Economic evaluation of technology to reduce back injuries to nurses.

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Abstract

Caregivers, mostly those related to nursing professions, have a high degree of vulnerability to back injuries attributable to events that occur during the handling and lifting of patients. Conditions that contribute to this include the frequency of patient lifting, the lack of proper training, inadequate technology to move patients and transfer methods utilized. The Department of Veterans Affairs (VA) in the United States incurs significant costs estimated at over $135 million in workers' compensation related to back injuries inflicted on its personnel in lifting patients.

The James A. Haley Veterans Hospital in Tampa, Florida, USA with a grant from Veterans Affairs is designing and implementing a Back Injury Program for Nurses that successfully integrates evidence-based practice, technology and safe improvement approaches. Technological interventions to be introduced at the Haley hospital include state of the art lifts to facilitate patient movement. To study the cost effectiveness of this intervention two other Vertically Integrated System Networks in the VA system will be used as control sites. Data to be used in the economic evaluation include the direct and indirect costs of the intervention and subsequent costs savings associated with this multi disciplinary approach to reduce back injuries.

Cost analysis will include pre and post intervention data collection on the direct and indirect costs of Muskuloskeletal injuries to nursing personnel. They include the costs of disability as afforded by workers compensation, costs of restricted duty and the costs of medical care provided inside and outside VA facilities. Costs of technology include training of personnel, amortized values of equipment over expected life and costs of maintenance and insurance. Cost of restricted duty is the loss in productivity associated with restricting the injured caregiver to non patient handling duties. Workers wages and salaries are to be used as proxies for productivity measures.

1. Introduction

Occupational back injury in nursing personnel is a serious problem both in terms of suffering and financial costs. Nursing staff have been identified as high-risk for job-related musculoskeletal injuries (Harber, 1985; Ljungberg, 1989; Engkvist, 1992). Nursing staff who perform frequent patient handling activities are at particular risk (Khuder, 1999; Pheassant, 1992; Hignett, 1996). One study found that patient lifts and transfers were the most common cause of reported back injury (Yassi, 1995). Within the nursing profession, those employed in the nursing home or long term care setting have the third highest rate for occupational injuries and illnesses among all US industries (US Department of Labor, 1994). Recent studies have shown that a majority of hospital's compensation claims are back strains and sprains to health care workers, primarily nurses (Khuder, 1999). While cases of low back pain represent approximately 16% of all workers compensation claims, they represent over 33% of all claim costs (Webster, 1994).

Patient handling is the precipitating event in the vast majority of nursing back injuries (Stobbe, 1988; Jensen, 1989; Owen, 1987). Patient care rooms are small, crowded and not optimally designed to support patient handling and movement tasks. Patients are bulky, asymmetrical, lack handles and can be combative or uncooperative. Moving even the smallest adult patient can exert forces on the back in excess of the National Institute of Occupational Safety and Health (NIOSH) making manual lifting of patients unsafe (Owen, 1991).

However, mechanical lifting devices are not always well accepted by caregivers and patients. Nurses' reluctance to use mechanical aids is well documented (Moody, 1996; Owen, 1991; Venning, 1988; Garg, 1992). The most common reasons for not using the aids include: (1) time constraints, (2) knowledge deficit in use of the equipment, (3) limited availability/accessibility of mechanical lifts and/or sling attachments, (4) spatial constraints, and (5) patient preferences. National no-lift policy mandates in Europe, Canada, and Australia have promoted innovations in technology for safe patient handling and movement, such as the ceiling mounted patient lifts. These lifts are not yet widely used in the United States. In today's healthcare environment, costs of job-related injuries, problems in recruiting and retaining nursing staff, and increasing patient acuity, have all contributed to the emergence of patient care ergonomics as a national healthcare priority. The purpose of this 12-month longitudinal evaluation was to evaluate the impact of ceiling mounted patient lifts on: cost efficiency, provider satisfaction, incidence of injuries, severity of injures, and modified duty days, as well as nursing turnover.

2. Methods

Design: This longitudinal study was conducted over a 12-month period. Data was collected prospectively at baseline using the Veterans Affairs (VA) Automated Safety Incident Surveillance Tracking System program (ASISTS) and staff surveys. Qualitative data from focus groups was collected 7 months post intervention. Cost elements that were recorded during the study included the direct costs of purchase, installation and maintenance of the ceiling lift systems. Average salaries of staff including RN's, LPN's and NA's were computes from administrative data bases to enable the calculation of the monetary costs associated with lost and restricted days.

