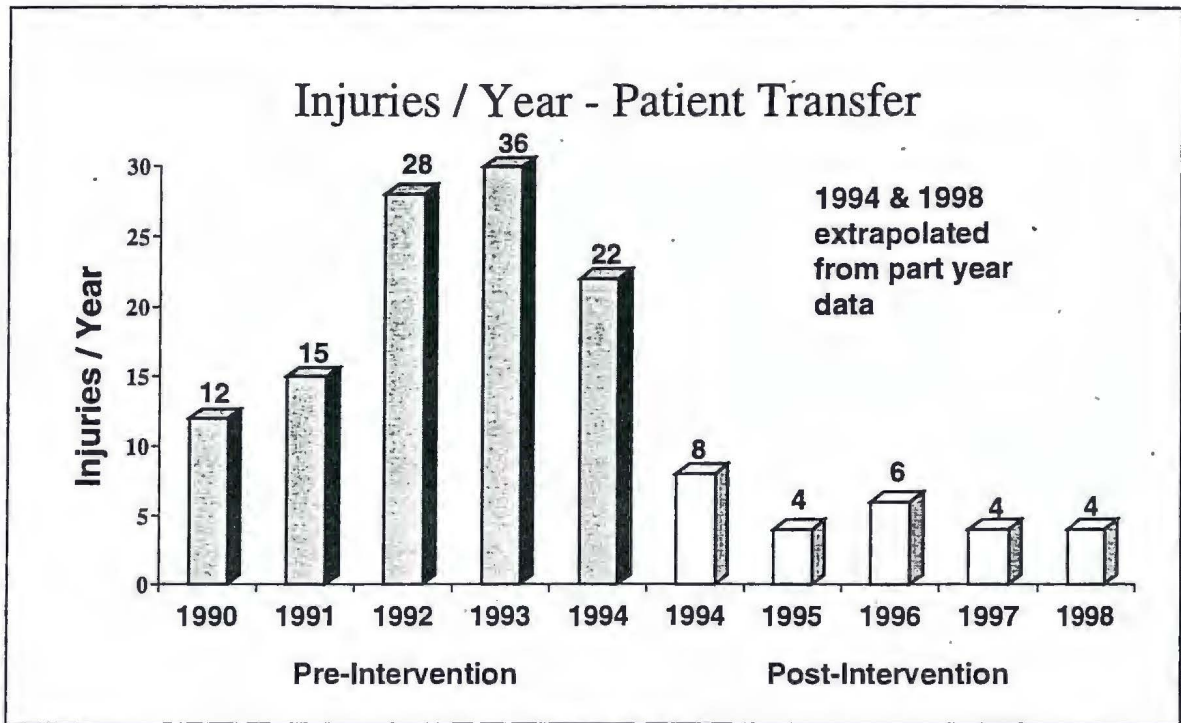


Figure 38: Patient transfer injuries in nursing home G.

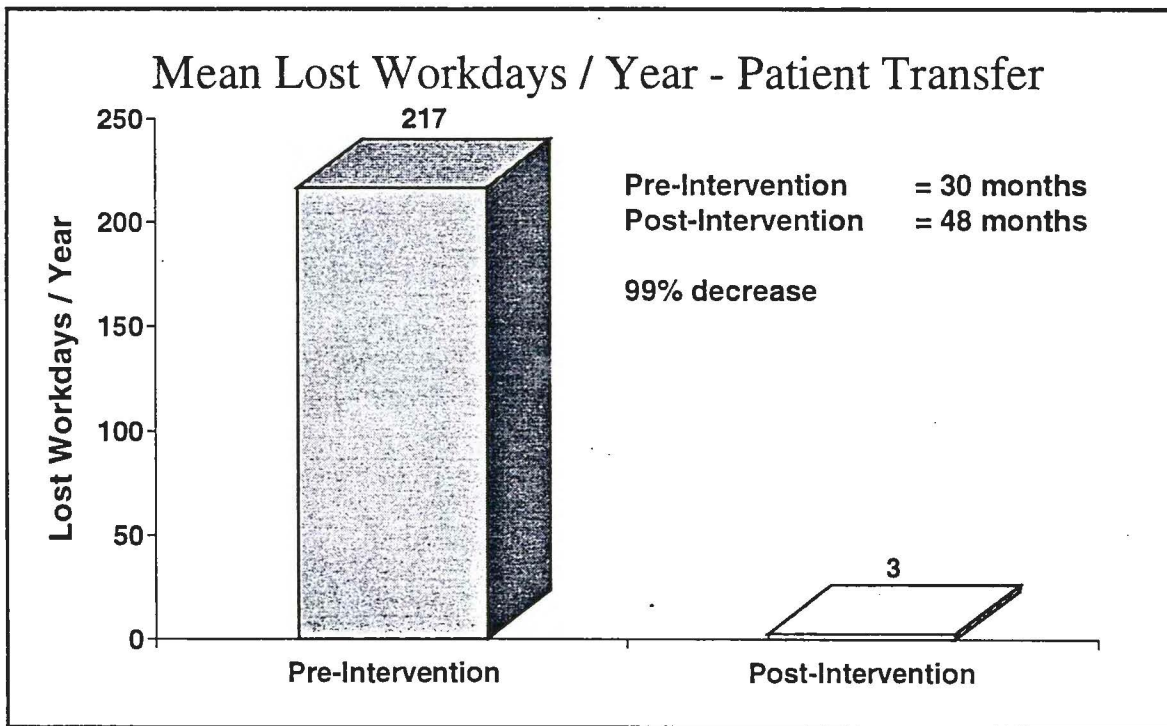
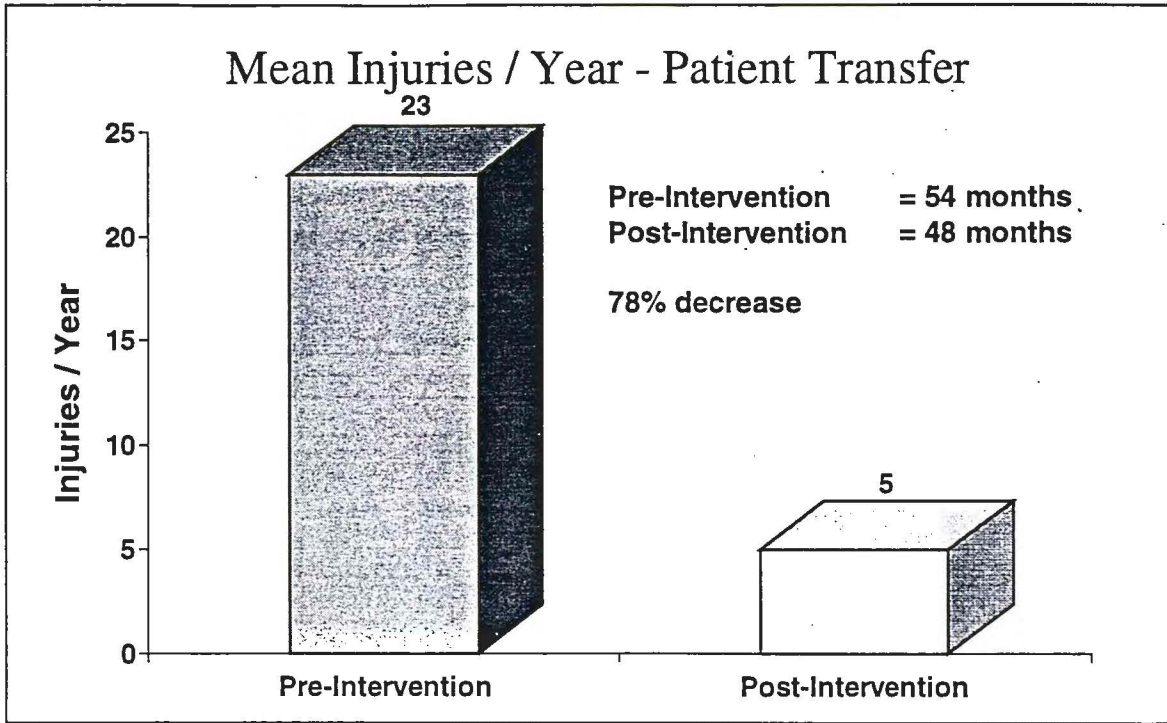


Figure 39: Number of injuries and lost workdays from patient transfers before and after implementation of the zero-lift program in nursing home G.

