Developing Evidence-Based Interventions to Address the Leading Causes of Workers' Compensation Among Healthcare Workers

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KEY WORDS

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Overexertion and slip, trip, and fall (STF) incidents are two of the leading sources of workers' compensation claims and costs in healthcare settings (Bell et al., 2008; Bureau of Labor Statistics [BLS], 2008). Working in conjunction with a team of international researchers, the National Institute for Occupational Safety and Health (NIOSH) has been conducting research to demonstrate the effectiveness of comprehensive safe patient handling and STF-prevention programs. The purpose of this article is to summarize the research and outreach efforts of NIOSH and their partners to address the leading occupational injury hazards facing healthcare workers. This article also provides an overview of the changes that are occurring in the healthcare industry as a result of the evidence-based research on safe patient handling and STF prevention that has been conducted in recent years.

Work-related injuries are not only deleterious to healthcare workers' well-being, but they also affect lost work days and the cost of care. When examining the most disabling work-related injuries, overexertion ranks first among causes, with approximately 50 lost workday injuries per 10,000 full-time equivalent (FTE) employees (Bureau of Labor Statistics [BLS], 2008). This event category includes injuries related to lifting, pushing, pulling, holding, carrying, or throwing and costs businesses more than $12 billion in direct costs, accounting for more than one-quarter of the overall national burden of work-related injuries (Liberty Mutual Research Institute for Safety, 2009). The category *falls on the same level* ranked second as a leading cause of disabling injury, with 34.3 injuries requiring time away from work per 10,000 FTE (BLS, 2008). In 2006 falls on the same level claimed direct costs of $6.4 billion and accounted for 13.3% of the U.S. injury burden. According to BLS data, those who work at hospitals and nursing homes, especially nursing aides, are at high risk of sustaining a musculoskeletal disorder or overexertion injury (particularly of the back and shoulder) and slip, trip, and fall (STF) injuries (BLS, 2007a). Frequent lifting and repositioning of patients is the leading source of injury for healthcare workers (BLS, 2003). Among female workers in the United States, nursing aides and orderlies suffer the highest prevalence (18.8%) and report the most annual cases (n = 269,000) of work-related back pain (Guo et al., 1995). In 2000, 10,983 registered nurses (RNs) suffered lost-time work injuries due to lifting patients (BLS, 2002). The average workers' compensation cost for back pain is $10,689 and $11,411 for upper extremity disorders (Silverstein & Adams, 2006). In a follow-back study of nurses, 12% reported leaving the nursing profession because of back pain (Stubbs, Buckle, Hudson, Rivers, & Baty, 1986). Employment demand for nurses is projected to increase 25% by 2012, creating an expected shortage in the nursing labor pool of 20% by 2015 and 30% by 2020 (American Nurses Association [ANA], 2003). The high injury rate coupled with a critical nursing shortage raises serious concerns about the nursing workforce's capacity to care for our nation's growing population (Buerhaus, Staiger, & Auerbach, 2000). The critical shortage of nursing faculty in U.S. nursing schools places additional pressure on meeting the demand for the nursing labor pool. A science base has been developed that identifies root causes and effective intervention strategies to reduce these injuries in health care.

Progress in Reducing Healthcare Worker Injuries

According to BLS data, lifting healthcare patients is the leading source of injury in health care (Personick, 1990). From 1992–2005 the incidence rate for sprains and strains involving days away from work in nursing homes steadily decreased by 67% (from 482.7 to 159.7 per 10,000 workers), and the incidence rate for sprains and strains in hospitals decreased 52% (from 222.4 to 106.1 per 10,000 workers). **Figure 1** shows that from 1992–2005, there has been a 70% reduction (from 397.8 injuries

to 121.2 injuries per 10,000 workers) in injury rates in nursing homes in which healthcare patients were listed as the source of injury. Similarly, a 52% reduction in lost workday injuries (from 110.8 to 53.5 per 10,000 workers) occurred from 1992–2005 in hospitals in which healthcare patients were listed as the source of the injury (Figure 1).

