ASSE ACADEMICS PRACTICE SPECIALTY

VOLUME 7, ISSUE 2 • 2011

Journal of **Safety, Health & Environmental Research**

THIS ISSUE

ALSO

AMERICAN SOCIETY OF SAFETY ENGINEERS • www.asse.org

Journal of Safety, Health & Environmental Research

Mission: The Journal of Safety, Health and Environmental Research (JSHER) is to peer review theoretical and empirical manuscripts, reviews and editorials devoted to a wide variety of SH&E issues and practices.

Scope: As such, JSHER accepts theoretical and empirical papers committed to concepts, analytical models, strategy, technical tools and observational analyses that enhance the decision-making and operating action capabilities of SH&E practitioners and which provide subject matter for academics. JSHER is an online journal intended to be of interest to SH&E academics and to field practitioners concerned with SH&E science, emergency and disaster preparedness, fire and homeland security, corporate sustainability and resiliency, economic evaluation of SH&E programs or policies, risk-loss control, engineering and other legal aspects of the SH&E field.

Submission Guidelines: Each submission to JSHER will be blind peer-reviewed by at least two reviewers. Submission of a manuscript to JSHER indicates that the effort expressed has not been published previously and that it is not currently under consideration for publication elsewhere.

Manuscripts that are in agreement with JSHER's mission and scope should be crafted carefully and be professionally written. They should be submitted as an attachment within an e-mail message. Specifically, they should:

- be submitted as an MS Word file(s) with no author identifiers;
- be 8 to 20 double-spaced pages with 1" margins all around (approximately 3,000 to 8,000 words, including references, but not including illustrations, tables or figures, which are not included in the text)
- include a separate document with title page indicating the title, co-authors and the person to whom correspondence should be directed, including that person's name, title, employer, phone number, fax number, e-mail address and a short (50-word) bio-sketch of each author indicating at least the author's current position, highest degrees earned and professional certifications earned;
- include an abstract of no more than 200 words, which states briefly the purpose of the research, the principal results and major conclusions, including a short list of key words;
- include a reference section at the end of the manuscript, using APA style to cite and document sources;
- have the pages numbered consecutively and new paragraphs clearly indicated;
- be sure that facts and figures are documented and acknowledged;
- present tables and figure legends on separate pages at the end of the manuscript, but indicate where in the manuscript the table or figure should go;
- make sure that graphics, such as figures and photos, are submitted as separate files and are not embedded in the article text;
- for empirical research, at a minimum, the text should include an introduction, methods, results and discussion sections in the main text;
- for all submission types, section headers, which describe the main content of that portion of the manuscript, are advisable.

All submissions should be sent to:

Michael Behm, Ph.D., CSP
Managing Editor
Associate Professor, Occupational Safety
East Carolina University
231 Slay Hall
Greenville, NC 27858
Phone: (252) 328-9674
behmm@ecu.edu

Editorial

Role of Research in Education & the Profession

"He who does not research has nothing to teach."

"It is necessary for the administration of a university, if service to students be the goal, to differentiate between teaching knowledge to students and teaching information. A teacher who is competent in his line will teach knowledge. Less competent men will teach information. There is an old Chinese proverb that applies here: 'Give me fish, and you feed me today; teach me how to fish, and you feed me for life.' We should teach students how to fish."

"Our job is education, not to train people in the trades and skills. Education means understanding of theory, and the interlocking of theories, the history of the development of thought in a discipline, the limitations of theory. Education means theory and research, unfolding of questions and answers, with more questions than answers as the cloth comes off the loom."

"In the absence of research, a teacher can only teach what is wrong. Without research, a man cannot appreciate the limitations of his knowledge and certainly cannot impart these limitations to students. The limitations of knowledge are the most important ingredients of knowledge itself. Only he who does research can know this."

A mentor of mine once suggested to me that our profession needs to stop teaching students how high to hang the fire extinguisher; rather, we must create conditions for students to become critical thinkers, researchers and problem solvers. He was explaining the difference between training and educating and emphasizing the importance of research.

The four boxed quotes are from W. Edwards Deming, taken from his 1972 memo to the dean of New York University's Stern School of Business. I have always admired Deming's work and have appreciated how authors, particularly Fred Manuele, have applied Deming's principles to occupational safety. I recently came upon these quotes and his view of teaching and research in an essay by Josué Guzmán. As an academic, my view is that teaching, research and service to the profession are the foundation of the academics role. The three go hand in hand; they complement each other rather than compete for the time. This is certainly easier said than done. However, as I reflect on what Deming wrote, his words reinforce my view but also cause me to reconsider certain activities.

Since taking over the editorial duties for the *Journal of Safety, Health and Environmental Research (JSHER)* in January 2011, my view of the important contribution research makes to the discipline and practice of occupational and environmental safety and health has evolved and been strengthened. Too often, we think we know the answers—sometimes before we are asked a question. Research allows us open and forthright inquiry into a topic; it provides the process to explore that topic, develop hypotheses and think about the unknowns. Valid and reliable methodologies provide quality data to analyze the anecdotal. It helps us make better decisions both individually and generally. Research is a foundation for remaining humble and asking additional improved questions. Reading Guzmán's paper, and in particular Deming's memo, gave me an opportunity to think about what I do in my professional life. I hope it gives readers, academics and professionals a similar reflection.

I offer three additional parting quotes to reflect the significance of research to our discipline, and I hope readers will continue in their personal pursuit of lifelong learning with research as a significant part of that process.

"An education is not how much you have committed to memory, or even how much you know. It is being able to differentiate between what you do know and what you do not." Anatole France, French novelist (1844-1924)

"Sixty years ago I knew everything; now I know nothing; education is a progressive discovery of our own ignorance." Will Durant, American historian (1885-1981)

"The test of a good teacher is not how many questions he can ask his pupils that they will answer readily, but how many questions he inspires them to ask him, which he finds it hard to answer." Alice Wellington Rollins, American author (1847-97)

JSHER Update

During the past year, *JSHER* has been off to some exciting changes. First, the look of the journal has changed to an ezine format. Through the work of the Editorial Review Board and the publication team at ASSE, we feel that establishing *JSHER* with an academic appearance will help upgrade the journal's credibility both within the Academics Practice Specialty and among global readers and authors. Second, the Editorial Review Board has some exciting special issues planned. The announcements page highlights those special issues and guest editors. Third, we are looking at ways to increase readership, and our Editorial Review Board is hard at work to disseminate the journal. Last, *JSHER* is always looking to enhance quality so that we can be a source for academics, students and practitioners as they seek to learn and impact the profession. Through the aforementioned changes, we envision a continually improved product. Your feedback and contributions are always welcome.

Finally, I am very excited to be the editor of *JSHER*. Founding editor Jim Ramsay and former editor Anthony Veltri did such an excellent job of establishing a solid foundation for *JSHER*. I am extremely grateful for their dedication, commitment, innovation and hard work.

Yours sincerely,
Michael Behm, Ph.D., CSP
Managing Editor, *JSHER*

Reduced Workers' Compensation Costs With Roof Screening

Jonisha P. Pollard, Susan M. Moore & Christopher Mark

Abstract

Each year, more than 300 underground coal miners are injured or killed by rocks falling from between or around roof supports. Researchers have reported that a reduction in rock fall injuries by implementing wire-mesh roof screens would reduce a mining company's workers' compensation (WC) premiums and would offset the annual cost of screen installation. However, the authors calculated these savings using formulas that are not used by all coal mining states, including Pennsylvania. Pennsylvania coal mines may also benefit from reduced WC premiums with roof screening.

In this paper, the potential savings in WC premiums that could be achieved due to a reduction in rock fall injuries after roof screening in Pennsylvania's underground coal mines were quantified. Hypothetical mines (representing two mine sizes: 67 and 150 employees) were constructed with realistic estimates of injuries and WC premiums. Using the Pennsylvania Coal Mine Compensation Rating Bureau's (PA CMCRB) formulas, total savings in WC premiums after a 3-year period were determined. Savings in WC premiums ranged from 5.1% to 22% when injuries were reduced by 10% to 30%. This translated to savings between $73,000 and $1.2 million, which may largely offset the annual cost of a roof screening program.

Keywords

Workers' compensation, rock fall injuries, roof screening, underground bituminous coal

More than 300 rock fall injuries are reported to the Mine Safety and Health Administration (MSHA) each year. Nearly all of these injuries, which included six fatal injuries between 2006 and 2008, are caused by rocks falling between and around roof supports. Technology is available to prevent the vast majority of these injuries and fatalities. Surface controls like straps, headers and large roof-bolt plates can help, but by far the most effective prevention technique is roof screening. Roof screens work best because they can cover up to 94% of the roof (Robertson, et al., 2003). Roof screens also offer a first line of defense for roof-bolter operators by confining or deflecting small rocks that can come loose during drilling or bolt installation.

Several studies have now shown that roof screening is the most effective way to prevent rock fall injuries (Molinda & Klemetti, 2008; Compton, et al., 2007). At a Maryland mine studied by the National Institute for Occupational Safety and Health (NIOSH), rock fall injuries were reduced from 14 per year to 2.2 per year, 5 years after implementing roof screening. In addition, an Illinois mine showed a reduction from 8 to 0.25 injuries per year, 8 years after implementing roof screening (Robertson, et al., 2003). Despite the fact that roof screening has obvious benefits to the safety of mine workers, some mining companies have yet to implement this safety measure due to cost concerns. However, by preventing injuries to the mine workers, roof screening has a direct positive impact on a mine's WC premiums.

Background

Previous research has demonstrated that the savings in WC premiums may largely offset, or even exceed, the direct costs of a roof screening program. Moore, et al. (2010) determined savings in WC premiums associated with reducing rock fall injuries in Illinois and Kentucky. Moore selected these states' programs for evaluation because they have the highest WC premiums for underground bituminous coal, and the rating organization responsible for these states (National Council on Compensation Insurance) provides services to some 36 states. Moore's analysis illustrated a decrease in WC premiums ranging from 1.8% to 14.6% when injuries were reduced by 10% to 20%.