Site: The 60-bed long-term care unit selected for this evaluation had the highest incidence and severity of musculoskeletal injuries of any acute or long-term care unit within the VA hospitals in Florida and Puerto between 1998-2000. Nursing staffing on this unit ranged from 44 to 56 with a mean of 47 over the 12-month study period. The average daily census ranged from 42 to 58 with a mean of 52.9. Patients on this unit had neurological impairments; most were physically dependent and many had concomitant cognitive deficits.

Sample: All nursing staff on the unit with direct patient care responsibilities were invited to participate; written informed consent were obtained. At baseline, there were 44 unit employees, 10 males (22%) and 34 females (77%). Thirteen were RN's (30%), 13 were LPN's (30%), and 18 were NA's (40%). Of these original 44 employees, 6 declined to participate. Five months later, 11 new employees joined the unit; 2 declined to participate and two previous employees joined the study. The 12-month participation rate for the unit was 91%.

Intervention: A track mounted patient lift system was installed in each patient room over a 4-day period, including the single overhead track, fixed power unit, two sling attachments, and an ergoscale weighing device. Ceiling tracks were installed over each bed and tracked to most areas of the room; however, the lift did not track into the toileting area. Training and maintenance was provided to all staff. Training included an overview of the lift system and the use and operation of lift. A training videotape of the system was used to train new staff.

3. Data Collection Strategies:

Questionnaires: Nurses' satisfaction with the ceiling mounted lifts was measured via self-administered surveys. The questionnaire was administered at baseline, as well as quarterly, and included demographic data, detailed information on recent injuries (date of injury, lost workdays, restricted duty days, description of event, use of personal or sick days due to injury, visits to medical care within and outside of hospital, etc), title and start date at hospital, shift work, reported stress levels, and opinions on general features of the ceiling lift. Collecting injury data via the survey verified the injury data being pulled from the ASISTS program. Reported stress levels were measured on a 1 to 10 point scale with ten being the most stressed. Opinions on the general features of the lift were measured using a 7-point scale with one being strongly disagree and 7 being strongly agree.

Focus Group: A focus group was held 7 months post-intervention to further examine satisfaction and use of the lift system. Invitations to participate in the focus groups were individually mailed to all unit staff and advertisements were placed in public areas. The focus groups were audio taped and notes were taken by a research assistant. This data was transcribed into a word document and analyzed using Ethnograph 5.0.

Staff Injuries: All nurses who sustained a work-related injury or illness are required to report the injury to their supervisor. This injury data is entered into the Automated Safety Incident Surveillance Tracking System (ASISTS) program. Data retrieved from these reports include gender of nurse, date and time of injury, primary body part affected by injury, secondary body part affected by injury, and a brief description of the injury. Inclusion criteria for injuries included; injury occurred while moving or handling a patient and injury was musculoskeletal in nature. Injuries were not restricted to only the back and shoulder, however, the majority of the injuries were to this area of the body. Injury incident reports were monitored one-year post implementation of the ceiling lifts on the unit and compared to reports one year prior to the implementation of the lift system. Lost and restricted time resulting from each unique injury was collected via the ASISTS program and verified with the Office of Workman's Compensation (OWCP).

Nursing Turnover: Turnover was measured as a percentage from one year pre-implementation and one year post implementation using the AcuStaf computer program system.

Cost Benefit Analysis: Cost effectiveness and cost benefit analysis. In recent years increasing emphasis has been placed on the effective utilization of health care resources. Methodologies used to determine the efficacy of health care interventions have included cost effectiveness analysis (CEA) and cost benefit analysis (CBA). The results of a CEA analysis is a cost effectiveness ratio that shows the cost of achieving one unit of health outcome such as a unit reduction in injuries to health care workers incurred in lifting patients. Cost benefit analysis is similar to CEA in many respects, however the benefit of the health intervention is expressed in dollar terms rather than in terms of a non monetary effectiveness measure. This difficulty in measuring health outcomes as dollars and cents has caused many health economists to embrace CEA over cost benefit analysis. Another methodology used in financial analysis to determine effectiveness is return on investment or pay back period to recoup the cost of an investment. In pay back period analysis cash flows from an investment are not discounted in determining the length of time it takes to recoup ones investment.