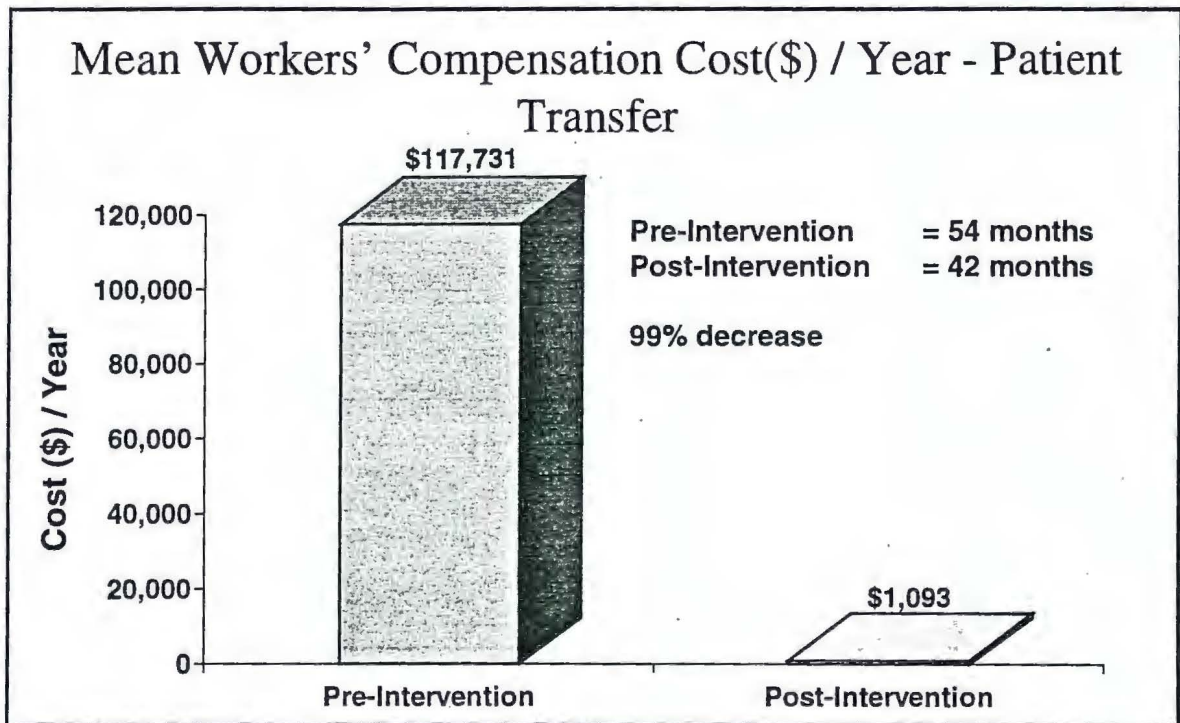
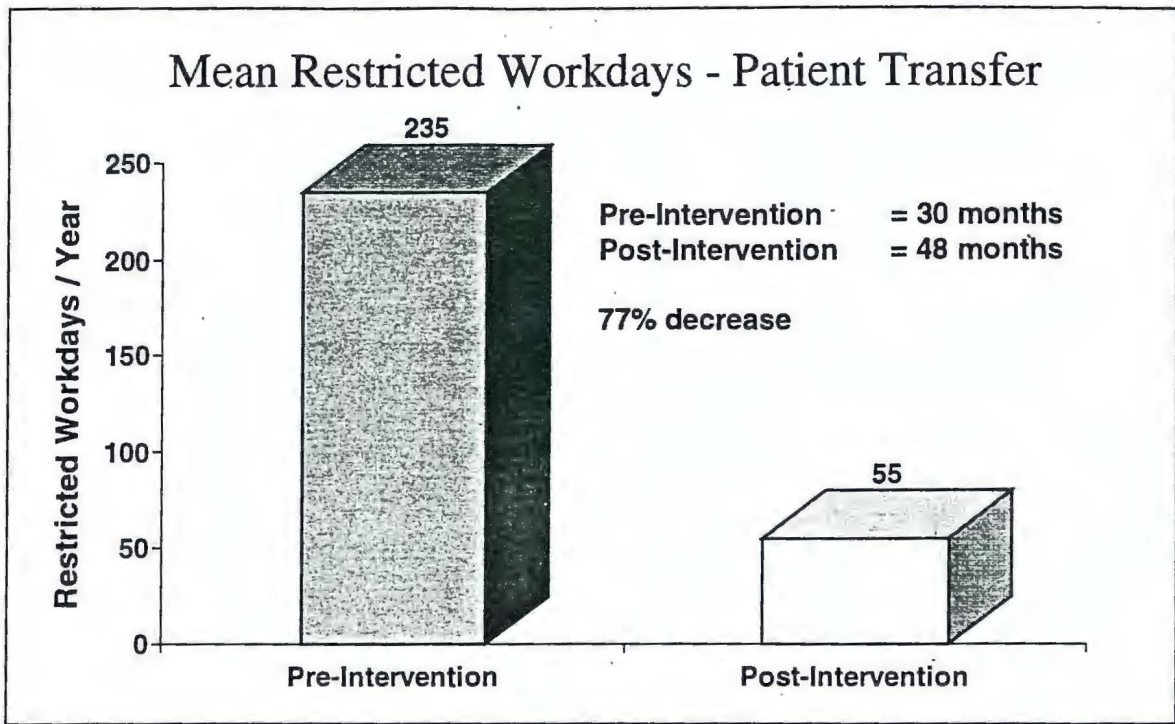


Figure 40: Restricted workdays and workers' compensation costs from patient transfers before and after implementation of the zero-lift program in nursing home G.

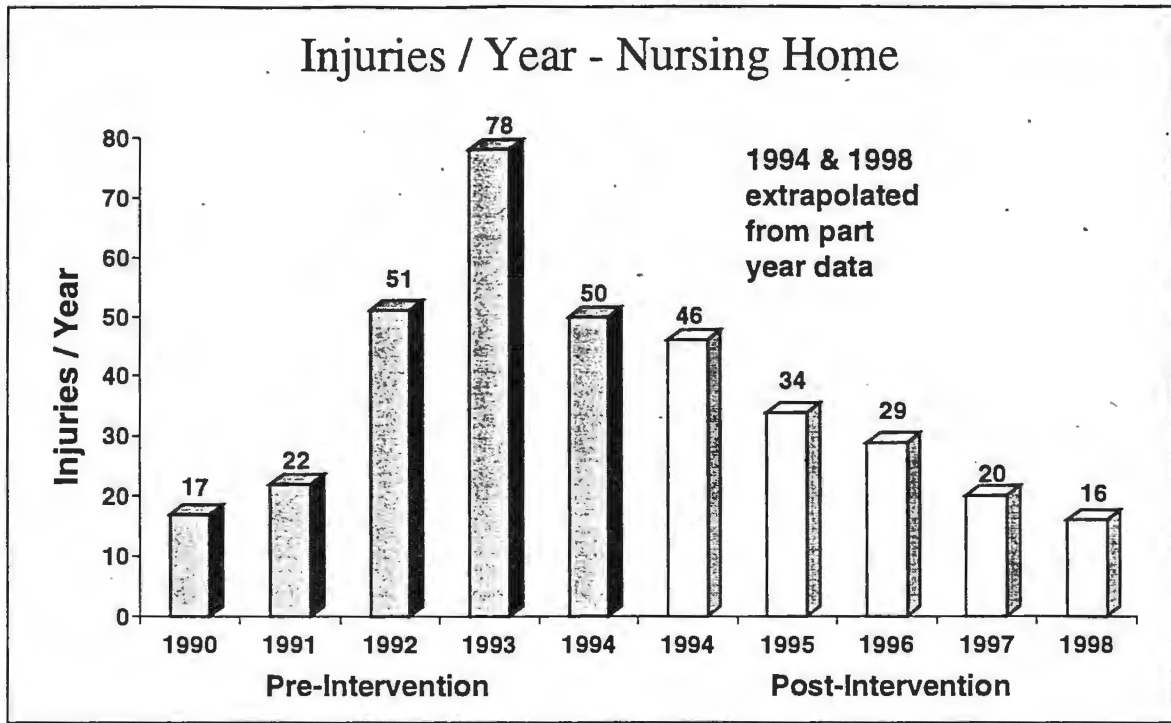


Figure 41: Total number of injuries in nursing home G.