The state of Pennsylvania, however, is not serviced by the National Council on Compensation Insurance, but rather has its own WC rating organization for coal mining and, thus, its own unique formula to evaluate mines within its borders. In 2008, Pennsylvania's bituminous coal mines produced 63.7 million short tons of coal representing 16.3% of the total coal produced in the Appalachian Region (USEIA, 2010).

Given Pennsylvania's unique rating equations, it is important to verify that a reduction in a Pennsylvania coal mine company's WC premiums due to roof screening may partially or fully offset the cost of screen installation. Therefore, this research sought to quantify the potential savings in WC premiums that mining companies in Pennsylvania might expect after implementing roof screening as a method of reducing rock fall injuries. These savings could then be used to offset, or cover completely, the cost of implementing a roof screening program.

Jonisha P. Pollard, M.S., is a research engineer in the Musculoskeletal Disorder Prevention team at the Office of Mine Safety and Health Research. She can be contacted at JPollard@cdc.gov.

Susan M. Moore, Ph.D., is the executive management intern for the associate director of mining in the Office of Mine Safety and Health Research.

Christopher Mark, Ph.D., P.E., is the principal roof control specialist for the Mine Safety and Health Administration.

Overview of Workers' Compensation Rate-Setting Methods in Pennsylvania

Coal mines in Pennsylvania are rated by the Coal Mine Compensation Rating Bureau (CMCRB) of Pennsylvania. Insurance providers offering coverage for coal mines in Pennsylvania must be a member of CMCRB. Several rating plans exist, including manual rating, merit rating and experience rating. Manual rating is the simplest rating plan where rates are averages reflecting the normal conditions found in each classification and is typically used for small employers.

Merit rating plans were formulated for smaller companies and provide a 5% premium credit to employers with no lost-time accidents over a 2-year period. Employers with two or more lost-time claims receive a 5% surcharge and those with one lost-time claim have no change in premium. This plan provides premium savings for safety-conscious small businesses. Under an experience rating plan, a company is provided an incentive (i.e., decreased costs) for implementing loss prevention programs to decrease injury costs. Any entity or company with a modified payroll of at least $300,000 during the 3-year experience period qualifies for an experience rating. Of the plans described, experience rating is the most commonly used and, therefore, is presented in this paper.

Each year, data are collected by CMCRB for each individual coal company. These companies are categorized by one of 10 possible classifications:

1) preparation plants—anthracite;
2) preparation plants—bituminous;
3) underground—anthracite;
4) underground—bituminous;
5) surface—anthracite;
6) surface—bituminous;
7) cogeneration fuel—anthracite;
8) cogeneration fuel—bituminous;
9) auger;
10) coke.

CMCRB then sets a base loss cost rate (per $100 of payroll), which must be approved by the State Insurance Commissioner's Office. The base loss cost rate consists of three components: 1) federal black lung coverage (FBLC), 2) state black lung coverage (SBLC) and 3) traumatic coverage (TC) (PA CMCRB, 2009).

Based on a mine company's 3-year injury history, a modification factor (MOD) is calculated. (For a detailed explanation of determining the MOD and the use of the Pennsylvania WC rate-setting equations, see Moore & Pollard, 2010.) The MOD is the only factor that an individual mine can influence to reduce its WC premiums. This MOD is calculated each year based on the previous 3 full-coverage years (e.g., the MOD for 2004 is based on the mine's experiences between 2000 and 2002; the MOD for 2005 would then be based on the mine's experiences between 2001 and 2003). The MOD is then used to determine whether or not the mine is credited (has a decreased premium) or debited (has an increased premium) relative to the base loss cost rate. The MOD is based on the individual company's losses. Therefore, reducing losses by implementing safety and health interventions, such as roof screen, should reduce the MOD. It should be noted that the MOD is only multiplied by the traumatic coverage portion of the base loss cost rate and not the FBLC and SBLC portions. The federal and state black lung portions are static and remain unaffected by the company's performance over the experience rating period. Additionally, each insurance provider applies its own multiplier to the base loss cost rate to cover administrative fees (e.g., taxes, overhead costs, costs associated with handling, settling and defending claims). Thus, a company's WC premium per $100 of payroll would be determined as follows:

WC premium = admin fee multiplier * (FBLC + SBLC + MOD*TC)

Methods

Data Used in This Study

The rating period used for this study was 2001, 2002 and 2003, yielding WC costs for 2005. To demonstrate the expected amount of savings in WC premiums, hypothetical mines were created that are representative of experience-rated mines in Pennsylvania. Between 2001 and 2003, there was an average of 44 active underground bituminous coal mines reporting production in PA with an average of 98 employees per mine (PA Department of Environmental Protection, 2001-03). Two sizes of mines were used in the analysis, one with 67 employees and the other with 150 employees. A mine with 67 employees was chosen because an economic analysis was previously conducted to determine the cost of screening for a mine of this size (Compton, et al., 2007). The mine with 150 employees was chosen as a larger mining company with a significantly higher payroll. To estimate the savings in WC premiums for these mines, the following parameters were necessary:

•payroll for 2001, 2002 and 2003;
•total number of injuries each of the 3 years;
•number of injuries that would have been prevented by implementing roof screening each of the 3 years;
•base loss cost rate in 2005;
•insurance provider's administrative fee;
•ultimate losses associated with each injury.

In 2005, the base loss cost rate was $25.30 for bituminous, underground coal mines. In Pennsylvania, typical multipliers applied by insurance providers to cover administrative fees range from 1.17 to 1.60; the average of these numbers, 1.385, was used in this study. To obtain the remaining parameters, several assumptions were made:

•**Payroll:** In 2002, the average mine worker salary in Pennsylvania was $53,700 (U.S. Census Bureau, 2002). This salary was used to estimate the salaries in 2001 and 2003 by adjusting for 1.14% inflation between 2001 and 2002 and 2.60% inflation between 2002 and 2003 (Bureau of Labor Statistics, 2001-03). The average mine worker salaries were determined for 2001 as $53,094 and for 2003 as $55,096. The total payroll for a 3-year period was used to determine the MOD. Therefore, the total payroll for each year was summed to yield a 3-year payroll.

•**Total number of injuries:** A sensitivity analysis was

	# Employees	Total Injuries	Preventable Injuries	Total Payout Per Year	Average One-Year Payroll
Mine 1	67	20	2	$303,694	$3,615,564
Mine 2	67	20	4	$303,694	$3,615,564
Mine 3	67	20	6	$303,694	$3,615,564
Mine 4	67	34	3	$506,157	$3,615,564
Mine 5	67	34	7	$506,157	$3,615,564
Mine 6	67	34	10	$506,157	$3,615,564
Mine 7	67	47	5	$708,620	$3,615,564
Mine 8	67	47	9	$708,620	$3,615,564
Mine 9	67	47	14	$708,620	$3,615,564
Mine 10	150	45	5	$679,913	$8,094,546
Mine 11	150	45	9	$679,913	$8,094,546
Mine 12	150	45	14	$679,913	$8,094,546
Mine 13	150	75	8	$1,133,188	$8,094,546
Mine 14	150	75	15	$1,133,188	$8,094,546
Mine 15	150	75	23	$1,133,188	$8,094,546
Mine 16	150	105	11	$1,586,463	$8,094,546
Mine 17	150	105	21	$1,586,463	$8,094,546
Mine 18	150	105	32	$1,586,463	$8,094,546

Table 1. Demographics of each hypothetical mine.

performed where the total number of injuries was varied to determine its effect on WC premiums. Over the 3-year period, the total numbers of injuries at both mines were defined as being 30%, 50% and 70% of the number of employees. These percentages were based upon actual injury data reported to MSHA during the same timeframe.

•Number of preventable injuries: A sensitivity analysis was performed where the number of preventable injuries is varied to determine the effect of reducing rock fall injuries on WC premiums. The total number of injuries that could have been prevented with roof screening was defined as being 10%, 20% and 30% of the total number of injuries. These percentages were based upon actual injury data reported to MSHA. (Injury narratives were read to determine the number of rock fall injuries and the size of the rocks associated with these injuries. The "preventable falls" were small falls and their general size was described in a variety of ways, including as the size of a golf ball, a "piece of rock" or in specific dimensions, such as 18" x 18" x 8", 4' x 3' x 1", 3' diameter x 8", 2" x 2', 2" x 9" x 2' or 6" x 6" x 2".)

•Ultimate losses per injury. CMCRB provided the total ultimate losses and total number of medical and indemnity claims during the 2001-03 policy years. Indemnity claims are associated with claims resulting in lost-time. Medical claims are those where costs are exclusively medical. On average, two thirds of all claims each year were medical claims with an average cost of approximately $5,000. The average cost of indemnity claims ranged from approximately $40,000 to $55,000 depending on the year.

Thus, to arrive at a representative average claim cost, it was not reasonable to divide the ultimate losses by the total number of claims. Therefore, an average claim cost was calculated for each year. The average cost of medical claims was multiplied by the number of medical claims reported, and the average cost of the indemnity claims was multiplied by the number of indemnity claims reported. This allowed the average injury costs to be weighted based on their frequency. The average of these parameters across the 3 years was then determined to be $15,109. In the current analysis, therefore, every injury was assumed to cost this amount.

Nine hypothetical mines were created, each with 67 employees, such that a mine existed representing all possible combinations for the total number of injuries (30%, 50% and 70% of the number of employees) and the total number of preventable injuries (10%, 20% and 30% of the total number of injuries). Similarly, nine hypothetical mines were created with 150 employees, yielding a total of 18 hypothetical mines in this analysis.

Results

The demographics and injury statistics associated with each hypothetical mine are shown in Table 1. The total injuries across the 18 hypothetical mines ranged from 20 to 105 injuries, of which 2 to 32 were assumed to be preventable with roof screening. The total injury payout per year ranged from $303,694 to $1.6 million. Table 2 shows the MODs and resulting WC premiums for each of the 18 hypothetical mines with and without roof screening. Additionally, the expected savings in WC premiums, which may be achieved with roof screening, are also provided. Almost all mines had MODs greater than 1, which indicates that most mines were debited and were expected to pay above the base loss cost rate. The MODs ranged from 1.21 to 2.15 before roof screening and 0.99 to 1.99 after roof screening. This reduction in the MOD yielded savings in WC premiums of $73,000 to $1.2 million.