Statistical Analysis: Statistical differences across the four surveys were examined using one-way analysis of variance (ANOVA), post-hoc tests, and planned comparisons. The musculoskeletal injury incidence rate was defined as the number of reported injuries to the ASISTS program divided by the number of full time equivalents, reported per 100 nurses. SPSS 9.0 was used to run all analyses (SPSS, 1989).

4. Results

Questionnaires: A one-way analysis of variance (ANOVA) was conducted to evaluate the relationship between reported stress and satisfaction with general features of the lift and the timing of the surveys from baseline to the fourth survey. There were four time levels, each one occurring 3 months after the previous and the same survey was given each time. Reported stress significantly decreased from 6.52 at baseline to 5.35 at the final survey ($F(3,91) = 5.350$, $p=0.002$). A significant increase in satisfaction with two features of the lift were found; "Since the implementation of the ceiling mounted patient lift, in you opinion, are patients getting ambulated more often" increased from 2.4 at baseline to 5.06 for the final survey ($F(3,94)=9.752$, $p=0.000$) and "Do you experience any musculoskeletal discomfort during or after the use of this system" ($F(3,91)=8.84$, $p=0.000$). The question, "The controls are easily reached and activated", approached statistical significance increasing from 5.72 to 6.33 ($F(3, 93)=2.094$, $p=0.106$). Several questions consistently increased non-significantly, such as; "Do you believe the ceiling mounted patient lift relieves you of patient lifting", "In your opinion, do patients respond well to the ceiling lift", "Do you believe the ceiling mounted patient lift makes job easier, and "The ceiling lift is comfortable for you" (Table 1).

For those significant ANOVA's, a planned comparison was conducted to test for a linear tend using simple linear contrasts. For reported stress, scores decreased from 6.52 at baseline to 3.20 for the final survey ($t= -3.4361$, $p=0.000$). The question, "Do you experience any musculoskeletal discomfort during or after the use of this system?" was not found to have a linear trend ($t=1.630$, $p=0.109$), however, significant differences were found between time period one and three ($p=0.00$) and three and four ($p=0.003$) using Tukey's HSD post hoc tests (ref). Finally, the question "Since the implementation of the ceiling mounted patient lift, in you opinion, are patients getting ambulated more often?" showed a significant linear trend ($t=4.835$, $p=0.00$) (Chart 1).

Focus Group: Qualitative analysis revealed 9 major categories from the annual focus group: (1) Frequency of Use, (2) What Lift Can be Used for, (3) What Lift Can't be Used for, (4) Staff Feelings About Lift, (5) Problems with the Lift, (6) Learning to Use the Lift, (7) Changes in Nursing Tasks with the Lift, (8) Patient Comfort with the Lift, and (9) Hospital Unit Safety. To summarize the first three categories, nurses felt the lifts were used "all the time" and "every time you move a patient". In addition, they felt the lifts could be used for many different tasks though they noted dissatisfaction that the lifts could not be used for "lateral transfers, "toileting" and "a fall in a corner of room". In summary, the staff felt the lifts were being used often and for a variety of tasks.

Table 1. Survey Question One-Way ANOVA's

	Survey 1	Survey 2	Survey 3	Survey 4	F	P-value
Reported Stress	6.52	6.19	5.71	3.2	5.35	0.002
Lift relieves you of lifting	6.04	6.18	6.31	6.69	1.543	0.208
Patients getting ambulated more	2.4	3.91	4.97	5.06	9.752	0.000
Patients respond well to lift	5.44	5.59	5.63	5.75	0.241	0.867
Experience musculoskeletal pain after use	1.83	3.05	4.36	2.19	8.884	0.000
Lift makes your job easier	5.93	5.95	6.29	6.69	2.01	0.118
Lift comfortable for you	5.92	5.77	6.23	6.64	2.02	0.116
Lift easy to use	6.2	6.18	6.23	6.67	1.153	0.332
Lift provides stable patient transfers	6.04	6.05	6.31	6.2	0.649	0.586
Lift is durable and long-lasting	5.84	5.5	5.91	5.87	0.649	0.586
Lift can be used for a variety of tasks	5.88	5.45	5.71	5.33	0.683	0.565
Controls are easily reached and activated	5.72	5.36	6.06	6.33	2.094	0.106
Controls are logical and natural	6.04	5.82	5.94	6.07	0.215	0.886
Lift causes awkward postures	3.33	3.55	3.44	3.6	0.083	0.969
Lift causes muscle tiredness/soreness	2.76	2.27	2.34	2.13	0.794	0.500
I feel fatigued after using lift	2.52	2.55	2.23	2.01	0.406	0.749
Lift is safe for caregiver and patient	6.12	5.73	5.91	5.93	0.295	0.829