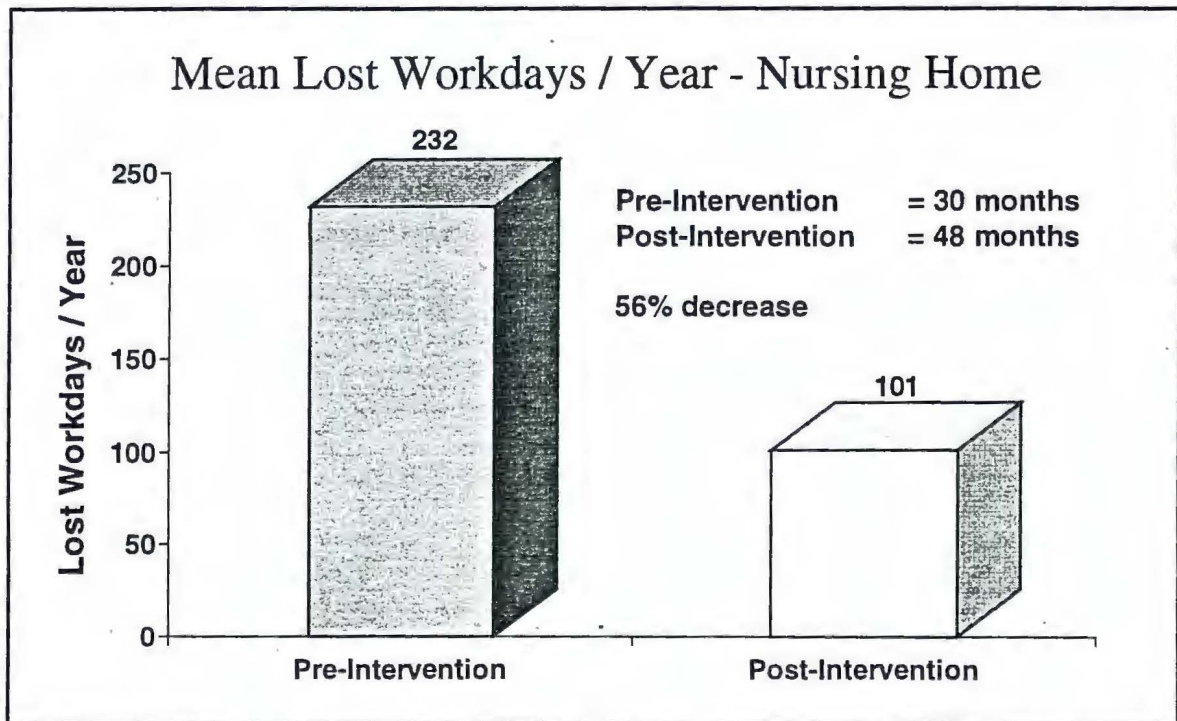
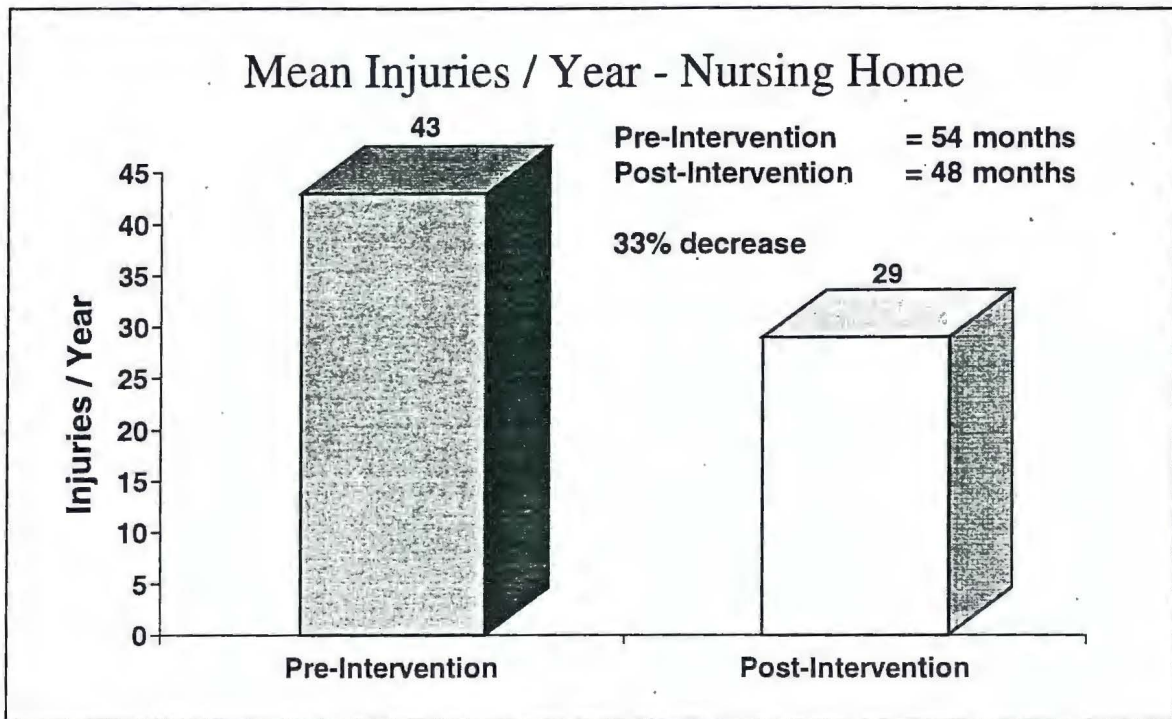


Figure 42: Number of injuries and lost workdays in ht entire nursing home G before and after the implementation of the “zero-lift program”

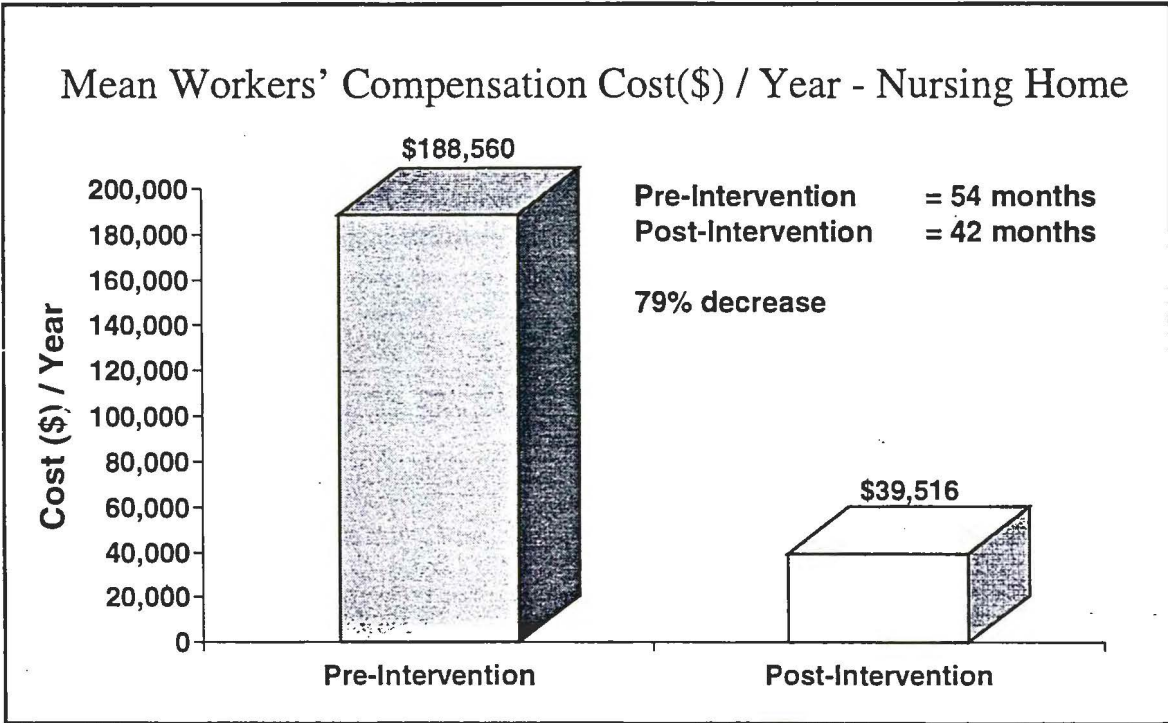
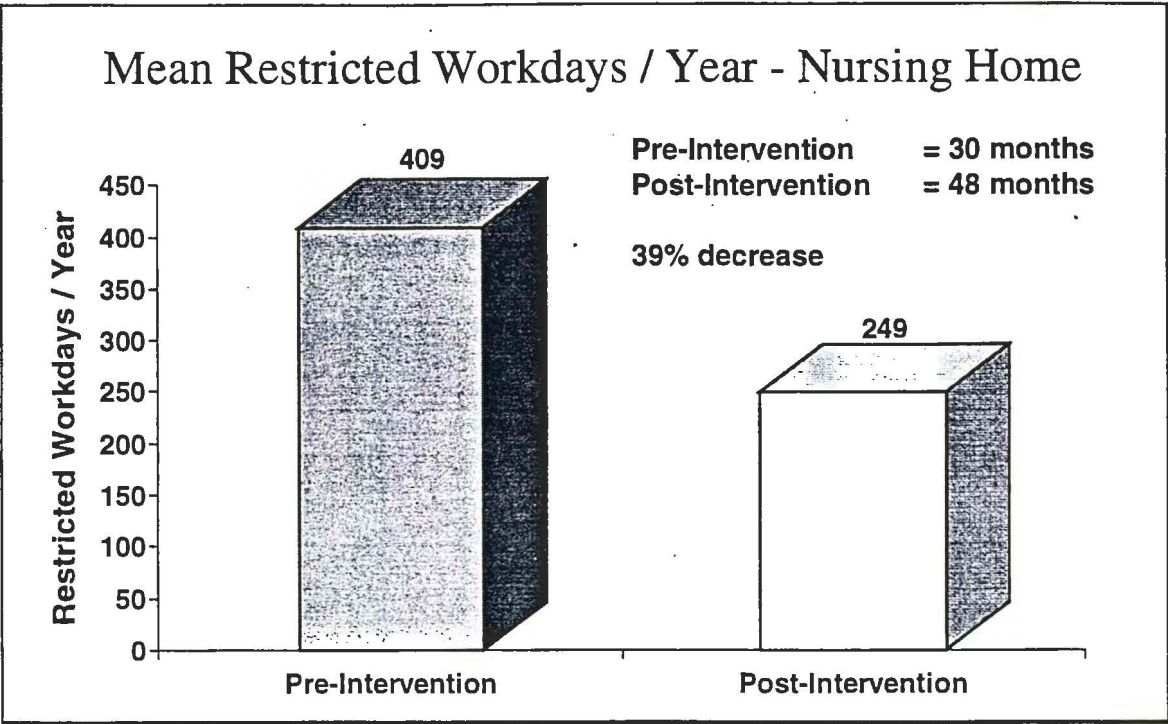


Figure 43: Restricted workdays and workers' compensation costs for the entire nursing home G before and after implementation of the "zero-lift program".

6.7 Nursing Home H

Nursing home H showed significant decreases in the number of injuries, lost workdays, restricted workdays, and workers' compensation costs from patient transfers after implementation of the "zero-lift program." The above injury statistics also decreased for the entire nursing home but the decreases were less pronounced as compared to those associated with patient transfers. The number of injuries from patient transfers decreased by 64% (Figure 44). Similar to other nursing homes, the lost workdays associated with patient transfers showed a more profound effect and decreased by 80% (Figure 44). The restricted workdays from patient transfers decreased by 84% (Figure 45). The workers' compensation costs from patient transfers showed the most effect, decreasing by 90% (Figure 45).

Regarding the entire nursing home, the injuries decreased by 30% and lost workdays by 81% (Figure 46). The restricted workdays showed 75% improvement and workers' compensation costs 66% improvement (Figure 47).

The "zero-lift program" had a greater impact on lost workdays, restricted workdays and workers' compensation costs than on the number of injuries reported. This was true both for patient transfer injuries as well as all injuries in the nursing home. This shows that the program had greater impact on severity of injuries than incidence of injuries.