Figure 1 (p. 28) shows the percent savings in WC premiums for each of the hypothetical mines. Savings in WC premiums ranged from 5.1% to 22%. Additionally, Figure 2 (p. 29)

	Without Roof Screening			When Injuries Prevented Through Roof Screening			**Savings in WC Premium with Roof Screening**
	MOD	WC per $100 Payroll with Admin Fee	WC Premium	MOD	WC per $100 Payroll with Admin Fee	WC Premium	
Mine 1	1.21	$40	$1,447,836	1.14	$38	$1,374,408	$73,427
Mine 2	1.21	$40	$1,447,836	1.08	$36	$1,300,981	$146,855
Mine 3	1.21	$40	$1,447,836	1.01	$34	$1,227,553	$220,282
Mine 4	1.66	$54	$1,937,351	1.55	$50	$1,814,972	$122,379
Mine 5*	1.66	$54	$1,937,351	1.43	$47	$1,692,593	$244,758
Mine 6*	1.66	$54	$1,937,351	1.32	$44	$1,570,215	$367,137
Mine 7	2.10	$67	$2,426,867	1.95	$63	$2,255,537	$171,331
Mine 8*	2.10	$67	$2,426,867	1.79	$58	$2,084,206	$342,661
Mine 9*	2.10	$67	$2,426,867	1.63	$53	$1,912,876	$513,992
Mine 10	1.21	$40	$3,228,117	1.13	$38	$3,054,057	$174,060
Mine 11	1.21	$40	$3,228,117	1.06	$36	$2,879,998	$348,119
Mine 12*	1.21	$40	$3,228,117	0.99	$34	$2,705,938	$522,179
Mine 13*	1.68	$54	$4,388,514	1.56	$51	$4,098,415	$290,099
Mine 14*	1.68	$54	$4,388,514	1.44	$47	$3,808,315	$580,199
Mine 15*	1.68	$54	$4,388,514	1.32	$44	$3,518,216	$870,298
Mine 16	2.15	$69	$5,548,911	1.99	$64	$5,142,772	$406,139
Mine 17*	2.15	$69	$5,548,911	1.82	$59	$4,736,633	$812,278
Mine 18*	2.15	$69	$5,548,911	1.65	$54	$4,330,494	$1,218,417

Table 2. MOD and associated WC premiums with and without roof screening showing savings. ***Note: *Savings in WC premium may fully cover the cost of roof screen installation assuming roof screening costs $240,000 and $480,000 for the 67 and 150 personnel mines, respectively (Compton, et al., 2007).***

shows the savings in WC premiums associated with a decrease in ultimate losses. Although not a 1:1 ratio, savings in injury claim costs result in large savings in WC premiums.

Discussion

In this study, the methods used by the state of Pennsylvania to determine an underground bituminous coal mine's WC premiums were also used to determine the savings in WC premiums that may be realized after reducing the number of injuries with roof screening. A sensitivity analysis with 18 different hypothetical PA underground bituminous coal mines was performed. In this analysis, the number of total injuries and the number of injuries that could have been prevented with roof screening were varied to determine their effects on a mine's MOD and, therefore, WC premium.

This analysis was completed for a medium-sized mine (67 employees) and for a larger mine (150 employees). The reduction in losses associated with roof screening was shown to decrease the MOD in all cases. While reducing actual losses by a set dollar amount does not directly correspond to the expected reduction in WC premiums, a significant savings in WC premiums is passed on to the mine. These savings ranged from 5.1% to 22% when injuries were reduced by 10% to 30%. For mines with a larger number of employees, and thus a larger payroll, the percent savings in WC premiums was slightly greater than that of a smaller mine with a similar percent reduction in injuries.

The savings after reducing injuries with roof screening may largely offset, if not cover completely, the cost of implementing a roof screening program. Compton, et al. (2007) determined the cost of roof screening for a room-and-pillar mine employing 67 people and producing 800,000 tons per year. If roof screens were installed in 50% of the drivage, the annual cost for screen installation was estimated to be $240,000. This cost varies between mines but provides a relative estimate for the expected cost of screen installation. Based on this estimate, several of the 67-employee hypothetical mines in this study would cover the cost of their roof screen program solely from savings in WC premium.

It is important to note that mines with greater rock fall injuries will see more substantial savings in their premiums. The size of the mine (determined by their payroll) determines their expected losses (injury costs expected for a mine of that size) and the premium paid to the WC insurance provider (WC premiums are relative to every $100 of payroll). However, the actual losses at the mine influence how much the mine will pay in premiums. This means that a larger mine with fewer injuries may actually have a lower WC premium than a smaller mine with more injuries.

There were several limitations to the current study. The

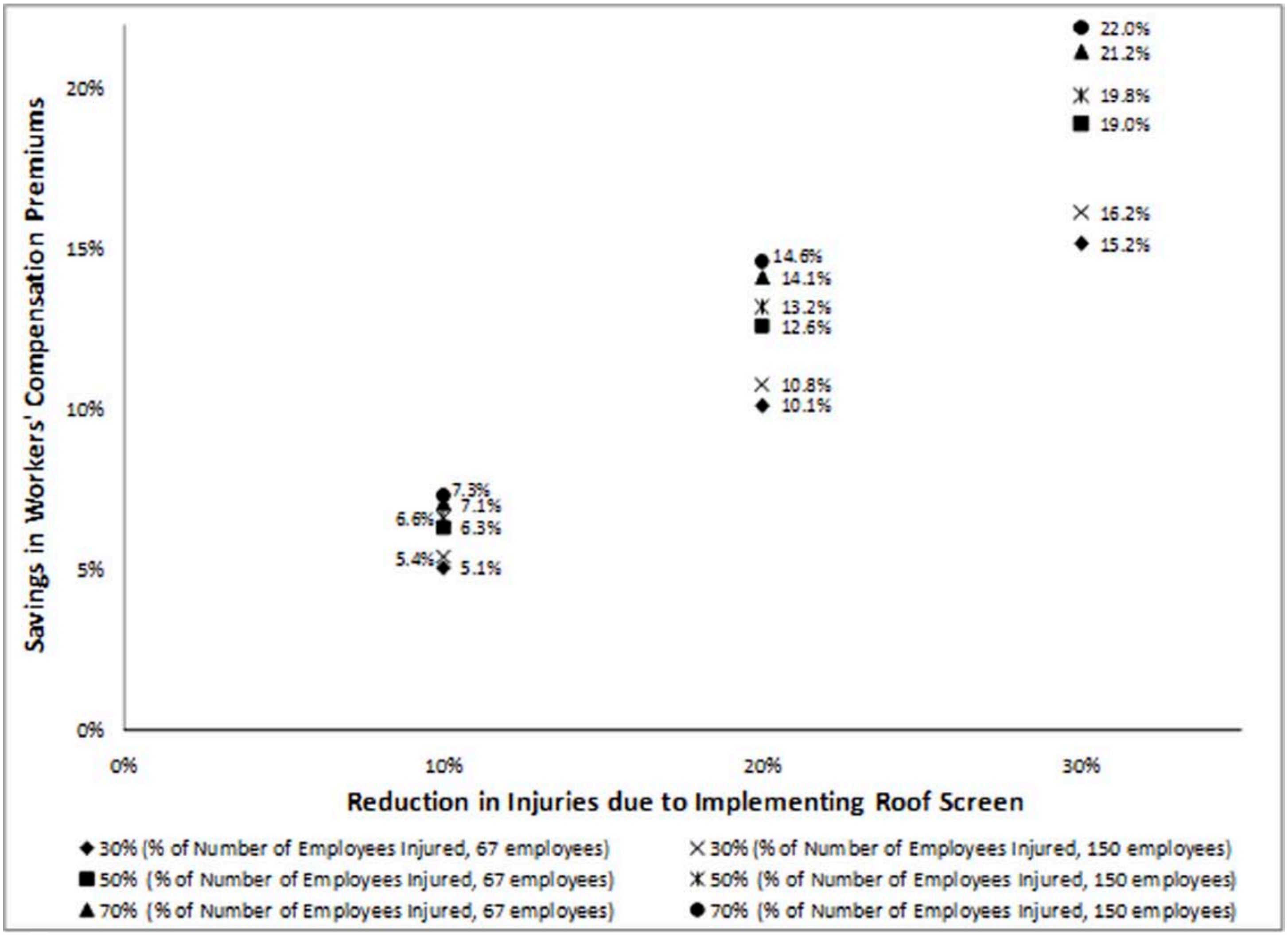

Figure 1. Percent savings in WC premiums associated with 10%, 20% and 30% reductions in injuries due to implementing roof screens for mines with total injuries equal to 30%, 50% and 70% of the number of employees. The number of employees was set to equal either 67 or 150.

mines in the study were hypothetical as opposed to using real mine demographic and injury data. The total number of injuries and the preventable injuries at each hypothetical mine were based upon injury data obtained from the MSHA injury database. As a result, mines of comparable size may have more or less savings depending on their actual injury records and roof control plans.

Another limitation to the study was that an average injury cost was used instead of determining the true injury costs associated with known injuries at a specific mine. The estimated cost for installing roof screens presented in this study ($240,000) was associated with only one mine of 67 employees; however, this cost estimate was based on an actual mine providing them more validity than a hypothetical estimation of costs.

Finally, it should be noted that large coal companies tend to purchase nonstandard WC policies. Specifically, there would be some type of risk-sharing policy, such as a large deductible or the mining company may be self-insured and have purchased an excess WC policy. For the latter case, the cost associated with every claim eliminated through roof screening is directly saved by the company; additional savings would then be observed by the reduction in the MOD associated with the excess WC policy.

The data presented in this study demonstrate that a savings in WC premiums may be expected after roof screening for a 3-year period. This means that companies may not fully benefit from reduced injuries until 5 years after instituting their safety measures. However, some financial benefits may be seen after 3 years. While the hypothetical mines used in this sensitivity analysis were only PA mines, the results are comparable to those obtained in a similar study, which investigated the potential savings in WC premiums for states using a different, and more commonly implemented, experience rate-setting formula (Moore, et al., 2010).