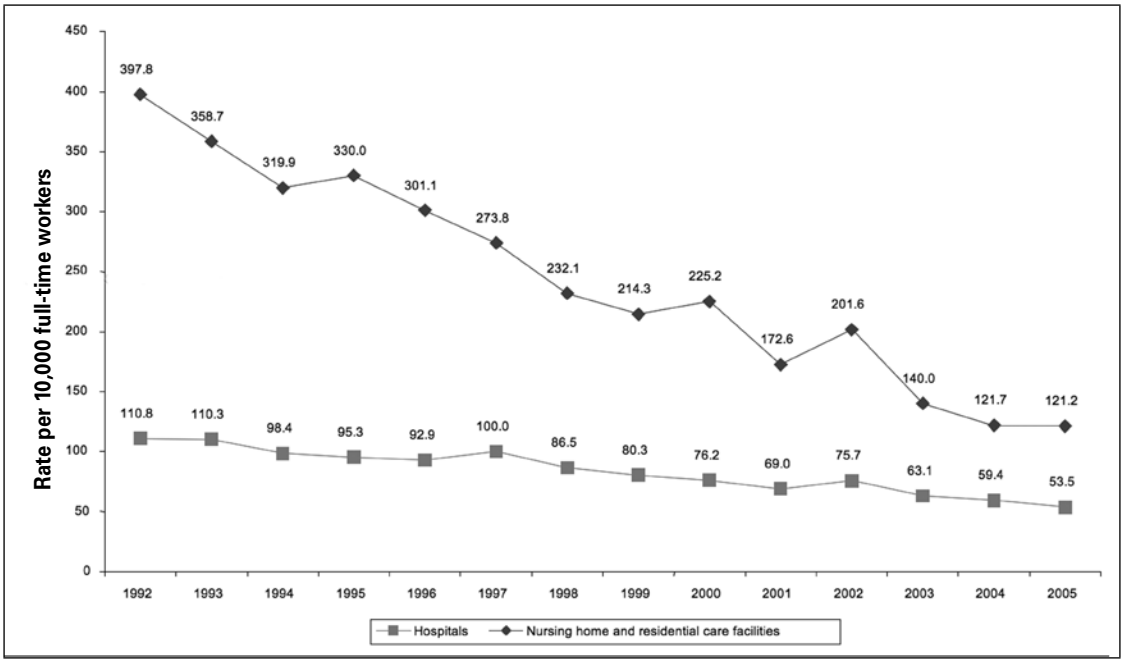
Safe Patient Handling and Movement Research

A search of the scientific literature revealed almost 4,000 published papers on the topic of nursing back injury. Nursing textbooks have discussed the risk of back injury since the emergence of professional nursing (Hampton, 1898). Although nurses have been at risk for the past 110 years, the musculoskeletal hazards of nursing work have historically been blamed on nurses' lack of strength and poor lifting technique. A significant rise in work-related disability can be traced to shifting nursing care from the home to hospitals. Because hospitals had the reputation as unclean facilities, only 10% of the sick were cared for in such institutions in 1915 (Joel & Kelly, 2002). Most nurses worked in private homes caring for a single patient who was prescribed a long period of bed rest. With the advent of penicillin in the 1940s, the reputation of hospitals began to improve and more patients began receiving health care in hospitals rather than in their homes (Joel & Kelly). The revolutionary concept of early ambulation, which made its way from the battlefield to hospitals in the 1940s during World War II (Sheldon & Blodgett, 1946), increased the physical burden of nursing work from a single patient to a multitude of postoperative patients who could collapse or lose their balance with little notice while being ambulated. Shortly after this shift in nursing care, articles began to appear in nursing journals about "aching backs" (Svec, 1951). The research literature examining back and musculoskeletal injuries among nurses has been expanding rapidly since the 1980s. More recently, the emphasis on nursing back injury research has shifted from describing the magnitude of the problem to seeking solutions to significantly reduce the problem.

Prevention Effectiveness Research for Lifting and Moving Patients

During the 1990s caregivers made progress developing ways to handle and move patients in healthcare facilities. Since the emergence of professional nursing during Florence Nightingale's time, *lifting properly* (or *body mechanics*) has been taught to nurses and nursing aides to help them perform lifts properly and prevent injury. Using body mechanics is intrinsically unsafe because the biomechanical forces required to lift and reposition adult patients exceeds the lifting capacity of most caregivers (Collins, Wolf, Bell, & Evanoff, 2004). Numerous studies have shown that training caregivers how

Figure 1. Rates of Nonfatal Injuries and Illnesses Involving Days Away from Work in Hospitals and Nursing Homes Where Healthcare Patients Were Listed as the Source of Injury (1992–2005)