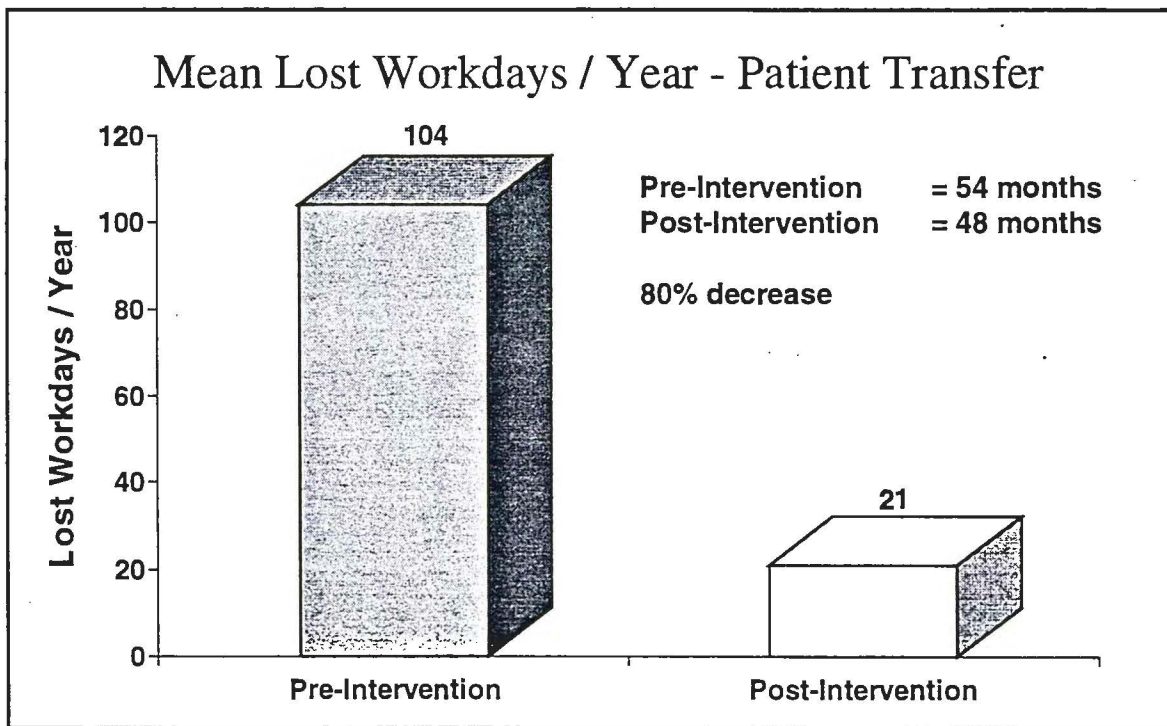
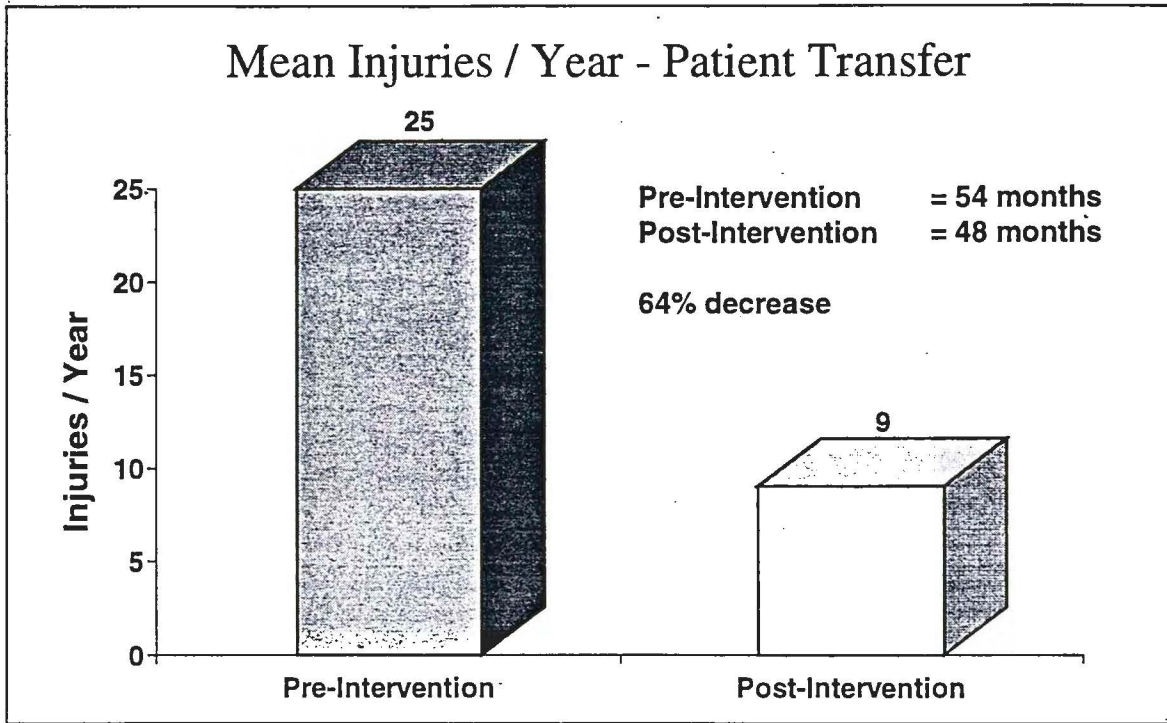


Figure 44: Number of injuries and lost workdays from patient transfers before and after implementation of the “zero-lift program” in nursing home H.

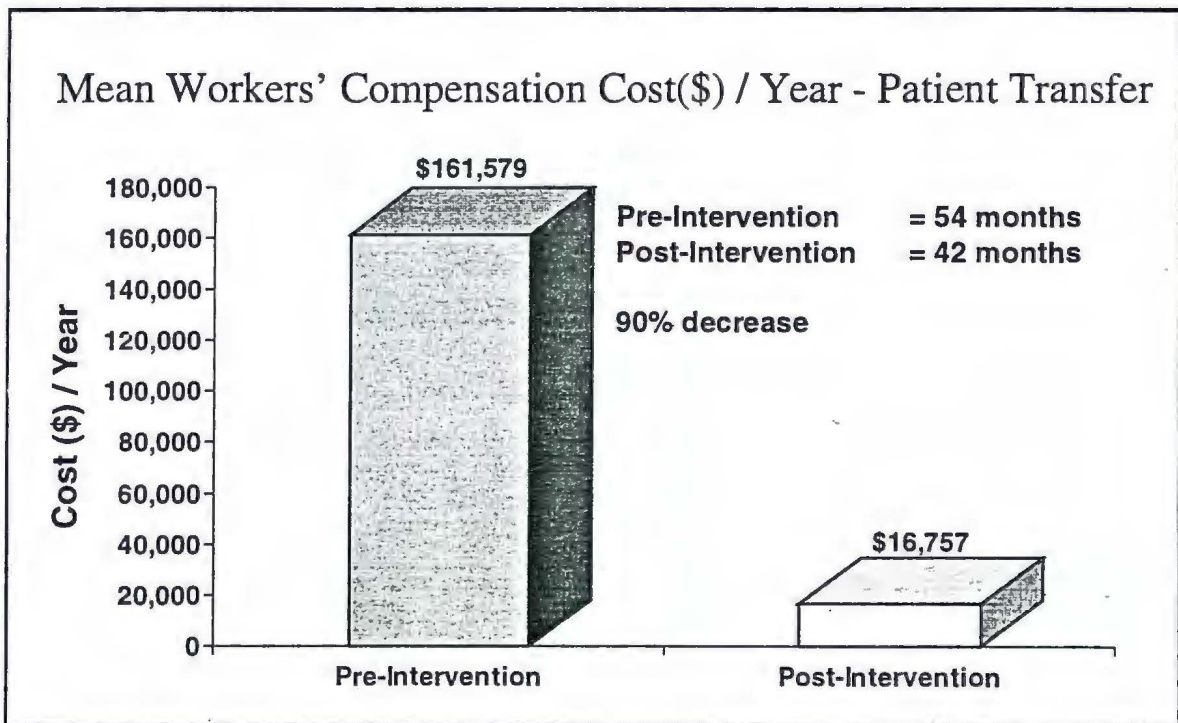
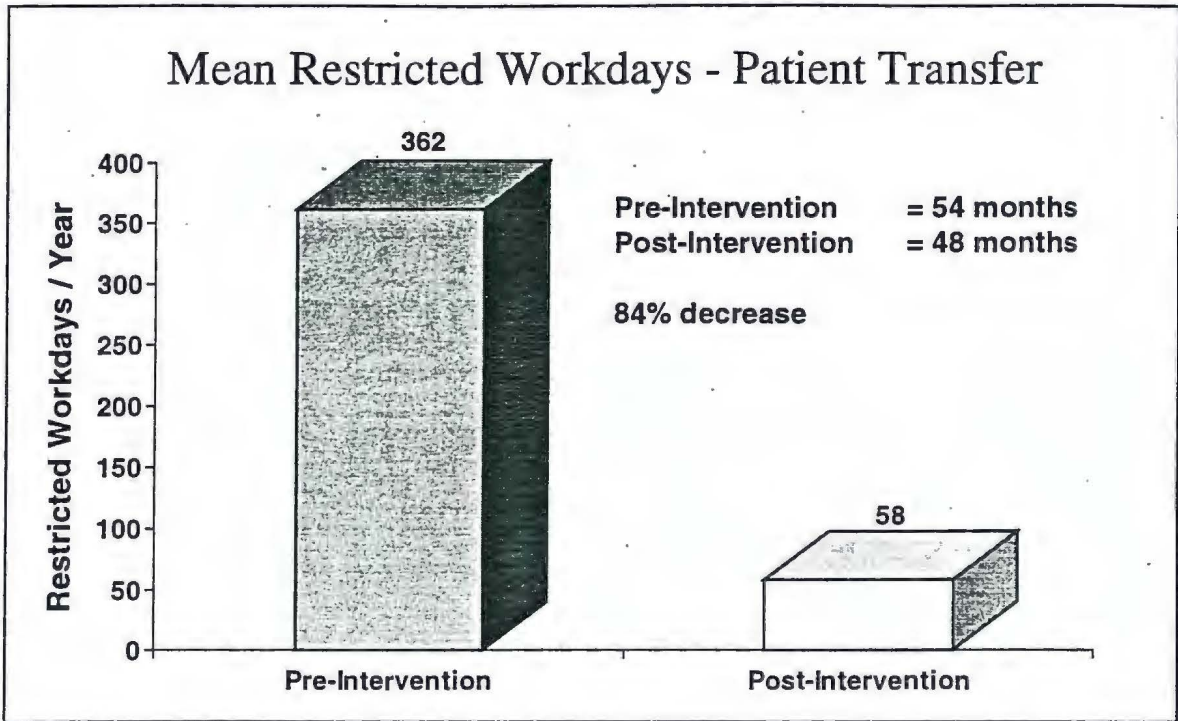