While the savings in WC premiums are less than the value saved in direct injury costs, the savings are still substantial. Results of this analysis showed a linear relationship between the decrease in ultimate losses and the savings in WC premiums. Injury costs are directly proportional to WC premiums, and implementing safety measures to reduce injuries may be financed by the potential savings in WC premiums alone.

Roof screening allows mines to provide up to 94% roof cov-

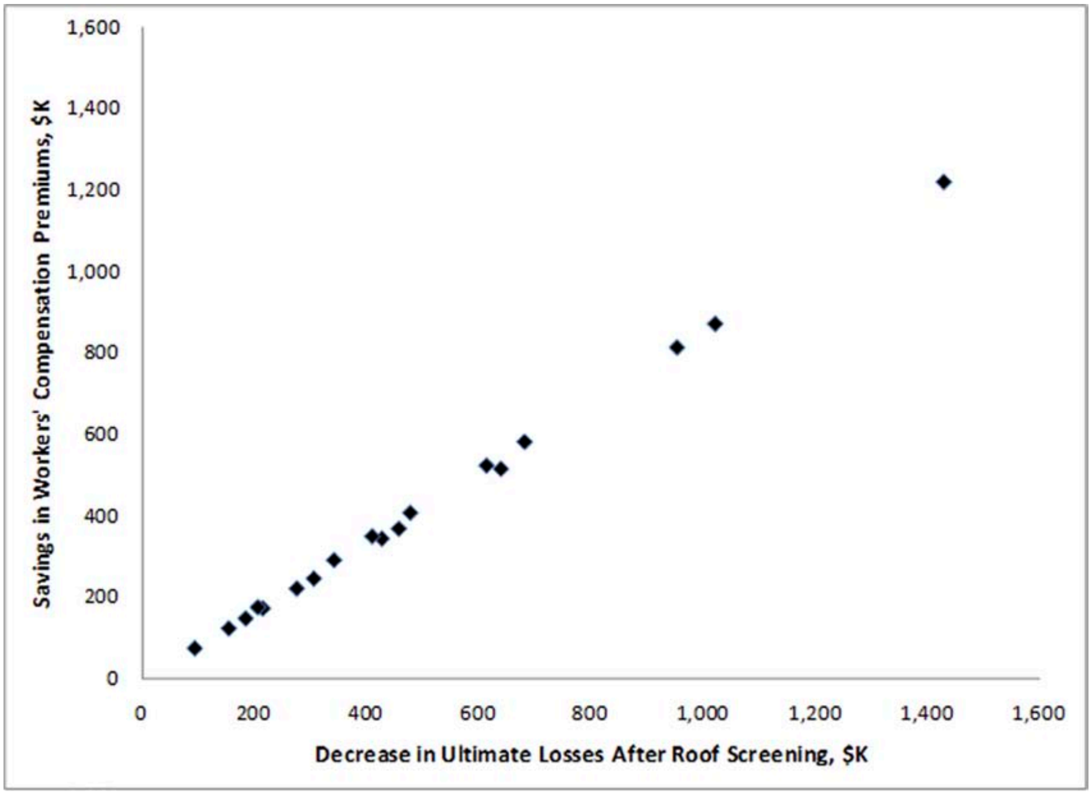

Figure 2. Savings (in thousands of dollars) in WC premiums associated with decreased ultimate losses (in thousands of dollars) after roof screening.

erage and, therefore, reduce the potential falls of smaller rocks, which cause about 99% of all rock fall injuries (Robertson, et al., 2003; Molinda, et al., 2002). Considering the obvious safety benefit of using roof screen, some mines still do not implement a roof screening program. Barriers for screen installation include material costs, time for installation and possible ergonomic risks to the operators (Robertson & Hinshaw, 2002). NIOSH studies, including this analysis, have examined all of these barriers and recommendations are provided for alleviating these concerns. Moore, et al. (2010) found significant savings in WC premiums after roof screening in Illinois and Kentucky underground bituminous coal mines. The results of their analysis were in agreement with this study in that many mines may fully cover the cost of roof screen installation with savings in WC premiums.

In a case study of four underground coal mines, the additional material costs and time associated with roof screening were examined (Robertson & Hinshaw, 2002). Authors found that the material costs for roof screening resulted in an extra $0.58/ft when used instead of steel straps and significantly increased roof coverage by 61%. A significant variation in the additional cycle time required for roof screening was seen between the four mines, and the authors noted that some of this time may be reduced with time and practice. In general, the use of a bolting machine with a built-in materials handling system was shown to decrease the necessary cycle time. The authors also noted the concern with sprains and strains associated with manually handling roof screens and stated that "any innovations in bolting machines, supplies or processes that could eliminate or reduce material handling are worthy of consideration for the safety of the workforce."

In a later analysis, Compton, et al. (2007) conducted ergonomic analyses of roof screen handling techniques. Subjects manually handled roof screen while instrumented with devices to measure the muscle activity of the arms and torso and trunk position, velocity and acceleration. Results showed reduced demands and decreased cycle time when roof screens are slid along rails mounted on top of the roof bolter. The authors also suggested storing screens on the mine rib or stacked/stored on the rails mounted on the roof bolter to reduce the risk for back injuries.

Roof screening has been proven to be a successful means of reducing the hazards of working under a coal mine roof. NIOSH researchers have examined the roof screening process in hopes of alleviating the concerns with increased material costs, cycle times and risks for materials handling injuries. Researchers have found the effects of roof screening to result in financial savings that may recoup some (if not all) of the costs of installation.

WC premiums are just one of the financial savings that may be realized with roof screening. The actual cost savings to the mine are expected to be greater than that which has been estimated using the method described in this paper. Other savings include reduction in costs associated with replacing injured workers, reduced requirements for extra spot bolts to support loose roof and reduced costs associated with long-term cleanup and resupport (Compton, et al., 2007). Moreover, production rates are often impacted by nontangibles, such as increased employee morale, positive safety culture, maintenance of a consistent, knowledgeable workforce, etc., which exist when safety is made a priority, hazards are removed and injuries are reduced or eliminated. ✪

References

Bureau of Labor Statistics. (2001-03). U.S. Department of Labor: Consumer price index tables. Retrieved from http://www.bls.gov/cpi.

Compton, C., Gallagher, S., Molinda, G., Mark, C., & Wilson, G. (2007). Roof screening for underground coal mines: Recent developments. *Proceedings of the 26th International Conference on Ground Control in Mining,* July 31-Aug. 2, Morgantown, WV, 270-276.

Molinda, G.M., Dolinar, D.R., & Robertson, S.B. (2002). Reducing Injuries from the fall of roof in U.S. coal mines. *Society of Mining, Metallurgy and Exploration Annual Meeting and Exhibit,* Feb. 25-27, Phoenix, AZ.

Molinda, G.M. & Klemetti, T. (2008). Diagnosing and controlling moisture-sensitive roof in coal mines. E*lectronic Journal of Geotechnical Engineering, 13*(A), 1-20.

Molinda, G., Mark, C., Pappas, D., & Klemetti, T. (2008). Overview of ground control issues in the Illinois Basin. *Society of Mining, Metallurgy and Exploration's Annual Transactions, 324,* 41-48.

Moore, S.M. & Pollard, J.P. (2010). Evidence that reducing knee injuries in underground mining may have a substantial impact on mine company finances. *Journal of Safety, Health and Environmental Research, 6*(3).

Moore, S.M, Pollard J.P., Mark, C., & Bhatt, S. (2010). An analysis of the potential of roof screening to reduce workers' compensation costs. *Society of Mining, Metallurgy and Exploration Annual Meeting and Exhibit,* Feb. 28-Mar. 3, Phoenix, AZ.

Pennsylvania Coal Mine Compensation Rating Bureau. (2009). Pennsylvania coal mine experience rating plan manual. Retrieved from http://www.cmcrbpa.com/Manual.html.

Pennsylvania Department of Environmental Protection. (2001-03). Pennsylvania annual reports on mining activities. Retrieved from http://www.dep.state.pa.us/dep/deputate/minres/bmr/historicalminingreports/index.html.

Robertson, S. & Hinshaw, G. (2002). Roof screening: Best practices and roof bolting machines. *Proceedings of the 21st International Conference on Ground Control in Mining.* Morgantown, WV: West Virginia University, 189-194.

Robertson, S., Molinda, G., Dolinar, D. Pappas, D. & Hinshaw, G. (2003). Best practices and bolting machine innovations for roof screening. *Society of Mining, Metallurgy and Exploration Annual Meeting and Exhibit,* Feb. 24-26, Cincinnati, OH.

U.S. Census Bureau. (2002). Economic census. Mining industry series report. Bituminous coal underground mining.

U.S. Energy Information Administration. (2010). U.S. coal production by coal-producing region and state. Report No. DOE/EIA 0584. Retrieved from http://www.eia.doe.gov/cneaf/coal/page/acr/tables2.html.

Does Implementation of a Minimal Lift Policy Change Job Satisfaction & Number of Injuries Among Direct Care Staff?

A Case Study in an Extended Care Facility

Sara F. Maher & Charles W. McGlothlin Jr.

Abstract

*Manual transfers of patients are a major source of injury to direct care workers. The purpose of this study was to determine if a "minimal lift policy" in combination with mechanical lift purchase (based upon a calculated formula) would decrease injury rates and improve job satisfaction among direct care staff. This study utilized a pre/post design. An onsite evaluation was conducted to determine mechanical lift needs at an extended care facility. At the same time, employees (*n *= 35) were evaluated on job satisfaction, and data were collected on employee injuries during the previous year.*

*One year later, data were again collected on job satisfaction (*n *= 32) and staff injury rates. Post-survey analysis showed an increase in one measure of job satisfaction, "Independent thought and action in work." The remaining measures of job satisfaction and changes in injury rates were not statistically significant from pre- to post-lift purchase. While one aspect of job satisfaction significantly improved, trends were observed in decreased injury rates and improved job satisfaction levels. These trends are supported by previous authors.*

This is the first study to identify a formula for calculating mechanical lift purchase, and future authors may want to expand on this information. In addition, other outcome measures (e.g., patient comfort, staff musculoskeletal discomfort), increased data collection points and collecting data from larger sample sizes and more than one facility may provide meaningful information for future studies.