Note. From U.S. Bureau of Labor Statistics Supplemental Tables (1992–2005). Available at www.bls.gov/iif/oschcdnew.htm.

to use proper body mechanics does not reduce the risk of injury to nursing personnel (Dehlin, Berg, Anderson, & Grimby, 1981; Dehlin & Lindberg, 1976; Snook, Campanelli, & Hart, 1978; Wood, 1986). After it became widely recognized that the hazard of lifting adult human bodies could not be alleviated by training alone, research studies began to examine patient lifting from an ergonomic viewpoint. Task analyses and biomechanical evaluations of patient handling tasks were conducted to redesign patient handling tasks so they would not exceed the capacities of caregivers.

Biomechanical Laboratory Studies

Laboratory-based biomechanical studies identified safer ways to lift and move patients that included removing the excessive forces and extreme postures that can occur when manually lifting residents. The collective assessment of the laboratory studies concluded that mechanical lifting equipment significantly reduces the biomechanical stresses that lead to musculoskeletal injuries among caregivers associated with patient lifting (Gagnon, Sicard, & Sirois, 1986; Lloyd, 2004; Marras, Davis, Kirking, & Bertsche, 1999; Ulin et al., 1997; Zhuang, Stobbe, Hsia, Collins, & Hobbs, 1999).

Field Studies and Demonstration Projects

After it was demonstrated that mechanical lifting equipment significantly reduced the physical stresses on caregivers under controlled conditions in the laboratory, the next phase of research validated the effectiveness of mechanical lifting equipment in field studies in real-world settings, specifically nursing homes and hospitals. A strong body of research evidence has been developed, demonstrating that a comprehensive safe patient handling and movement program can significantly reduce musculoskeletal injuries among healthcare workers (Collins, Wolf, Bell, & Evanoff, 2004; Garg, 1999; Garg & Owen, 1992; Nelson & Fragala, 2004; Yassi et al., 2001).

The elements of a comprehensive safe patient handling and movement program include

- ergonomic assessment for patient care environments
- an enthusiastic peer leader to promote and sustain program implementation
- mechanical patient lifts and repositioning aides
- patient care assessment protocols that prescribe the best methods for patient transfers
- written safe-lifting policies
- training on the proper use of patient handling equipment
- management support of the program.

Key Practice Points

1. Although slip, trip, and fall incidents appear to be random events that can occur anywhere inside or on the grounds of hospitals, evidence-based prevention actions specifically targeted at reducing slip, trip, and fall incidents among hospital employees have been proven to reduce fall injury rates among hospital employees by 58%.
2. Despite advances in the design of patient lifting equipment, legislation in certain states requiring safe patient lifting programs, and changes in student nursing curriculum to incorporate evidence-based science on patient lifting, musculoskeletal disorders associated with lifting and moving patients continue to be the leading cause of workers' compensation among healthcare workers.
3. Although the frequent heavy lifting and repositioning of residents in nursing homes exceeds the lifting capacity of most caregivers, an evidence base of science has been amassed demonstrating that comprehensive safe patient handling and movement programs can protect workers' from injury, reduce workers' compensation costs, and improve the quality of care delivered to residents.
4. A business case has been developed to show that the investment in comprehensive safe patient lifting programs can be recovered through reduced workers' compensation expenses and costs associated with lost and restricted work days.

A 6-year field study conducted by the National Institute for Occupational Safety and Health (NIOSH; Collins et al., 2004) demonstrated that a comprehensive safe resident handling program significantly reduced workers' compensation injury rates by 61%, lost workday injury rates by 66%, and restricted workdays by 38% (injuries attributed to resident handling only). In addition, the number of workers suffering repeat injuries was significantly reduced. During the 36-month preintervention period, there were 129 workers' compensation claims attributed to resident handling, and 11 workers filed more than one workers' compensation claim for musculoskeletal injuries. During the 36-month postintervention period, 56 workers' compensation claims were attributed to resident handling and only three employees filed more than one workers' compensation claim associated with resident handling tasks. The initial investment of $158,556 for lifting equipment and worker training was recovered in less than 3 years based on postintervention savings of $55,000 annually in workers' compensation costs.