Figure 45: Restricted workdays and workers' compensation costs from patient transfers before and after implementation of the "zero-lift program" in nursing home H.

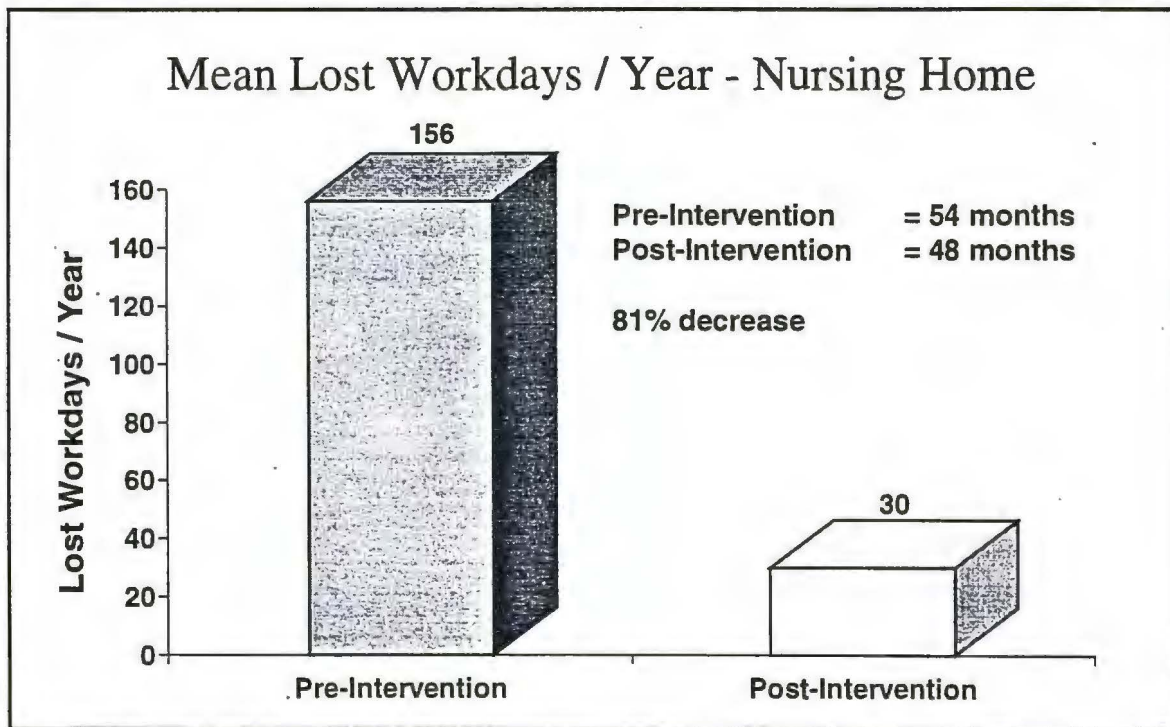
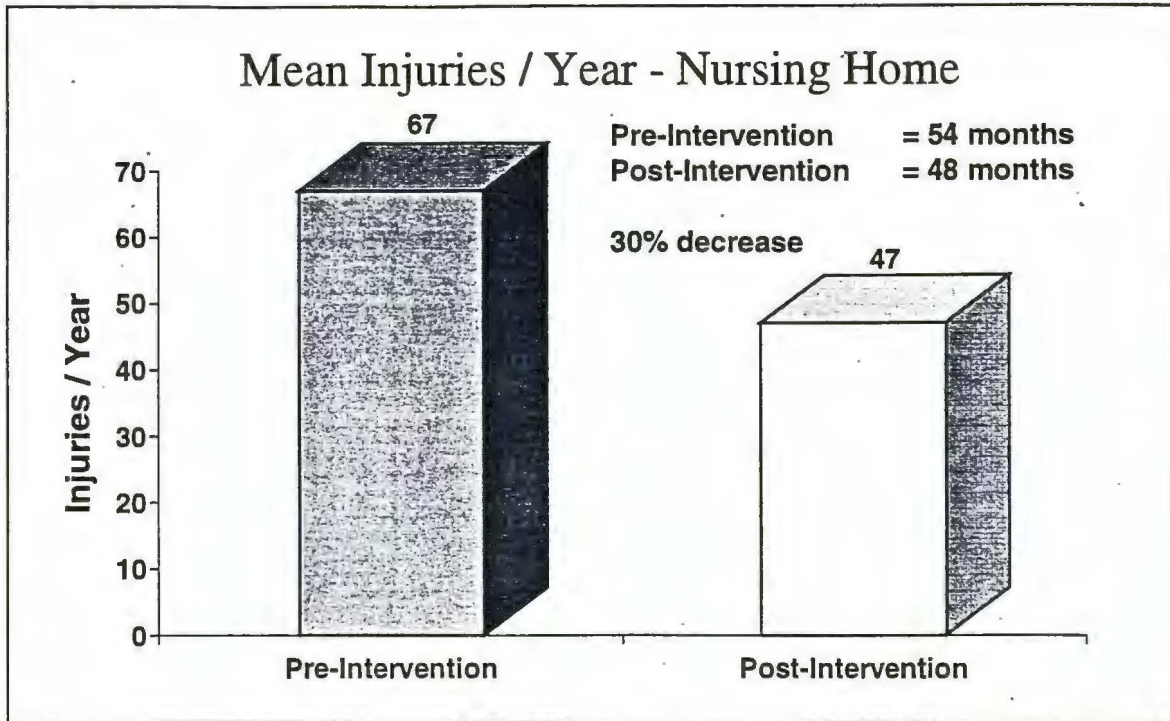


Figure 46: Number of injuries and lost workdays for entire nursing home H before and after implementation of the “zero-lift program”.