Keywords

Engineering controls, healthcare workers, injury reduction, minimal lift policy, mechanical lifts, musculoskeletal injuries

Introduction

Injuries sustained on the job were among the highest for healthcare workers (Evanoff, et al., 2003; Li, et al., 2004; Nelson, et al., 2005). Injury rates among healthcare workers were found to equal or exceed injury rates of workers in traditionally high-risk occupations, such as construction and manufacturing (Evanoff, et al., 2003; Collins, et al., 2004; Li, et al., 2004) and were primarily musculoskeletal, caused by the lifting and transferring of patients (Owen, et al., 2002; Evanoff, et al., 2003; Li, et al., 2004; Charney, et al., 2006). Manual lifts and transfers may be difficult to perform due to the weight, size and combativeness of patients and the possibility of patients shifting during a transfer, causing workers to fall or be injured. In addition, some manual lifts may be performed in small confined areas (e.g., patient bathrooms, rooms cluttered with medical equipment), where it is difficult for caregivers to perform techniques correctly and safely (Collins, et al., 2004; Lloyd, 2004; Nelson & Baptiste, 2006; Nelson, et al., 2005). Even while lying in bed, a patient may not be positioned in a manner convenient for lifting. Attempting to lift a recumbent patient can significantly load an employee's low back, at levels as high or higher as those seen in industrial workers (Evanoff, et al., 2003). Furthermore, training to improve manual lifting and handling of patients has not been shown to reduce low-back injuries or back pain (Evanoff, et al., 2003; Owen, et al., 2002).

Methods to reduce injuries due to manual lifting of patients had varied results in the literature. As mentioned, the implementation of educational programs for proper lifting and transferring techniques did not significantly reduce employee injuries (Evanoff, et al., 2003; Owen, et al., 2002). However, the use of mechanical lifts was found to significantly reduce the number of injuries in a number of studies (Charney, et al., 2006; Evanoff, et al., 2003; Garg, 1999; Li, et al., 2004; Nelson & Baptiste, 2006; Owen, et al., 2002).

Collins, et al. (2004) reported implementation of mechanical lifts and employee education had the greatest impact on the most serious injuries in the facility, resulting in significantly reduced workers' compensation claims. Charney, et al. (2006) reported a 43% decrease in patient handling injury, a 41% reduction in healthcare claims, a 50% decrease in time-lost frequency rate and a 24% decrease in total incurred loss per claim after the implementation of mechanical lifts. Nelson, et al. (2005) evaluated the effectiveness of an ergonomics program for nursing staff, which consisted of mechanical lifts and repositioning aids, a zero-lift policy and employee training on lift usage. The program resulted in significant decreases in injury rate, modified duty days and workers' compensation costs.

The major challenges reported in the implementation of mechanical lifts were the financial cost of the equipment and adherence of nursing staff (Li, et al., 2004). Mechanical lifts

Sara F. Maher, PT, DScPT, OMPT, is an assistant professor in the Department of Physical Therapy at Oakland University in Rochester, MI. She can be contacted at sfmaher@oakland.edu.

Charles W. McGlothlin Jr., Ph.D., P.E., is special instructor and program director of the occupational safety and health program at Oakland University in Rochester, MI.

were identified as time-consuming processes and were often not utilized once the systems and devices were purchased (Li, et al., 2004). Non-usage of lifts was identified as a prime limitation in a number of studies (Charney, et al., 2006; Li, et al., 2004). The reasons for not utilizing equipment included inexperience with the new equipment, hindrance in job performance (at least initially), high staff turnover rates, time constraints, inadequate number of lifts and poor maintenance/cleaning of equipment (Collins & Owen, 1996; Collins, et al., 2004; Evanoff, et al., 2003; Nelson, et al., 2005; Zhaung, et al., 2000). However, skill-based training on lift equipment (one or two nursing staff at a time), nursing staff input on the selection of equipment before implementation and a policy with written guidelines for assessing patient transfer needs and procedures were shown to increase staff compliance and improve staff buy-in (Collins, et al., 2004).

Guidelines for using mechanical lifts varied from facility to facility. Although the term "no-lift" policy is common, the policy may also be called "zero-lift," "minimal lift," "lift-free" or "safe patient handling and movement," according to Nelson and Baptiste (2006). In general, most written policies about mechanical lifts have a basic intention that care providers should avoid manual handling in virtually every patient care situation and instead use patient-handling equipment and devices (Nelson & Baptiste, 2006). However, none of the studies in the literature review identified how the number and type of lifts were determined for each facility or unit. Therefore, it may be difficult to compare results since ratios of patients to lifts could vary drastically across studies. In addition, types of lifts vary from partial to total assist. The purpose of this study, therefore, was to determine if a "minimal lift policy" in combination with a formula to calculate the type and number of lifts needed by the facility (based upon resident transfer abilities) would decrease staff injury rates and improve job satisfaction.

Methods

Participants

Approval for the study was obtained from the Institutional Review Board for the Protection of Human Subjects at Oakland University. Participants in the job satisfaction survey were a convenience sampling (employees working at the facility on the days the authors collected data) of direct care staff employed by Martha T. Berry Medical Care Facility, an extended care facility in southeast Michigan. At the time of the study, the facility had an average daily census of 213 residents. Demographic data about residents (e.g., transfer needs, needs for whirlpool/shower chair) were only collected at the beginning of the study.

Nursing staff employees (survey participants) were primarily females (98%) and included 28 registered nurses, 12 limited practical nurses and 109 certified nursing assistants. The average employment history of the participants was 6.4 years. To be included in the study, all participants had to be directly involved in resident care (lifting and transfers of residents). Participants were excluded from the study if their job did not include lifting and/or transfers (e.g., housekeeping staff members) or if they had a recent surgery or other medical conditions that restricted or hindered them from being able to participate in resident lifting tasks at the time of the study.

Although the facility owned 16 mechanical lifts prior to the start of the study, only 1 to 2 nursing staff members per unit were using the lifts on a regular basis. In fact, during the on-site evaluation (pre-intervention) four lifts were found stored in closets on several units, inaccessible to direct care staff.

Procedures

Prior to purchase and implementation of new mechanical lifts, the authors performed an on-site evaluation to determine the number of mechanical lifts needed in the facility. A tool called "Long-Term Care: Risk Reduction Form" calculated the type and number of lifts, based upon the physical functioning of residents on each floor (Murphy & Faulkner, n.d.). The tool was developed by several authors at Liko, a manufacturer of mobile and mechanical lifts.

The Liko authors allowed use of the tool without requiring the facility to purchase any patient lifting equipment from Liko. The tool had no published validity or reliability results. The factors assessed by the risk reduction form included: 1) identification of each resident's transfer ability (independent, minimally dependent, partially dependent or totally dependent); 2) facility layout; 3) staff behaviors and usage patterns of lifts; 4) future staff expectations (minimal lift policy); 5) future renovations; 6) barriers; and 7) facility budget.

After completion of the Long-Term Care: Risk Reduction Form, the facility was given a recommendation for the number and type of lifts based upon transfer assistance needs of residents and the number of mechanical lifts already in use at the facility. The basic formula was to provide one sit-to-stand lift for every 7 to 8 residents requiring partial assistance with transfers and one total lift for every 8 to 12 residents requiring total assistance with transfers (Murphy & Faulkner, n.d.).

Prior to the start of the study, the facility had 16 lifts (4 sit-to-stand and 7 total lifts). The recommendation was for the facility to have a total of 26 lifts (15 sit-to-stand and 11 total lifts), so 10 additional lifts were purchased (11 sit-to stand and 4 total lifts). A lift committee—formed of direct care staff and administrators—began meeting shortly after the on-site evaluation. The lift committee brought vendors to the facility and had a 1-month trial of various types of lifts on the units within the facility. The lift committee, with input from unit staff members, selected new lift equipment, which met the authors' recommendations for type of lift (sit-to-stand or total lift). The vendors trained all lift committee members on how to utilize the new equipment over a 2-week period. Lift committee members then provided an in-service to each unit about the new equipment, then worked on a one-to-two ratio to train unit staff members in equipment use. The lift committee continued to meet monthly to discuss the effectiveness of the new equipment, problems using the new equipment, etc.

After lift purchase, a "minimal lift" policy was implemented at the facility. At this facility, "minimal lift" meant that staff members were directed to avoid manual lifting in virtually every

Dependent Variables	Pre-Lift		Post-Lift	
	Mean	Std. Dev	Mean	Std. Dev.
Age	39.76 yrs.	± 9.73 yrs.	39.65 yrs.	± 7.80 yrs.
Work Hours (daily)	6.4 hrs.	± 5.91 hrs.	7.11 hrs.	± 7.36 hrs.
	Categories	Pre-Lift	Post-Lift	
Gender	Male	2 (6%)	1 (3%)	
	Female	33 (94%)	31 (97%)	
Job Classification	CENA	20 (57%)	16 (50%)	
	LPN	3 (8%)	3 (9.5%)	
	Nurse	9 (26%)	8 (25%)	
	Nurse Aide	1 (3%)	3 (9.5%)	
	Rehab Aide	1 (3%)	0 (0%)	
	Supervisor	1 (3%)	2 (6%)	

Table 1. Participant demographics.

resident care situation and to select lifts based upon the needs of each resident. For example, lifts were not utilized for residents who were considered independent in all aspects of transfers. Sit-to-stand lifts were utilized for residents who were minimally dependent (ambulatory, but needing assistance to stand) and partially dependent residents (not ambulatory, but partially weight-bearing). Total lifts were utilized for residents determined to be totally dependent (no participation in transfers).

Direct care workers were informed that the goal of the "minimal lift" policy was to promote an environment where the use of lifts was encouraged and expected. To achieve this goal, lifts had been purchased based upon the needs of the residents (as described here), and training had been provided on expectations of the policy and how to use new lifting equipment. Each unit manager was responsible for enforcement of the "minimal lift" policy. If a nursing staff member did not utilize mechanical lifts when appropriate, the non-compliant employee was given a verbal warning. After several verbal warnings, a written warning would be put in the employee's file. Records of verbal and/or written warnings were not provided to the study authors.