Patient Lifting Legislation in the United States

Although comprehensive safe patient handling and movement programs have not been fully implemented across the U.S. healthcare system, a paradigm shift is occurring in the healthcare industry. Legislation continues to be introduced in numerous states and at the federal level; the following safe patient handling legislation has been passed:

- Texas Senate Bill 1525 was signed into law on June 17, 2005 (State of Texas, 2005).
- New York companion bills A11484 and A07836 and S05116 and S08358 were signed into law on October 18, 2005 (State of New York, 2006).
- Ohio House Bill 67 was signed into law on March 21, 2006, Section 4121.48 (State of Ohio, 2006).
- Washington House Bill 1672 was signed into law on March 22, 2006 (State of Washington, 2006).
- Hawaii House Concurrent Resolution No. 16 passed on April 24, 2006 (State of Hawaii, 2006).
- Rhode Island House 7386 and Senate 2760, passed on July 7, 2006 (State of Rhode Island, 2006).
- Maryland SB 879 safe patient handling legislation was signed into law April 2007 (State of Maryland, 2007a,b).
- Minnesota HB 712.2 safe patient handling legislation was signed into law May 2007 (State of Minnesota, 2007a,b).
- New Jersey S-1758/A-3028 safe patient handling practice act was signed into law January 2008 (State of New Jersey, 2008).

The legislation varies between states regarding which healthcare institutions are covered, requirements of the legislation, and whether funding is available to assist with implementation.

ANA's Handle with Care Program

The ANA's Handle with Care Program (2003) is an industry-wide effort designed to prevent back and other musculoskeletal injuries among the nation's nurses. The campaign is helping reshape nursing education and federal and state ergonomics policy by highlighting safe patient lifting research that demonstrates technology-oriented safe patient handling benefits for patients and the nursing workforce. Other healthcare unions and employee organizations are launching similar efforts.

Safe Patient Handling and Movement Curriculum for Schools of Nursing

In 2004 NIOSH, ANA, and the Veterans Administration (VA) Patient Safety Center of Inquiry in Tampa, FL, collaborated to develop and evaluate a new safe patient handling and curriculum module at 26 nursing schools throughout the United States. The goal of the project was to "translate current research related to safe patient handling into the curricula that could be used by schools of nursing to change the way student nurses in the United States are taught to move and handle patients" (Waters, Collins, Galinsky, & Caruso, 2006, p. 4). The objectives of the project were to

1. develop, implement, and evaluate a "train-the-trainer" program for safe patient handling and movement, targeting faculty at 26 nursing schools
2. develop, implement, and evaluate an evidence-based safe patient handling curriculum module at 26 nursing schools
3. compare the knowledge, attitudes, and beliefs of the students who were educated and trained at 26 nursing schools using the evidence-based safe patient handling curriculum module with the knowledge, attitudes, and beliefs of nursing students at three schools offering traditional nursing school curriculum
4. describe the process of implementing this evidence-based safe patient handling curriculum module at 26 nursing schools.

The curriculum consists of five main elements: a narrated slide presentation with an embedded video, a series of algorithms (decision tools that help nurses assess patient needs and decide which equipment is appropriate for a specific patient handling activity), didactic materials, laboratory activities, and a quiz to help students evaluate their knowledge of the new patient handling concepts. When the study was designed, it was agreed that a clinical component, in which students would be provided hands-on practice for properly selecting and using patient handling equipment, was needed. To equip the clinical skills laboratories, equipment vendors loaned or donated equipment to participating nursing schools. The safe patient handling and movement training presentation can be downloaded from the NIOSH website (www.cdc.gov/niosh/review/public/safe-patient), and the safe patient handling and movement algorithms, didactic materials, and quiz can be downloaded from the VA Patient Safety Center of Inquiry website (www.visn8.med.va.gov/visn8/patientsafetycenter/safePtHandling/default.asp).

STFs Research

Falls on the same level or STFs have been documented as the leading cause of nonfatal injuries in the general population (Bergen, Chen, Warner, & Fingerhut, 2008) and are also one of the leading causes of

injury in occupational populations. According to BLS data (2008), STFs are the second leading cause of lost workday injuries (~24%) in all private industry, and also the second leading cause in the healthcare and social assistance (HCSA) sector (27%). Certain subsectors within HCSA, such as nursing homes and residential care facilities, have an even greater problem with STFs. The lost workday injury rate due to falls on the same level in nursing homes and residential care facilities is 62.5 per 10,000, which is almost three times the rate for all private industry (BLS, 2008).