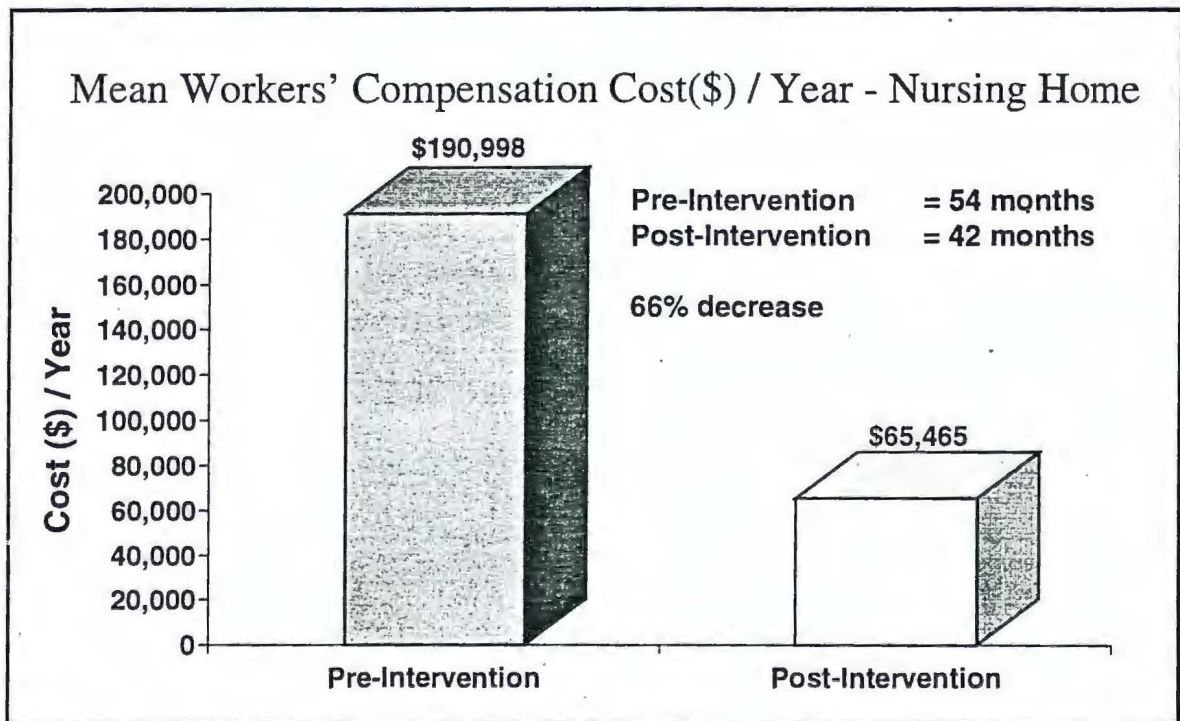
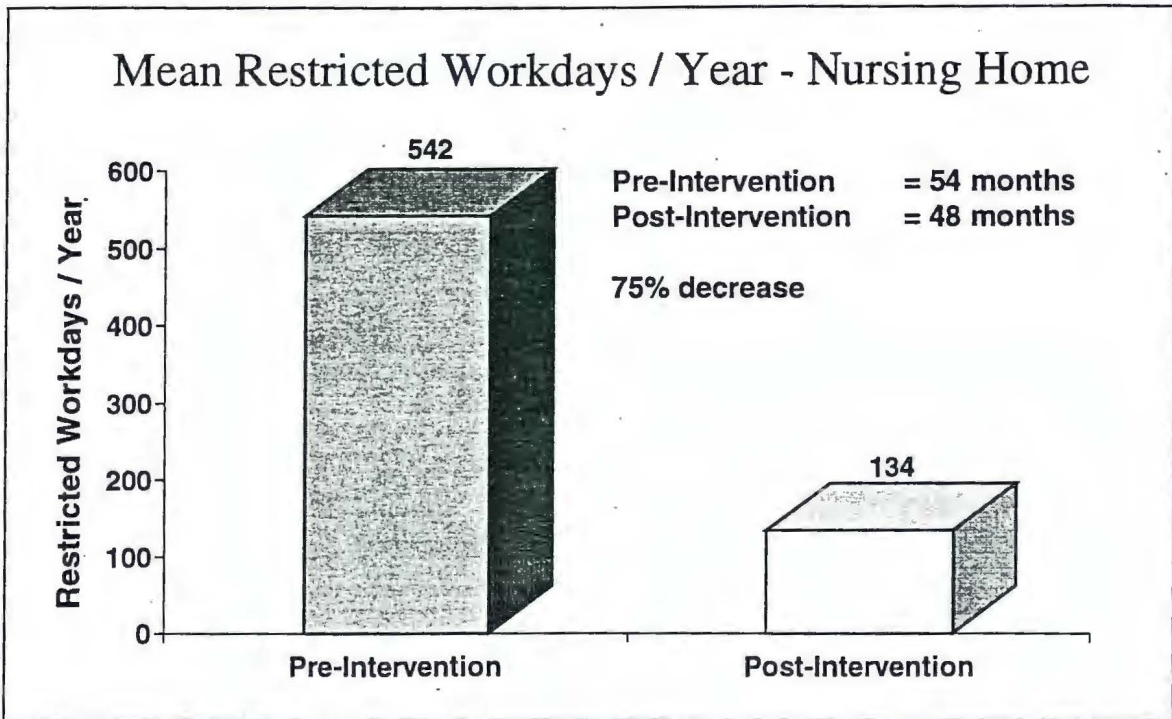


Figure 47: Restricted workdays and workers compensation costs for the entire nursing home H before and after implementation of the “zero-lift program”.

7. DISCUSSIONS

The “zero-lift programs” implemented using participatory ergonomics were highly effective in reducing the number of injuries, lost workdays, and workers’ compensation costs in all eight health-care facilities. The injuries from patient transfers decreased by 62% (range = 39% - 78%) (Table 13). On the average, the lost workdays from patient transfers for the eight facilities decreased by 86% (range = 50% - 99%) (Table 14) and the restricted workdays by 64% (Table 15). The workers’ compensation costs from patient transfers decreased by 84% (range = 53% - 99%) (Table 16). The greater reductions in the lost workdays and the workers’ compensation costs suggest that the programs were even more effective in reducing the severity of patient transfer injuries.

While the major emphasis in all eight facilities was on patient transfer injuries, the ergonomics teams did address health and safety issues in other areas of the facilities (dietary, housekeeping, maintenance) and injuries to the employees from other sources (slips and falls, patient assaults, etc.) to a lesser extent. As a result, while all eight facilities realized improvements in the number of injuries, lost workdays and workers’ compensation costs for the entire facilities (i.e., injury statistics including all departments covering all personnel and from all sources), these gains in injury statistics were less than those realized from patient transfer injuries (Tables 13-16). Overall, the eight facilities experienced a 32% decrease in number of injuries (Table 13), a 62% decrease in lost workdays (range = 30%-89%, Table 14), a 6% decrease in restricted workdays (Table 15), and a 55% decrease in workers’ compensation costs (range = 32% - 79%, Table 16).

The restricted workdays showed less improvements than the lost workdays both for patient transfer injuries as well as all injuries (Tables 14-15). This is because two out of the eight facilities (nursing homes B and C) had started an aggressive modified duty program one year prior to the ergonomics intervention. These nursing homes had started putting certain workers on restricted duties on their own without being asked by a physician. In fact, in that year the restricted workdays more than doubled. Secondly, nursing home D reported 17% and 220% increases in restricted workdays from patient transfer injuries and all injuries, respectively. This nursing home had zero restricted workdays for two years prior to the implementation of the ergonomics program. The nursing home had injuries as well as lost workdays for those two years. No reasonable explanation could be offered why there were no restricted workdays for those two years. The majority of restricted workdays during the post-intervention phase were due to a small number of injuries (1 injury in 1993, 1 injury in 1994, 6 injuries in 1995, 3 injuries in 1996, and 6 injuries in 1997). In the other four nursing homes (E to H) the restricted workdays from patient transfer injuries improved, on the average, by 84% (range = 77%-96%) and from all injuries by 61% (range = 39%-81%) (Table 15).

The aforementioned improvements in injury statistics (number of injuries, lost and restricted workdays, and workers’ compensation costs) are unlikely due to Hawthorne effect as both pre-and post-intervention periods were fairly long, the pre-intervention data from the eight facilities were collected for 37 months (range = 29-54 months) and the post-intervention for 51 months (range = 36 – 60 months).

Table 13: Summary of percent decreases in number of injuries / year.

Nursing Home / Hospital	Patient Transfer	Entire Facility
A	56%	55%
B & C	39%	32%
D	55%	16%
E	79%	37%
F	63%	19%
G	78%	33%
H	64%	30%
Average	62%	32%

Table 14: Summary of percent decreases in lost workdays year.

Nursing Home / Hospital	Patient Transfer	Entire Facility
A	99.6%	76%
B & C	86%	89%
D	95%	64%
E	50%	40%
F	94%	30%
G	99%	56%
H	80%	81%
Average	86%	62%

Table 15: Summary of percent decreases in restricted workdays / year.

Nursing Home / Hospital	Patient Transfer	Entire Facility
A	NA	NA
B & C	NA	10%
D	(17%)*	(220%)*
E	96%	81%
F	79%	48%
G	77%	39%
H	84%	75%
Average	64%	6%

* increase

Table 16: Summary of percent decrease in workers' compensation costs / year.

Nursing Home / Hospital	Patient Transfer	Entire Facility
A	99.8%	NA
B & C	NA	50%
D	66%	40%
E	53%	32%
F	98%	62%
G	99%	79%
H	90%	66%
Average	84%	55%

Secondly, while the ergonomics committees were represented by all departments (nursing, housekeeping, dietary, maintenance) and addressed safety issues and injuries in the entire facilities, only the “zero-lift programs” eliminated manual lifting and transferring of patients. The injury statistics associated with patient transfers showed much more improvements than those for the entire facilities. Lastly, while certain injuries such as slips and falls were addressed no major ergonomics changes were made. The injury statistics from slips and falls actually went up after implementation of the “zero-lift program” in some of the facilities.

The “zero-lift programs” neither required nor resulted in any increase in nursing staff in any of the eight facilities. None of the eight facilities hired any additional personnel because of the “zero-lift programs.” These programs did not affect employee turnover rates. While the turnover rate in nursing home D decreased, the other six nursing homes did not experience any improvements in turnover rates. It was about 80% during both pre- and post-interventions. The hospital A had very low turnover rate.

All eight facilities showed improvements in injury statistics while they varied in number of beds and number of employees. All eight facilities had a large percentage of acute care patients. All eight facilities believed that the patient acuity levels were rising. The data from nursing home D supported this belief. Two nursing homes (F and H) have converted one of their units with patients requiring minimum care (minimal assist and supervision) into acute care units during post-intervention. In the absence of the “zero-lift program” more acute care patients require more manual lifting and transferring. Therefore, one would expect that the number and severity of injuries from patient transfers would have gotten worse without the “zero-lift program.”

The cost savings reported in this study are in actual dollars. While no firm data could be obtained, all eight facilities believed that the medical costs were rising at a rate of 6%-8% per year. Similarly, employees’ wages increased by about \$1/hour in the last four years. In 1996, the insurance rates for long-term care personnel went up from \$8.03/\$100 of wages to \$9.73/\$100 of wages. Further, the data from three nursing homes show that the medical costs are about 4 times the indemnity payments (Tables 17-19). Therefore, in actuality the eight facilities realized much greater savings in workers’ compensation costs when accounted for medical inflation.

The average cost for the patient transferring equipment purchased by the seven nursing homes was \$51,666 (range = \$50,000 - \$60,000). The average saving in workers’ compensation costs for the seven nursing homes was \$71,821 per year (range = \$19,930 - 149,044). This resulted in an average payback period of 15 months (range = 5 – 29 months). These numbers are based on costs and saving for the entire facilities. If only patient transfer costs are considered, the savings were even higher (average \$79,940 per year from patient transfers versus \$71,821 for the entire facility). Hospital A saved \$82,167 per year in patient transfer costs resulting in a payback period of 9 months (data for the entire hospital were unavailable).