Outcome Measures

Data were collected on two outcome measures: job satisfaction and monthly injury rates. Job satisfaction was measured by a survey called the Measure of Job Satisfaction (MJS). The MJS contained 38 questions related to the level of job satisfaction in five factors: 1) workload/staffing issues; 2) independence in work and collegiality with co-workers; 3) compensation and career issues; 4) support from supervisors; and 5) and matters of patient care (Traynor & Wade, 1993). The survey was found to have satisfactory internal consistency, test-retest reliability and concurrent/discriminatory validity (Traynor & Wade, 1993; Van Saaneet, al., 2003).

Each question on the MJS was rated on a 5-point scale where 1 equaled "very satisfied" and 5 equaled "very dissatisfied." The survey was distributed twice, during the onsite evaluation and one year later. Completion of the MJS survey was voluntary. Attached to each MJS survey was an informed consent sheet. Only MJS surveys with a signed informed consent sheet were used for data analysis. The informed consent and MJS survey were separated at the time of data analysis and stored in separate locations. Demographic data were collected as part of the MJS survey and included information, such as age, occupational title and number of hours worked per week, etc. Information about previous experience with mechanical lifts was not collected.

The same respondents may or may not have completed the survey during the onsite evaluation and at data collection 1 year later. The reasons for not seeking the same respondents were that data were only collected on two dates (pre and post lift purchase), staff members had varied days off from week to week, staff turnover could not be predicted over the course of one year and staff members were extremely anxious about maintenance of confidentiality due to layoffs occurring at the facility during the period of the study.

Whenever a staff member at Martha T. Berry County Medical Facility sustained any type of injury on the job, an injury report was completed and turned in to the human resources department. Information contained in the report included who was involved in the injury (resident(s) and/or staff), how the injury occurred (bee sting, needle injury, repositioning of resident, etc.), the injured employee's department, the date and time of the incident and what type of medical treatment was sought (if any).

For confidentiality reasons, the human resources department compiled a monthly summary of injuries (given to all units) that contained injury data related to the unit(s) of occurrences, department(s), shift(s), nature of injuries and the total number of incidents. The monthly summaries of injuries were obtained from the human resource department for each month from June 2007 to July 2009. However, only injuries directly related to transfers and lifting of residents were included in the final data analysis. Data that appeared to be due to other issues, such as "slipping on a wet floor," "being struck by a resident" or "being stuck by a contaminated needle," were not included in the analysis.

Data Analysis

Data were analyzed using SPSS Windows version 14.0 (SPSS, Inc., Chicago, 2005). The MJS data were analyzed with Mann-Whitney U-tests to compare the Likert scale answers of the items on the survey. Fisher's Exact Test was used to examine gender and job classification attributes of staff and independent t-tests were utilized to compare age and number of work hours of staff. Staff injury rates were calculated based on the average monthly number of claims. Multiple paired t-tests were used to compare the number of injuries pre- and post-mechanical lift purchase. Statistical significance was set at $p < .05$.

Results

A total of 67 surveys were completed during the study ($n = 35$ pre-lift, $n = 32$ post-lift). As mentioned, the same respondents may or may not have completed the survey pre and post lift purchase. Demographic data of participants from both groups can be seen in Table 1 (p. 33). The two groups did not differ significantly in age, number of work hours, types of jobs performed or gender. However, the facility used a number of contingent staff as well as offered overtime on a regular basis to meet staffing needs. For this reason, employees had large deviations in the average number of hours worked per day.

Group means for job satisfaction were analyzed using

	Mean (pre)	S.D. (pre)	Mean (post)	S.D. (post)
Feeling of worthwhile accomplishment†	1.89	.932	1.80	.997
Use of skills†	2.15	.784	1.84	.723
Contribution to patient care†	1.68	.843	1.50	.568
Challenge in job†	2.29	.906	2.06	.982
Job is varied†	2.23	.942	2.00	.803
Accomplished at end of day†	1.94	.906	1.66	.787
Standard of care to patients†	1.83	.985	1.56	.669
Personal growth†	2.29	.957	2.03	1.092
Quality of work†	1.74	.950	1.47	.761
Independent thought and action±	2.29	1.100	1.65	.839
Time available to get work done†	3.09	1.121	2.84	1.194
Time to finish everything†	3.14	1.089	3.00	1.320
Time available for patients	2.79	1.038	2.84	1.273
Workload	2.91	1.121	3.06	1.268
Staffing levels†	3.23	1.031	3.16	1.370
Way I care for patients†	2.03	.985	2.00	.984
Time on administrative tasks	2.71	.871	2.84	1.347
Support and guidance from supervisor	2.31	1.132	2.38	1.212
Opportunities to discuss concerns†	2.63	1.003	2.56	1.134
Support available†	2.79	1.038	2.45	1.261
Quality of supervision	2.30	.951	2.33	.959
Respect from boss	2.48	1.228	2.53	1.135
Feel part of a team†	2.29	1.001	2.13	1.088
People I talk and work with	2.09	.886	2.19	1.061
Contact with colleagues	2.15	.784	2.22	1.039
Value colleagues place on work†	2.31	.867	2.26	1.064
Pay	2.86	1.115	2.97	1.329
Clinical grading	2.24	.781	2.31	1.120
Fairness of pay	2.83	1.071	3.00	1.244
Prospects for promotion†	3.00	.939	2.59	1.073
Opportunities for advancement†	3.06	.938	2.75	1.368
Match between job description and job†	2.53	.861	2.45	1.179
How secure things look for this organization	2.71	.906	2.84	1.298
Security of job	2.62	.853	2.94	1.366
Opportunity to attend courses†	2.89	1.157	2.84	1.417
Time to attend courses†	3.21	1.067	3.03	1.356
Funding for courses†	3.59	.988	3.48	1.288
Adequate training for job	2.17	.923	2.31	1.281

Table 2. Job Satisfaction Means (pre- and post-lift purchase).
SD = standard deviation
†Higher satisfaction (declining scores)—not statistically significant
±Higher satisfaction (declining scores)—statistically significant

Dependent Variables	Survey Group	N	Mean Rank	Sum of Ranks
Factor 1 (Q1,2,4,5,6,8,11-15)	Pre-Lift Installation Survey	35	35.49	1242.00
	Post-Lift Installation Survey	32	32.38	1036.00
	Total	67		
Factor 2 (Q10,23-26,28,32,38)	Pre-Lift Installation Survey	35	36.54	1279.00
	Post-Lift Installation Survey	32	31.22	999.00
	Total	67		
Factor 3 (Q27,29-31,33-37)	Pre-Lift Installation Survey	35	34.53	1208.50
	Post-Lift Installation Survey	32	33.42	1069.50
	Total	67		
Factor 4 (Q17-22)	Pre-Lift Installation Survey	35	33.81	1183.50
	Post-Lift Installation Survey	32	34.20	1094.50
	Total	67		
Factor 5 (Q3,7,9,16)	Pre-Lift Installation Survey	35	35.90	1256.50
	Post-Lift Installation Survey	32	31.92	1021.50
	Total	67		

Table 3. Group Ranks of Job Satisfaction Responses and Factor Score.

Mann-Whitney U-tests. The difference in the mean job satisfaction responses between the pre- and post-lift groups showed no significant differences for 37 questions on the survey. The groups' responses differed significantly ($\underline{p} = .01$) on Question 10, which asked the participants "The amount of independent thought and action I can exercise in my work." Post-lift participants were significantly more satisfied than the pre-lift staff on this question (Table 2, p. 34).

A data reduction procedure called "factor analysis" was applied to the survey answers to summarize the principal components contained in the 38 questions within the survey. Five factors were identified in the "factor analysis," which matched the 5 factors identified by the original authors (Traynor & Wade, 1993): 1) sufficient time to complete my work, other workload or staffing issues; 2) independence in performing my work; value or grading of my work; contact with colleagues; match between job description and actual tasks; 3) pay, promotion, security and advancement issues; opportunity to attend courses; 4) support, guidance and respect from supervisor; time spent on administrative tasks; and 5) patient care issues. Results of the Mann-Whitney U-tests revealed that the two groups did not have statistically significant differences from pre to post lift purchase, on any of the composite question factors (Table 3).

After ensuring the assumption of normal distribution, independent samples t-tests were used to compare monthly average injury rates in the 12 months before and after the acquisition