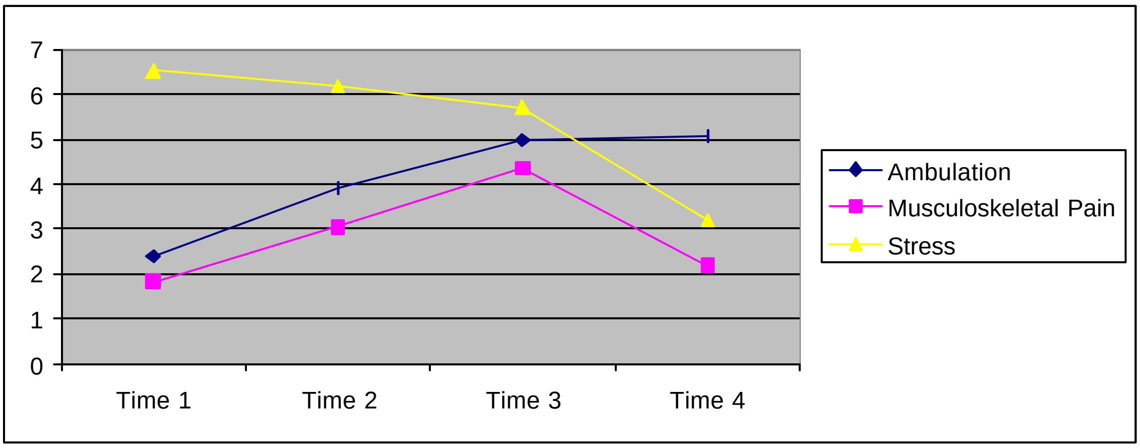

Chart 1. Significant ANOVA's

The staff held both negative and positive views of the lift. Some of the remarks regarding the positive remarks: “I love the thing”, “the best we have” and “It’s a great thing”. Some of the problems the staff identified included the sling and cord getting stuck, waiting on maintenance to repair the lift, and difficulties moving heavier patients. The lift bar was identified as a safety hazard to the caregiver as it swings freely over the bed (when not pushed out of the way). In addition, staff felt that the addition of the lift positively changed their nursing tasks by improving efficiency. The staff felt that the lift increased the unit’s safety and that patients felt comfortable with the lift after help from the staff. They stated that, “not lugging around a floor mechanical lift”, “less clutter in hallway, and “equipment is much more concise” all added to the unit’s safety. The staff noted that, initially, patients were fearful of the lift being far off the ground. However, all agreed that through a variety of measures, patients soon became comfortable with the lift. Some of the interventions to reduce patient discomfort included: “let the patient get the feel of it before you lift them all the way up” and “talk to them and show them how it works”. In conclusion, the information from the focus groups corresponded with the survey results. However, two previously unknown factors were revealed; the persistent use of the lifts by staff and the initial fearfulness of the lift by most patients.

Staff Injuries: There was a modest decrease in the incidence of reported injuries pre- and post-implementation of the ceiling mounted lifts. Pre-implementation, 18 injuries occurred to staff on the unit, post-implementation, it decreased to 12 injuries, a 33% reduction in frequency of injuries. However, the number of restricted duty days decreased from 16 to 6 days, reflecting a 63% reduction in restricted days. Most notable, was the decrease in the number of lost workdays from 39 to 0, representing a 100% reduction in lost time. Furthermore, the average work days lost per injury decreased from 2.17 to 0, a 100% reduction in average lost days per injury (Table 2).

Table 2. Pre and Post-Implementation Injury Statistics

	Pre Implementation	Post Implementation	% Decrease
Number of Injuries	18	12	33%
Total Restricted duty days	16	6	63%
Total Work Days Lost	39	0	100%
Average work days lost per injury	2.17	0.00	100%

Table 3 provides a description of the pre and post implementation injuries. The majority of injuries occurred to NA's (50% post and pre implementation). Post-implementation, seventeen percent of injuries occurred to RN's and 33% occurred to LPN’s, similar to percentages from the pre-implementation phase. Over half of both the pre and post implementation injuries occurred to the back and shoulders. Post-implementaion, a smaller percentage of injuries occurred to the neck (8%) and 17% to miscellanous body parts (elbow and knee). Post-implementation, the majority of injuries (92%) occurred between 6:00 am and 6:00 PM, the time of heaviest patient care. One injury occurred between midnight and 6:00 AM. The description of the injuries provided in the ASISTS program was not detailed, however, the reasons for injury was categorized when possible. Pre-implementation, 33% of injuries were directly related to moving and handling of patient during care, 22% during transferring, turning, or repositioning, 11% due to moving and handling when equipment was involved, one fall (6%), and three were missing or could not be categorized (17%). Similarly, post-implementation, 33% of injuries were directly related to moving and handling of patient during care, 34% during transferring, turning, or repositioning, 25% due to moving and handling when equipment was involved, and one could not be categorized (8%) (Table 3).