Table 17: Medical and indemnity costs (% of total cost) for nursing home E

Intervention	Year	Medical	Indemnity	Ratio
Pre- Intervention	1990	54%	41%	1.32
	1992	60%	30%	2.00
	1993	71%	15%	4.70
	1994	79%	21%	3.76
Average				2.91
Post- Intervention	1994	78%	22%	3.54%
	1995	47%	37%	1.27
	1996	76%	14%	5.43
	1997	88%	12%	7.30
	1998	100%	0%	Infinite
Average				4.38

Table 18: Medical and indemnity costs (% of total cost) for nursing home F

Intervention	Year	Medical	Indemnity	Ratio
Pre- Intervention	1992	59%	30%	1.97
	1993	82%	17%	4.82
	1994	81%	4%	20.25
Average		74%	17%	4.35
Post- Intervention	1994	100%	0%	-
	1995	61%	28%	2.17
	1996	47%	34%	1.38
	1997	71%	14%	5.07
	1998	87%	13%	6.69
Average		73%	13%	4.05

Table 19: Medical and indemnity costs (% of total cost) for nursing home G

Intervention	Year	Medical	Indemnity	Ratio
Pre- Intervention	1990	158,881	155,269	1.02
	1991	41,823	33,224	1.26
	1992	112,468	101,889	1.10
	1993	39,144	16,514	2.37
	1994	57,668	38,782	1.49
Average		81,997	69,135	1.19
Post- Intervention	1994	10,691	1,084	9.86
	1995	27,098	7,205	3.76
	1996	14,896	51,236	0.29
	1997	11,297	3,195	3.54
Average		15,996	15,680	4.36

Besides reduction in injury statistics, there were many intangible benefits of the “zero-lift program.” The nursing personnel in all eight facilities believed they were lot less tired at the end of their shifts. They felt their backs were lot less sore when they went home. Most of the older nursing aides in their fifties and sixties continued their employment. The pregnant nursing aides continued to work well into their pregnancies, some of them worked almost up to their delivery dates. Both the older as well as the pregnant nursing aides felt there was no way they would have continued to work without the “zero-lift program.” The management believed there was an increase in employee morale and a decrease in call off rate.

Some of the injured workers on modified duty were able to perform their regular duties. Nursing home D, in consultation with the company designated, treating physicians, had developed a policy that if an employee could lift 25 pounds or more, he/she could perform his/her regular duty. In nursing home G, a nursing aide who underwent surgery for herniated disc and returned to work with permanent restrictions of no lifting of more than 40 lbs., no repetitive lifting and bending, performed her regular duties for the entire post-intervention period (42 months). Similarly, in nursing home F a nursing aide was diagnosed with a herniated disc but continued to perform her regular duties. There were other cases where nursing aides were diagnosed with degenerative spine disease but continued to perform their regular duties.

The “zero-lift program” also had an impact on patient care and injuries. There were no injuries to any patient from patient transfers in seven of the eight facilities during the post-intervention period (average = 51 months, range = 36 – 60 months). There was one injury to a patient (shoulder fracture) in nursing home D during the 60 months post-intervention period. A questionnaire survey of patients from four nursing homes (Garg 1999) as well as direct observations found that the patients felt more secure and comfortable when transferred using patient transferring devices as compared to manual lifting and transferring. Both management and employees believed that there was a decrease in skin tears. Patients, especially those who were heavy and/or with severely contracted lower limbs, were toiletted more often after implementation of the “zero-lift program” than before (personal communications with nursing aides).

The greater impact of the “zero-lift program” on lost workdays and workers’ compensation costs than on number of injuries is consistent with other ergonomics intervention studies reported in the literature. Garg and Owen (1992), based on an ergonomics intervention in two units of a nursing home, reported that the incidence rate for back injuries decreased from 83 to 43 while the severity rate decreased from 834 to 0. The post-intervention period lasted for 13 months. Similarly, Head (1997) reported greater impact on average cost of back claims than on the number of back injury claims based on a no lifting program implemented in a hospital in Australia. Ridyard (1990) reported the effects of significant ergonomics improvements in a chemical plant. Over an 8-year follow up period, the incidence of over exertion back injuries reduced by 62% while there were no lost-workday back injuries in the same period.

8. CONCLUSIONS

The “zero-lift programs” implemented in seven nursing homes and one hospital using participatory ergonomics were highly successful. All eight health-care facilities showed marked improvements in number of injuries, lost workdays and workers’ compensation costs. Seven out of eight facilities also showed improvements in restricted workdays. The “zero-lift programs” had greater impact on lost workdays and workers’ compensation costs (measures of severity of injuries) than on number of injuries. The decreases in injury statistics due to patient transfers were greater than the decreases in injury statistics for the entire facilities. On the average, data from the eight facilities showed:

- 62% decrease in patient transfer injuries and 32% decrease in all injuries;
- 86% decrease in lost workdays from patient transfers and 62% decrease in all lost workdays;
- 64% decrease in restricted workdays from patient transfers and 6% decrease in all restricted workdays; and
- 84% decrease in workers’ compensation costs from patient transfers and 55% decrease in workers’ compensation costs for the entire facilities.

There were many intangible benefits. Older and pregnant nursing aides continued to perform their regular duties much longer. Employees felt less fatigued and less back pain at the end of their shifts. Some employees on modified duty could perform their regular duties. There was improvement in employee moral.

It appeared that the patient care had improved. There were no injuries to the patients except one injury in one nursing home. The patients felt more comfortable and secure during transfers. The management believed that there was a decrease in skin tears.

9. REFERENCES

- Bell, F., 1984, Patient Lifting Devices in Hospitals. Croom Helm, London.
- Bell, F., Dalgity, M.E., Fennell, M.J. and Aitken, R.C.B., 1979. Hospital ward patient-lifting tasks. *Ergonomics*, **22**:1257-1273.
- Biering-Sorensen, F., 1985, Risk of back trouble in individual occupations in Denmark, *Ergonomics*, **28**, 51-54.
- Borg, G., 1962, Physical performance and perceived exertion. Thesis. Gleerup, Lund.
- Buckle, P. 1982, A multidisciplinary investigation of factors associated with low back pain, Ph.D. Thesis, Cranfield Institute of Technology.
- Bureau of Labor Statistics, 1993, Occupational Safety and Health Reporter, August, Washington, D.C.
- Bureau of Labor Statistics, 1994, Occupational Safety and Health Reporter, August, Washington, D.C.
- Carlson, B.L., 1989, Ergonomics job evaluation of nursing assistants at Rock County health care nursing home facility. M.S. Thesis, Department of Industrial & Manufacturing Engineering, University of Wisconsin, Milwaukee, WI.
- Cohen, A., 1994, Worker participation approaches and issues. In: Participatory ergonomics interventions in meatpacking plants. DHHS (NIOSH) Publication No. 94-124, CDC, NIOSH, Cincinnati, Ohio.
- Cust, G., Pearson, J.D.G. and Mair, A., 1972, The prevalence of low back pain in nurses, *International Nursing Review*, **19**, 169-178.
- Dehlin, O., Hedenrud, B. and Horal, J., 1976. Back symptoms in nursing aides in a geriatric hospital. *Scand. J. Rehab. Med.*, **8**:47-53.
- Estryn-Behar, M., Kaminski, E., Peigne, E., Maillard, M.F., Pelletier, A., Berthier, C., Delaporte, M.F., Paoli, M.C., and Leroux, J.M., 1990, Strenuous working conditions and musculoskeletal disorders among female hospital workers. *Occupational Environmental Health*, **62**: 47-57.
- Ferguson, D., 1970, Strain injuries in hospital employees. *The Medical Journal of Australia*, **1**: 376-379.
- Fletcher, J.A., 1981, To lift or not to lift, *Radiography*, **47**: 162-164.

Fuortes, L.J., Shi, Y., Zhang, M., Zwerling, C., and Schootman, M., 1994, Epidemiology of back injury in university hospital nurses from review of workers' compensation records and a case-control survey. *Journal of Occupational Medicine*, **36(9)**: 1022-1026.

Gagnon, M., Sicard, C. and Sirois, J.P., 1986, Evaluation of forces on the lumbo-sacral joint and assessment of work and energy transfers in nursing aides lifting patients. *Ergonomics*, **29**: 407-421.

Garg, A., 1991, An ergonomics evaluation of Olympia Brewery participatory approach. Dept. of Labor and Industries, Seattle, WA.

Garg, A., 1996, Effectiveness of ergonomics interventions in nursing homes using participatory approach: preliminary results, in A. Mittal, H. Krueger, S. Kumar, M. Menozzi, and J.E. Fernandez (eds.) *Advance in Occupational Ergonomics and Safety I*, **2**: 164-169.

Garg, A., 1997, Reducing safety and ergonomics hazards with a zero-lift program. *Long Term Care*, **7(4)**: 26-27.

Garg, A., 1999, A manual for implementing zero-lift program in nursing homes and hospitals. Dept. of Industrial & Manufacturing Engineering, University of Wisconsin, Milwaukee, WI.

Garg, A., 1995, Effectiveness of ergonomics interventions at United Health, Inc. Preliminary Report, Industrial and Manufacturing Engineering, Univ. of Wisconsin-Milwaukee, Milwaukee, WI.

Garg, A. and Owen, B.D., 1994, An ergonomics approach to preventing injuries from patient lifting. *Plant Technology and Safety Management Series: Ergonomics in health care facilities*. No. 2, pp. 15-22.