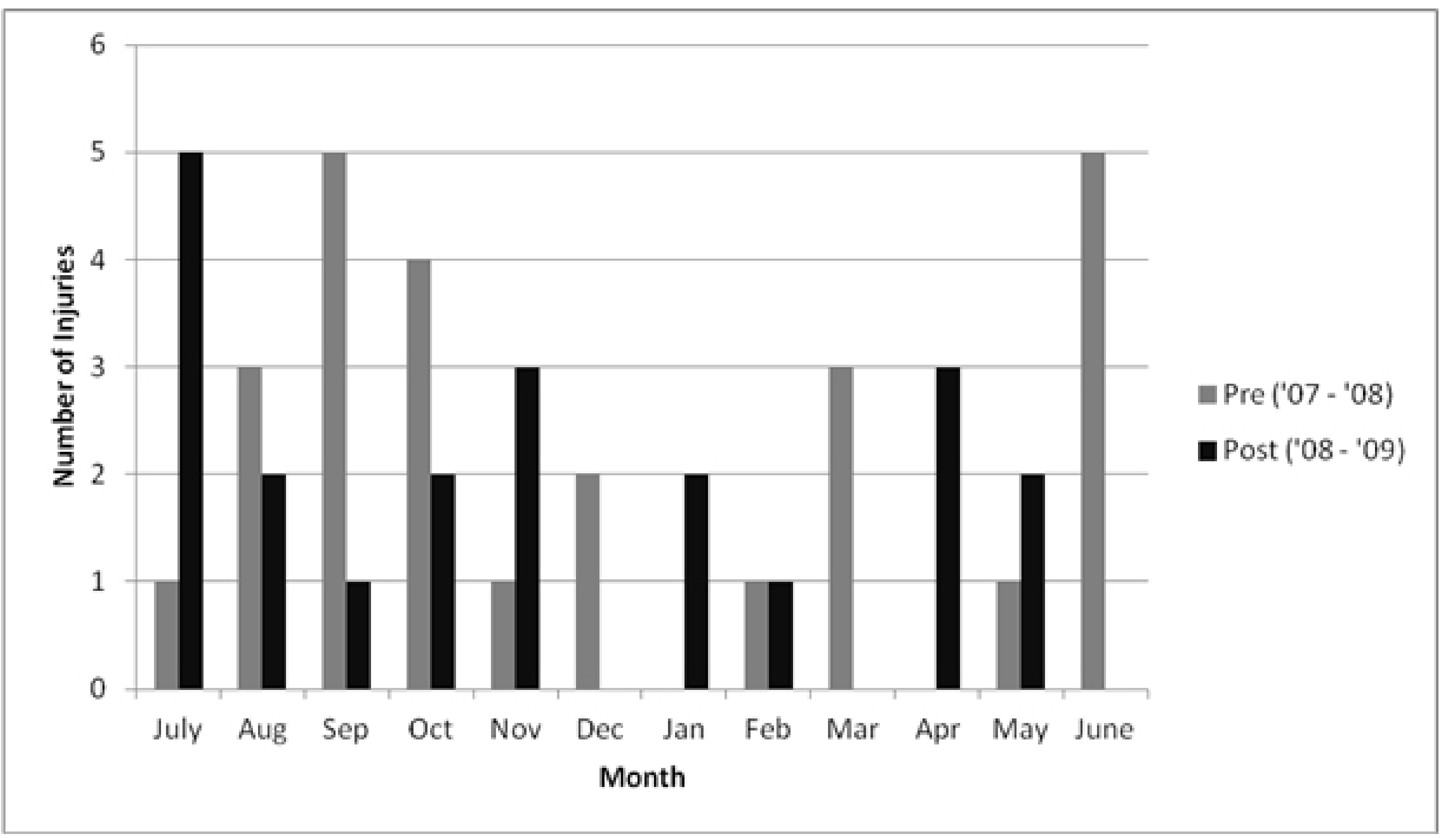

Figure 1. Number of monthly injuries pre- and post-lift purchase.

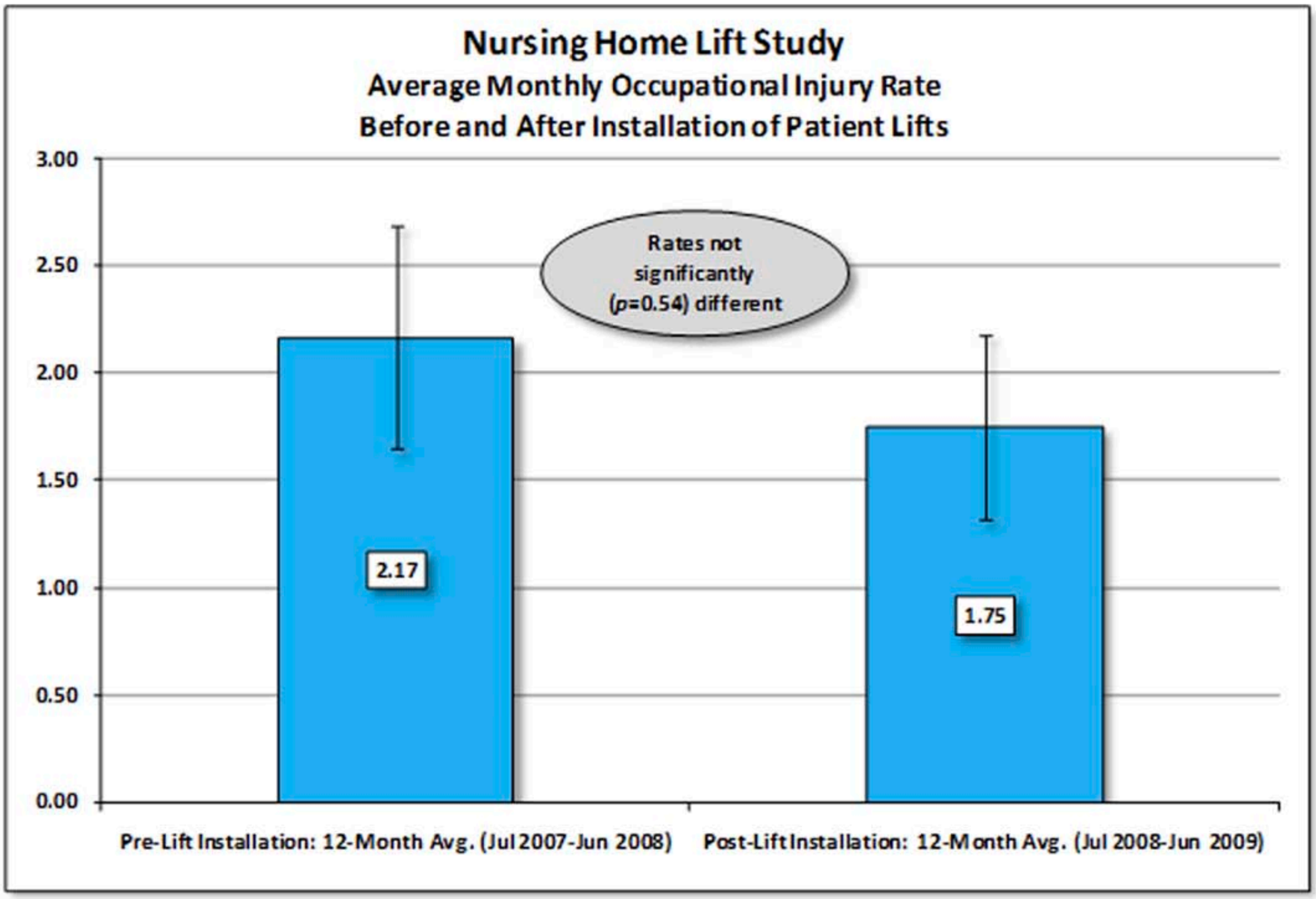

Figure 2. Average monthly injury rate pre- and post-lift purchase (installation).
**Shown with standard deviation bars*

of new lifts in the facility (Figure 1, p. 35). While the average monthly injury rate was higher pre-lift, at 2.17, versus a post-lift rate of 1.75 (Figure 2), these results were not statistically significant [t(22) = 0.62, p = 0.54]. The types of injuries were similar from pre-to-post lift purchase: low back pain was the most common (50%), followed by hand/wrist (25%), foot/ankle (12%) and other body parts (13%).

Discussion

The purpose of this study was to determine if implementation of a minimal lift policy in combination with the purchase of mechanical lifts (based upon a calculated formula) would improve job satisfaction levels and decrease staff injuries related to manual transfers of residents. Post-survey analysis showed a statistical significant improvement in only one measure of job satisfaction, "The amount of independent thought and action I can exercise in my work." The remaining job satisfaction questions were not statistically significant, although post-lift participants had slightly higher satisfaction levels (declining scores) than their pre-lift peers on 23 (62%) of the remaining 37 questions (Table 2). The survey did not allow for feedback from participants on any of the questions, so additional follow-up could not be conducted.

The authors of studies that utilized "zero-lift" policies found improvement in professional status, task requirements (Nelson, et al., 2005) and general job satisfaction (Li, et al., 2004). However, staff members were more in favor of lifting equipment (96%) than a "no lift" policy (68%) (Nelson, et al., 2005). There may be some confusion among nursing staff about the term "zero lift" leading to a dislike of a "no lift" policy. Common misconceptions about the term "no lift" include: 1) staff should never attempt to manually move a patient, 2) staff should not use lift equipment or 3) the concept only examines high-risk tasks associated with lifting and ignores routine tasks, such as repositioning in bed (Nelson & Baptiste, 2006).

These misconceptions may lead to challenges implementing and enforcing a "no lift" policy. A "minimal lift" policy, on the other hand, may promote a different focus: 1) patients should be encouraged to assist with their own transfers; 2) manual lifting remains an option if the patient can assist with most of the weight; and 3) transfers should be based upon the patient's cognitive and physical status, as well as the status of the worker (Nelson & Baptiste, 2006). "Minimal lift" terminology may reinforce staff independence by allowing choices in type of lift (sit-to-stand lift, total dependent lift, etc.), when other forms of assistance may be useful (slings, transfer sheets, etc.) or if no assistance is needed at all.

In a study by Zhuang, et al. (2000), the authors examined a number of transfer techniques and asked nursing staff to evaluate each technique on perceived exertion, ease-of-use and task performance time. Depending on the staff and the task at hand, results were varied. Walking belts, for example, were rated as easy to use, with fairly good control of the resident, but provided limited back support. Overhead lifts were generally viewed as slow and were the least liked of all transferring methods. Basket-sling and stand-up lifts were generally the preferred method of transfer. However, staff responses varied based upon the manufacturer of the device. In general, comments were favorable for assistive devices versus more manual methods of transfers (Zhuang, et al., 2000). If given opportunities to select not only the lifts for a facility but the type of lift for a particular transfer, staff members may have decreased resistance to use of lift equipment and the enforcement of a "minimal lift" policy.

While previous authors examined staff responses to the use of mechanical lifts, few authors have examined patient perceptions about lifts. Zhuang, et al. (2000) reported that residents found stand-up lifts and basket-sling lifts more comfortable than manual transfers. However, stand-up and overhead lifts were rated by the residents as feeling less secure (Zhuang, et al., 2000). These results were in contrast to studies by Owen, et al. (2002) and Garg (1999), where residents reported more comfort and security when assistive devices were used. With contrasting results in the literature, additional studies could explore patient perspectives on the use of lifts. In addition, patient injury rates using mechanical lifts may also be a consideration. Garg (1999) reported that no injuries occurred among patients during the implementation of mechanical lifts, while one patient had been injured in the year prior to the study.

While a decrease was noted in the average number of monthly injuries in our study, the decline was not statistically significant. Only three studies in the literature review had injury rates similar to those seen at our facility (Li, et al., 2004; Owen, et al., 2002; Yassi, et al., 2001). During two of the studies injuries declined significantly (Li, et al., 2004; Owen, et al., 2002), while in the third study the number of injuries actually increased from 13 injuries pre-intervention to 20 injuries post-intervention (Yassi, et al., 2001).