The monthly full-time equivalent employee was used to determine denominators to calculate incidence rates. The full time-equivalent of employees was computed by adding all 1.0 FTE employees and then determining the FTE for part time employees. The injury rate pre-implementation ranged from 0.0 to 10.8, with the yearly average being 3.43. Post-implementation rates ranged from 0.0 to 6.5 with a yearly average of 2.14. The injury rate is reported per 100 nurses and is defined as the number of nursing injuries due to patient handling and movement over the number of full-time equivalents (Table 4). The average yearly injury rate per 100 nurses dropped from 3.43 to 2.14.

Table 3. Injury Description

	Pre Implementation	Post Implementation
RN's	2 (11%)	2 (17%)
LPN's	7 (38%)	4 (33%)
NA's	9 (50%)	6 (50%)
Back	9 (50%)	6 (50%)
Arm/Shoulder	4 (22%)	3 (25%)
Hands	1 (6%)	0 (0%)
Neck	2 (11%)	1 (8%)
Misc	2 (11%)	2 (17%)
6:00 AM - Noon	11 (61%)	3 (25%)
Noon - 6:00 PM	6 (33%)	8 (67%)
6:01 PM - Midnight	0 (0%)	0 (0%)
Midnight- 5:59 AM	1 (6%)	1 (8%)
Falls	1 (6%)	0 (0%)
Transfers	2 (11%)	2 (17%)
Turning/Repositioning	2 (11%)	2 (17%)
Patient Care'	6 (33%)	4 (33%)
Missing/Not Categorized	3 (17%)	1 (8%)
Transporting	2 (11%)	0 (0%)
Equipment	2 (11%)	3 (25%)

Table 4. Injury Rates

	Pre-Implementation	Post-Implementation
October	4.7	2.3
November	4.6	0.0
December	2.3	2.2
January	4.4	6.5
February	0.0	4.3
March	9.5	0.0
April	0.0	2.2
May	0.0	2.1
June	0.0	4.1
July	2.3	2.0
August	10.8	0.0
September	2.5	0.0
Average	3.43	2.14

Cost Analysis: Cost effectiveness and cost benefit analysis. In recent years increasing emphasis has been placed on the effective utilization of health care resources. Methodologies used to determine the efficacy of health care interventions have included cost effectiveness analysis (CEA) and cost benefit analysis (CBA). The results of a CEA analysis is a cost effectiveness ratio that shows the cost of achieving one unit of health outcome such as a unit reduction in injuries to health care workers incurred in lifting patients. Cost benefit analysis is similar to CEA in many respects, however the benefit of the health intervention is expressed in dollar terms rather than in terms of a non monetary effectiveness measure. This difficulty in measuring health outcomes as dollars and cents has caused many health economists to embrace CEA over cost benefit analysis. Another methodology used in financial analysis to determine effectiveness is return on investment or pay back period to recoup the cost of an investment. In pay back period analysis cash flows from an investment are not discounted in determining the length of time it takes to recoup ones investment. In our analysis we used the payback period as a measure of the efficacy of installing ceiling lifts to reduce injuries among caregivers.

In our analysis the investment was the money for the purchase, installation and maintenance of the BHM Medical Inc. Voyager 420 track mounted patient lift systems

5. Discussion

Several national agencies have recognized the need to reduce musculoskeletal injuries in nurses patient handling and movement. One of the National Institute's of Occupational Safety and Health research agenda's for 2001 include low back disorders as well as musculoskeletal disorders to the upper extremity (www.cdc.gov, 2002). In 2001, the Institute of Medicine released a report entitled, "Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities" (www.iom.edu, 2002). This report expressed the magnitude of the problem of occupational musculoskeletal disorders, the scientific debates surrounding the pertinent risk factors and future possible intervention strategies. Lastly, a national health promotion and disease prevention objective put forth in 1991 aimed to reduce injuries at work, specially those that result in lost time, by 6 cases per 100 by the year 2000 (U.S Department of Health and Human Service, 1991). Companies and nursing home operators have also have made policy changes to adopt specific measures to reduce back injuries as a result of injuries due to the lifting and handling of nursing home residents (www.osha.gov, 2002).