Although falls from elevation typically result in more severe injuries, falls on the same level are much more common, comprising more than 60% of total falls (Andersson & Lagerlöf, 1983; Leamon & Murphy, 1995; National Safety Council, 1999). Furthermore, falls on the same level do have the potential to result in serious or fatal injury. In a U.K. study, an estimated 9% of same-level falls resulted in death in the general population (Manning, 1983). Data from Sweden show that falls on the same level from slipping, tripping, or stumbling accounted for 8% of all occupational deaths (Strandberg, 1983). Data from all private U.S. industries indicate that the median days away from work due to a same-level fall is 9 days and that 28% of same-level falls result in 31 or more days away from work (BLS, 2007b). Back pain and sprain or strain injuries are a common outcome; it is estimated that between 19% (Mital, Pennathur, & Kansal, 1999) and 36% (Troup, Martin, & Lloyd, 1981) of back pain cases can be attributed to STFs. Fractures comprise approximately 17% of the nonfatal injuries associated with same-level falls in the workplace (Buck & Coleman, 1985). Older workers are also more likely than younger workers to suffer a fracture after a same-level fall (Bell et al., 2008; Layne & Landen, 1997; McNamee, Kemmlert, Lundholm, & Cherry, 1997).

Slips and trips are important precursors to other injury events. According to one study (Baxter, Foreman, & Troup, 1985), underfoot incidents, during which the first event is an interaction between the victim's foot and the walking surface, were the most common event leading to injury in work settings, preceding 26% of the total occupational incidents (excluding violence- and traffic-incident-related injuries). Underfoot incidents are primarily slips (62%) and trips (17%; Manning, Ayers, Jones, Bruce, & Cohen, 1988). In a study of 113,000 occupational incidents in Sweden in 1979, slipping was a preceding event in 11% (12,500) of the incidents (Strandberg, 1983). In a study of falls (both on the same level and to a lower level), slipping was the most common event leading to injury, followed by tripping (Cohen & Compton, 1982).

A variety of factors have been cited as contributing to STF incidents in the general population. Human factors, such as loss of balance, fatigue, body mass index, alcohol consumption, and use of psychopharmacologic agents can lead to slip and fall incidents, as can workplace conditions such as spilled liquid or debris, uneven or slippery surfaces, or objects in the path of travel (Buck & Coleman, 1985; Davis, 1983; Leclercq, 1999; Maalmivaara, Heliovaara, Knekt, Reuanen, & Aromaa, 1993; Manning, 1983; Templer, Archea, & Cohen, 1985). Most often, slipping is initiated by walking on wet, icy, or oily surfaces (Cohen & Compton, 1982; Kemmlert & Lundholm, 1998; Manning et al., 1988). Cold weather is also associated with an increased risk for slip- and fall-related injuries (Bell et al., 2008; Haslam & Bentley, 1999; Hassi, Gardner, Hendricks, & Bell, 2000). In many workplaces, older workers suffer higher rates of STF injury than younger workers, and this effect is more pronounced in women (Bell et al., 2008; Kemmlert & Lundholm, 1998). Preliminary findings from a case crossover study conducted concurrently with NIOSH research in some of the same hospital locations suggest that contamination and unfamiliarity with pathways are important factors related to the risk of an STF incident in hospital workers (Lombardi et al., 2007).

Because STFs result from a wide variety of circumstances, a number of countermeasures have been cited as having the potential to reduce STF injury incidents. Companies who report success with STF reduction programs typically include some combination of employee training, housekeeping procedures, slip-resistant floor treatment or flooring, and slip-resistant footwear (LaBar, 1998; Lewis, 1997; Morrison, 1999; Norwich, 1992). Unfortunately, these success stories have not been rigorously evaluated. For example, there is limited discussion of study design or methods, detailed results, comparison groups, or possible confounding factors, among other concerns. Manning and colleagues (1988) suggested that one out of every four STF injury incidents could have been prevented by quickly cleaning up spills and removing objects from the floor. Controlling perioperative worker STFs has been addressed by Brogmus, Leone, Butler, and Hernandez (2007). They detail the potential effects that perioperative suite layout and equipment choices can have on STF risks and provide suggestions for mitigating them in this setting. In general, there are very few examples of STF prevention programs that have been rigorously evaluated in the literature.