Garg, A. and Owen, B.D., 1994, Prevention of back injuries in healthcare workers. *International J. of Industrial Ergonomics*, **14**: 315-331.

Garg, A. and Owen, B., 1992. Reducing back stress to nursing personnel: An ergonomics intervention in a nursing home. *Ergonomics*, **35**: 1353-1375.

Garg, A. and Owen, B., 1993. A biomechanical and ergonomics evaluation of patient transferring tasks: Wheelchair to toilet and toilet to wheelchair. In: R. Nielsen and K. Jorgensen (Eds.), *Advances in Industrial Ergonomics and Safety V*, Taylor and Francis, London.

- Garg, A., Owen, B., Beller, D. and Banaag, J., 1991a. A biomechanical and ergonomics evaluation of patient transferring tasks: Bed to wheelchair and wheelchair to bed. *Ergonomics*, **34**: 289-312.
- Garg, A., Owen, B., Beller, D. and Banaag, J., 1991b. A biomechanical and ergonomics evaluation of patient transferring tasks: Wheelchair to shower chairs and shower chair to wheelchair, *Ergonomics*, **34**: 407-419.
- Garg, A., Owen, B.D. and Carlson, B., 1992. An ergonomics evaluation of nursing assistants job in a nursing home. *Ergonomics*, **35**: 979-995.
- Greenwood, J.G., 1986, Back injuries can be reduced with worker training and reinforcement. *Occupational Health and Safety*, **55**: 26-29.
- Guo, H.R., Tanaka, S., Cameron, L.L., Seligman, P.J., Behrens, V.J., Ger, J., Wild, D.K., and Putz-Anderson, V., 1995, Back pain among workers in the United States: national estimates and workers at high risk. *American Journal of Industrial Medicine*, **28**: 591-602.
- Harber, P., Billet, E., Gutowski, M. Soohoo, K., Lew, M. and Roman, A., 1985. Occupational low-back pain in hospital nurses. *J. of Occupational Medicine*, **27**: 518-524.
- Harbor, P., Billet, E., Vojtecky, M., Rosenthal, E., Shimoszoki, S., and Horan, M., 1989, Nurses' beliefs about cause and prevention of occupational back pain. *Journal of Occupational Medicine*, **30**, 797-800.
- Head, M., 1997, Measuring the effects of training and workplace change, presented as a workshop paper in the 13th Triennial Congress of the International Ergonomics Association, Tampere, Finland.
- Hollis, M. and Waddington, P.J., 1975, Lifting patients, *Nursing Mirror*, **46**: 60-62.
- Iveson-Iveson, J., 1979, Prevention: how to stay healthy: VIII, Back strain, *Nursing Mirror*, **149**: 22-25.
- Jensen, R., 1987, Disabling back injuries among nursing personnel: Research needs and justifications, *Research in Nursing and Health*, **10**: 29-38.
- Jensen, R., 1985, Events that trigger disabling back pain among nurses. *Proceedings of the Human Factors Society*, 29th Annual Meeting. Santa Monica, pp. 799-801.
- Jensen, R.C., 1990. Back injuries among nursing personnel related to exposure. *Applied Occupational and Environmental Hygiene*, **5**: 38-45.
- Klein, B.P., Jensen, R.C. and Sanderson, L.M., 1984, Assessment of workers = compensation claims for back strains/sprains, *Journal of Occupational Medicine*, **26**: 443-448.

- Knibble, J.J. and Frielle, D., 1996, Prevalence of back pain and characteristics of the physical workload of community nurses. *Ergonomics*, **39(2)**: 186-198.
- Lagerstrom, M., Josephson, M., Pingel, B., Tjernstrom, G., and Hagberg, M., 1998, Evaluation of the implementation of an education and training program for nursing personnel at a hospital in Sweden. *International J. of Industrial Ergonomics*, **21**: 79-90.
- Lloyd, P., Tarling, C., Troup, J.D.G. and Wright, B., 1987, *The handling of patients: A guide for nurses*, 2nd ed., London: The Royal College of Nursing.
- MacMillan, P., 1979, Being a camel is a pain in the back, *Nursing Times*, **75**: 1037-1038.
- Marras, W.S., Davis, K.G., Kirkling, B.C., and Bertsche, D.K., 1999, A comprehensive analysis of low back disorder risk and spinal loading during the transferring and repositioning of patients using different techniques. *Ergonomics* (in press).
- Modica, M.E., 1994, Lifting and safety techniques for preventing back strain injury. PTSM Series, The Joint Commission, Number 2, pp. 23-28.
- Moore, J.S. and Garg, A., 1994, Case Study #2. In: *Participatory Ergonomics Interventions in Meatpacking Plants*. NIOSH, CDC., U.S. Dept. of Health and Human Services.
- Owen, B.D., 1980, How to avoid that aching back, *American Journal of Nursing*, **80**: 894-897.
- Owen, B.D., 1985, The lifting process and back injury in hospital nursing personnel. *Western Journal of Nursing Research*, **7**: 445-459.
- Owen, B.D., 1987, The need for application of ergonomics principles in nursing. In: S. Asfour (Ed.), *Trends in Ergonomics/Human Actors IV*, Elsevier Science Publishers (North-Holland), Amsterdam, 831-838
- Owen, B.D., 1988, Patient handling devices: An ergonomics approach to lifting patients. In: F. Aghazadeh (Ed.) *Trends in Ergonomics/Human Factors V*, Elsevier-Science Publishers (North- Holland), Amsterdam.
- Owen, B.D. and Garg, A., 1989, Patient handling tasks perceived to be most stressful by nursing assistants. In: A. Mital (Ed.), *Advances in Industrial Ergonomics and Safety I*. Taylor and Francis, London.
- Personick, M.E., 1990, Nursing home aids experience increase in serious injuries, *Monthly Labor Review*, **113**: 113-137.
- Raistrick, A., 1981. Nurses with back pain - Can the problem be prevented? *Nursing Times*, **77**: 853-856.

- Ridyard, D.T., 1990, A successful applied ergonomics program for preventing occupational back injuries. B. Das (ed.) *Advances in Industrial Ergonomics and Safety II*, Taylor & Francis, 125-132.
- Scholey, M., 1984, Patient handling skills, *Nursing Times*, **80**: 24-27.
- Smedley, J., Egger P., Cooper, C. and Coggon, D., 1995, Manual handling activities and risk of low back pain in nurses. *Occupational and Environmental Medicine*, **51**: 160-163.
- Snook, S. H. and Ciriello, V.M., 1991, The design of manual handling tasks: revised table of maximum acceptable weights and forces. *Ergonomics*, **34**(9), 1197-1213.
- Standard Association of Australia, 1982, Guide to the lifting and moving of patients, Part 1 – safe manual lifting and moving of patients, standards 2569, part 1 – 1982, North Sydney, NSW.
- Stubbs, D.A., Baty, D., Buckle, P.W., Fernandes, A.F., Husson, M.P., Rivers, P.M., Worringham, C.J. and Barlow, C., 1986, *Back Pain in Nurses* (Ergonomics Research Unit, University of Surrey, Guildford).
- Stubbs, D.A., Buckle, P.W., Hudson, P.W., Rivers, M.P., and Worringham, C.J., 1981, Back pain research, *Nursing Times*, **77**: 847-858.
- Stubbs, D.A., Buckle, P.W., Hudson, P.W., Rivers, M.P., and Worringham, C.J., 1983a, Back pain in the nursing profession I. Epidemiology and pilot methodology. *Ergonomics*, **26**: 755-765.
- Stubbs, D.A., Buckle, P.W., Hudson, M.P. and Rivers, P.M., 1983b, Back pain in the nursing profession II. The effectiveness of training, *Ergonomics*, **26**: 767-779.
- Takala, E.P. and Kukkonen, R., 1987, The handling of patients on geriatric wards. A challenge for on the job training. *Applied Ergonomics*, **18**: 17-22.
- Torma-Krajewski, J., 1986, Analysis of lifting tasks in the health care industry, Symposium on Occupational Hazards to Health Care Workers, University of Washington, Seattle, Washington.
- U.S. Dept. of Health and Human Services, 1994, Participatory ergonomics interventions in meatpacking plants. NIOSH, CDC., DHHS (NIOSH) Publication No. 94-124, Cincinnati, Ohio.
- Valles-Pankratz, S., 1989, What's in back of nursing home injuries? *Ohio Monitor*, **62**: 4-8.

Vasiliadou, A., Karvountzis, G., Soumilas, A., Roumeliotis, D., and Theodosopoulou, E., 1995, Occupational low-back pain in nursing staff in a Greek hospital. *Journal of Advanced Nursing*, **21**: 125-130.

Venning, P.J., Walter, S.D. and Switt, L.W., 1987, Personal and job related factors as determinants of incidence of back injuries among nursing personnel. *Journal of Occupational Medicine*, **29**: 820-825.

Venning, P.J., 1988, Back injury prevention among nursing personnel: the role of education, *AAOHN Journal*, **36**: 327-333.

Videman, T., Nurminen, T., Tola, S., Kuorinka, I., Vanharanta, H. and Troup, J.D.G., 1984. Low-back pain in nurses and some loading factors of work. *Spine*, **9**: 400-404.

Waters, T.R., Putz-Anderson, V., Garg, A. and Fine, L.J., 1993, Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Erg*

Yassi, A., Khokhar, J., Tate, R., Cooper, J., Snow, C., and Vallentyne, S., 1995, The epidemiology of back injuries in nurses at a large Canadian tertiary care hospital: implications for prevention. *Journal of Occupational medicine*, **45(4)**: 215-220.