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Appendix

Direct cost of purchasing, installation and maintenance of ceiling lifts

Costs of purchase

Purchase price: 33 lifts @ $ 2, 118 per lift	$ 69,915
Purchase price: 33 scales @ $ 790 per scale	$ 26,070
Purchase price: 33 x 2 slings @ $ 180 per sling	$ 11,880

Total	$ 107,865

Cost of training

Registered Nurses @ 2 hrs/trainee

Annual Salary of 1 FTE RN (Nurse II, step 6)	$ 45,000
Fringe benefits (25%)	$ 11,250

Total	$ 56,250
Direct cost of RN time per hour ($56,250/2,080 hrs)	$27.04/hr
Direct cost of training at 2hrs	$ 54.08

Cost of training an average of 10 RNs / year	$ 540	(1)

Licensed Practitioner Nurses @ 2 hrs/trainee

Annual Salary of 1 FTE LPN (GS4, step5)	$ 26,810	
Fringe benefits (25%)	$ 6,702	

Total	$ 33,512	
Direct cost of LPN time per hour ($33,512/2,080 hrs)	$16/hr	
Direct cost of training at 2hrs	$ 32	
Cost of training an average of 10 LPNs / year	$ 320	(2)

Nursing assistants @ 2 hrs/trainee

Annual Salary of 1 FTE NA (NA3, step 2)	$ 19,443	
Fringe benefits (25%)	$ 4,861	

Total	$ 24,303	
Direct cost of NA time per hour ($24,303/2,080 hrs)	$ 11.68/hr	
Direct cost of training at 2hrs	$ 23.36	
Cost of training an average of 24 NAs / year	$ 560	(3)
Sum of direct costs of training (1) + (2) + (3)	$ 1420	(4)
Fringe benefits (25%)	$ 355	(4a)
Allocation of indirect costs at 40% of direct costs	$ 710	(5)
Total (4) + (5)	$ 2485	
Costs of training yearly (labor turnover of 20 % x 2)	$ 794	(6)

(Factor of 2 to account for trainer and trainee)

Costs of Injury and Lost Productivity (Pre Implementation):

Assumptions:

Care givers are provided first aid at facility

Care provided in facilities external to the VA is not charged to VA

Average cost of imputed care at VA facility is $480/injury (from workmens compensation data)

Restricted days are computed as equivalent to .5 of a non restricted day in productivity

Direct cost of treating injuries

(pre implementation: # injuries x cost): 18 x480 = $8,640 (7)

Direct cost of lost days

(pre implementation: # lost days x cost/day):

26days x 8hrs/day x $16/hr	=	$ 3,328	
10 x 8 x 16	=	$ 1,280	
3 x 8 x 16	=	$ 384	

Total		$ 4,992	(8)

Average cost of lost day = 4992/39 = $ 128 (8a)

Direct cost of restricted days
(#restricted days x cost/day)

NA = 7days x .5(CF) x 8hrs x $11.68/hr = $ 308
LPN = 4days x .5(CF) x 8hrs x $16/hr = $ 256
RN = 5days x .5(CF) x 8hrs x $27/hr = $ 540

$ 1104 (9)

Average cost of restricted day = 1104/16 = $ 69

(7) + (8) + (9)	=	$ 14,736	(10)
Fringe benefits (25%)		$ 3,684	(10a)
Allocation of indirect costs at 40%		$ 7,368	(11)
Total cost of medical treatment, lost days and restricted days	(10) + (11) =	$ 25,788	(12)

Post Implementation

Direct cost of treating injuries (post implementation: # injuries x cost):	12 x 480 =	$ 5,760	(13)
Direct cost of lost days (post implementation: # lost days x cost/day):		$ 0	(14)
Direct cost of restricted days (post implementation: # restricted x cost/day):		$ 414	(15)
Total (13) + (14) + (15)		$ 6174	(16)
Fringe benefits (25%)		$ 1543	(16a)
Allocation of indirect costs (40%)		$ 2469	(17)
Total (16) + (17)		$ 10,186	(18)

Savings in direct costs of medical treatment
, lost and restricted days: (12) – (18) $15,602/year