Despite an increase in injury rates, the authors reported a decline in the frequency and intensity of physical discomfort associated with patient handling tasks. The authors postulated that injury rate data did not identify milder forms of musculoskeletal discomfort. Mild discomfort may not have met the criteria for injury reports, according to federal statutes, and therefore may have been overlooked when counting numbers of injuries (Yassi, et al., 2001). Even without the implementation of a zero or minimal lift policy, the use of mechanical lifts has been shown to decrease musculoskeletal discomfort and injury rates among nursing staff (Evanoff, et al., 2003; Li, et al., 2004; Owen, et al., 2002; Zhuang, et al., 2000) and should be a consideration for future researchers.

Limitations

Limitations to the present study included a small sample size with only two data collection points. Interviewing larger samples of direct care employees would have provided greater power to the study to detect small differences in satisfaction levels, which may or may not have been statically significant. A power analysis was not conducted prior to the start of the study, and this is also a limitation that future authors may want to address: to ensure an adequate sample size before discontinuing data collection. The addition of other outcome measures, such as patient satisfaction, patient comfort and staff musculoskeletal discomfort, may be warranted to see if these factors are more sensitive to changes, further validating the use of mechanical lifts and minimal lift policies. While we utilized a calculated formula to predetermine the number of lifts needed for our facility, this formula may have been different from that used by previous authors. Our calculation, therefore, may or may not have impacted our results.

Finally, using only one facility is a limitation. The facility where the study occurred underwent drastic budget cuts between the two data collection points. These budget cuts resulted in layoffs and wage freezes during the study period, which may have negatively impacted job satisfaction levels. One suggestion is to use a control group to negate extraneous variables. By adding a control group, external socioeconomic effects, such as wage freezes, may have a reduced impact on the results (Gerhart, 1987). A second suggestion is to increase the sample size by using larger facilities, multiple facilities or by continuing to collect data until a sample is obtained that meets a predetermined power analysis. A final suggestion is to create a longitudinal study to determine if the changes from lift implementation remain, improve or decline over time.

Conclusions

While one aspect of job satisfaction was found to be significantly improved, "The amount of independent thought and action I can exercise in my work" trends were observed in decreased injury rates and improved job satisfaction levels among direct care workers. These trends are supported by previous authors who reported significant improvements in job satisfaction and a significant reduction in injuries among nursing staff after implementation of mechanical lifts (Charney, et al., 2006; Collins, et al., 2004; Li, et al., 2004; Nelson, et al., 2005; Owen, et al., 2002). This is the first study known to the authors to describe a formula for calculating the number of lifts needed by a facility and may provide a starting point for determining patient lifting needs for future studies.

However, the lack of data collection points, the use of only one facility and the limited outcome measures may have contributed to the lack of statistical significance in our analysis. Future researchers should consider describing how the number of and type of lifts were determined for the facility being studied to allow for comparisons between studies. In addition, other outcome measures (e.g., patient perception of lifts, staff musculoskeletal discomfort, etc.), more data collection points (monthly, bimonthly, longitudinal, etc.), larger sample sizes (determined by prior analysis) and including multiple facilities may provide more meaningful information to future researchers.

References

Charney, W., Simmons, B., Lary, M. & Metz, S. (2006). Zero lift programs in small rural hospitals in Washington state. *American Association of Occupational Health Nurses Journal, 54,* 355-358.

Collins, J.W. & Owen, B.D. (1996). NIOSH research initiatives to prevent back injuries to nursing assistants, aides and orderlies in nursing homes. *American Journal of Industrial Medicine, 29,* 421-424.

Collins, J.W., Wolf, L. & Evanoff, B. (2004). An evaluation of a "best practices" musculoskeletal injury prevention program in nursing homes. *Injury Prevention, 10,* 206-211.

Evanoff, B., Wolf, L., Aton, E., Canos, J. & Collins, J. (2003). Reduction in injury rates in nursing personnel through the introduction of mechanical lifts in the workplace. *American Journal of Industrial Medicine, 44,* 451-457.

Garg, A. (1999). *Long-term effectiveness of a "zero-lift program" in seven nursing homes and one hospital* (NIOSH Publication No. U60/CCU512089-02). Cincinnati, OH: NIOSH.

Gerhart, B. (1987). How important are dispositional factors as determinants of job satisfaction? Implications for job design and other personnel programs. *Journal of Applied Psychology, 72,* 366-373.

Larrabee, J., Janney, M., Ostrow, C., Withrow, M.L., Hobbs, G.J. & Burant, C. (2003). Predicting registered nurses job satisfaction and intent to leave. *Journal of Nursing Administration, 33,* 271-283.

Li, J., Wolf, L. & Evanoff, B. (2004). Use of mechanical patient lifts decreased musculoskeletal symptoms and injuries among healthcare workers. *Injury Prevention, 10,* 212-216.

Lloyd, J.D. (2004). *Biodynamics of back injury: Manual lifting and loads. Back Injuries among Healthcare Workers: Causes, Solutions and Impacts.* Boca Rotan, FL: Lewis Publishers.

Murphy, J. & Faulkner, D. (n.d.). *Long-term care risk reduction form.* Unpublished document. Strongsville, OH: Liko, A Hill-Rom Co.

Nelson, A. & Baptiste, A.S. (2006). Evidence-based practices for safe patient handling and movement. *Clinical Reviews in Bone and Mineral Metabolism, 4,* 55-69.

Nelson, A., Matz, M., Chen, F., Siddharthan, K., Llyod, J. & Fragala, G. (2005). Development and evaluation of a multifaceted ergonomics program to prevent injuries associated with patient handling tasks. *International Journal of Nursing Studies, 43,* 717-733.

Owen, B.D., Keene, K. & Olson, S. (2002). An ergonomic approach to reducing back/shoulder stress in hospital nursing personnel: A five-year follow-up. *International Journal of Nursing Studies, 39,* 295-302.

Traynor, M. & Wade, B. (1993). The development of a measure of job satisfaction for use in monitoring the morale of community nurses in four trusts. *Journal of Advanced Nursing, 18,* 127-136.

Van Saane, N., Sluiter, J.K., Verbeek, J.H. & Frings-Dresen, M.H.W. (2003). Reliability and validity of instruments measuring job satisfaction: A systemic review. *Occupational Medicine, 53,* 191-200.

Yassi, A., Cooper, J.E., Tate, R.B., Gerlach, S., Muir, M., Trottier, J. & Beng, K.M. (2001). A randomized controlled trial to prevent patient lift and transfer injuries of healthcare workers. *Spine, 24,* 1739-1746.

Zhuang, Z., Stobbe, T.J., Collins, J.W., Hsiao, H. & Hobbs, G.R. (2000). Psychosocial assessment of assistive devices for transferring patients/residents. *Applied Ergonomics, 31,* 35-44.

Acknowledgement of Reviewers

The *Journal of Safety, Health and Environmental Research* gratefully acknowledges the following individuals for their time and efforts as manuscript reviewers during the period between Sept. 1, 2010, and Aug. 31, 2011. Their assistance in raising the standard of the papers published is immense and is greatly appreciated. Although the members of the Editorial Review Board (names are italicized) generally reviewed more manuscripts than others (and provided much additional support), the vast majority of reviews were handled by ad hoc reviewers, chosen for their unique expertise on the topics under consideration.

Magdy Akladios, University of Houston-Clear Lake, Clear Lake, TX, USA
Earl Blair, Indiana University, Bloomington, IN, USA
Sang Choi, University of Wisconsin-Whitewater, Whitewater, WI, USA
Jerry Davis, Auburn University, Auburn, AL, USA
Angela DiDomenico, Liberty Mutual Research Institute for Safety, Hopkinton, MA, USA
Maxwell Fogleman, Embry-Riddle Aeronautical University, Prescott, AZ, USA
Hamid Fonooni, East Carolina University, Greenville, NC, USA
Mark Friend, Embry-Riddle Aeronautical University, San Antonio, TX, USA
Charles Geraci, CDC/NIOSH, Cincinnati, OH, USA
Joel Haight, CDC/NIOSH, Pittsburgh, PA USA
Matthew Hallowell, University of Colorado, Boulder, CO, USA
Darryl Hill, Oakland University, Rochester, MI, USA
Tsuyoshi Kawakami, International Labour Organization, Bangkok, Thailand
Todd Loushine, University of Wisconsin-Whitewater, Whitewater, WI, USA
Michael O'Toole, Embry-Riddle Aeronautical University, Daytona Beach, FL, USA
Hans Pasman, Delft University of Technology, Delft, The Netherlands
Sathy Rajendran, Central Washington University, Ellensburg, WA, USA
James Ramsay, Embry-Riddle Aeronautical University, Daytona Beach, FL, USA
Mary Ann Rose, East Carolina University, Greenville, NC, USA
Sanjeev Saraf, Exponent, Houston, TX, USA
Elbert Sorrell, University of Wisconsin-Stout, Menomonie, WI, USA
Todd Smith, Embry-Riddle Aeronautical University, Daytona Beach, FL, USA
Anthony Veltri, Oregon State University, Corvallis, OR, USA
Donna Vosburgh, University of Wisconsin-Whitewater, Whitewater, WI, USA
Chip Wade, Auburn University, Auburn, AL, USA
Qingsheng Wang, Oklahoma State University, Stillwater, OK, USA
Cindy Wei, BASF Corporation, Wyandotte, MI, USA
Tom Young, Nike, Beaverton, OR, USA ✪

Call for Special Issue Papers

The *Journal of Safety, Health and Environmental Research* is pleased to announce several calls for special issue papers over the next 18 months. The call for papers is now open and guest editors have been assigned. The topics, guest editor information and scheduled publication dates are as follows:

- Research to Practice: Bridging the Gap Between Academia and the SH&E Practitioner; Sang Choi; mid-2012.
- Fire and Process Safety: Qingsheng Wang; late 2012.
- Safety Communications: Jerry Davis; mid-2013.

2012 Academic Forum

The Academics Practice Specialty (APS) is pleased to host the 2012 Academic Forum in conjunction with ASSE's Safety 2012 Professional Development Conference next June in Denver, CO. The event will take place June 3, 2012, from 10 a.m. to 3 p.m. Please contact Hamid Fonooni, APS Administrator, for more information.