NIOSH Research to Prevent STF Injuries to Hospital Workers

NIOSH, together with a diverse team of researchers, designed, implemented, and evaluated a comprehensive STF prevention program for hospital workers. The research team has previously published the work (Bell et al., 2008; Collins et al., 2008), and the methods from the previously published work are reviewed briefly below.

Descriptive Analyses

Workers' compensation injury data, hours worked per employee, and demographic data were linked for all staff employed at three acute care hospitals during a 6-year period (January 1, 1996–December 31, 2005). Demographic data included employee date of birth, gender, job title, and date of hire. The BLS's Occupational Injury and Illness Classification Structures were used to code injuries. Narrative descriptions of all cases were reviewed, and, for STFs, a more detailed code was assigned to each claim, which included as many details as possible about the specific type of STF incident. A descriptive analysis of preintervention STF incidents was conducted to examine the circumstances of the incidents and locations and patterns of work-related STF incidents to identify countermeasures and targets for prevention. A postintervention analysis was also conducted to identify any changes in patterns.

Case Crossover and Case Follow Back Study

As part of the research partnership, the Liberty Mutual Research Institute for Safety conducted a case crossover and case follow back study to identify the contribution of transient risk factors and describe STF circumstances that could be targeted for prevention during the intervention field study (Lombardi et al., 2007). Healthcare workers who suffered a fall in the study hospitals were recruited into the study when they reported the STF incident to the occupational health department. Employees who consented to participate were interviewed by telephone using a structured questionnaire. Preliminary findings (Lombardi et al.) suggest that the short-term relative risk (95% CI) of a STF was highest when

- walking on an unusual pathway, 86.8 (46.6–161.6)
- contamination was present, 39.8 (31.5–50.2).

Other transient factors in decreasing order of short-term relative risk included carrying objects, being distracted, or being rushed. Pushing or pulling reduced the short-term STF relative risk by about 77%, RR = 0.23 (0.12–0.45).

The results of the case crossover study suggest the importance of several transient modifiable risk factors to help prevent STF events at work. Importantly, floors should be kept clean and dry, and hospitals should develop a system that allows employees to rapidly report floor spills so that contaminants can be cleaned up promptly.

Laboratory Testing of Shoe/Floor Slip Resistance

Working in partnership with NIOSH, the Finnish Institute of Occupational Health (FIOH) conducted laboratory tests to evaluate the slipperiness of shoes (most commonly worn and promising slip-resistant shoes), and hospital flooring (existing and promising slip resistant) tested with soapy and oily contaminants (Collins et al., 2008). The test apparatus was a slip simulator instrument that was developed to closely reproduce the biomechanical parameters of a human walking with a normal gait (Grönqvist, Roine, Jarvinen, & Korhonen, 1989). Seven types of new shoes were first pretested on a stainless steel surface and again after abrasion of the shoe sole according to a draft standard (British Standards Institute, 2007). Glycerol was used to simulate the oily condition. **Table 1** presents the slip-resistance classification of the shoes and flooring based on the measured dynamic coefficient of friction.

The study identified slip-resistant shoes and flooring that performed optimally under soapy and oily conditions. The results for the shoes are presented in **Table 2,** and **Table 3** shows results for floorings in oily and soapy conditions. The results confirmed previous data (Grönqvist, 1995) showing that heel and sole abrasion significantly improved slip resistance.

Flooring Testing and Classification

Slip-resistance evaluations of ten hospital floorings were conducted with both slip-resistant (shoe 2; Table 2) and standard athletic shoes (shoe 3; Table 2). Shoe 2 was classified as slip resistant (Dynamic Coefficient of Friction [DCOF] > 0.30) and shoe 3 as "slippery" (DCOF < 0.20) on stainless steel (i.e., "oily") test condition.

All DCOF differences between the two contaminant conditions (oily versus soapy) were statistically significant ($p < .01$) for all floorings, except flooring 4 and 8 tested with shoe 2 (Table 2). All DCOF were significantly different ($p < .01$) between the two test shoes (2 and 3; Table 2). Quarry tile was the only tested flooring that was slip-resistant with both test shoes under all contaminant conditions (Table 2). Although there were limited opportunities to replace flooring in the hospitals, results from the laboratory studies were used to select slip-resistant shoes for hospital staff.

Hospital Hazard Assessments

On-site STF hazard assessments were conducted at the study hospitals to identify environmental conditions and housekeeping procedures that might contribute to the risk of STF incidents. The condition of walkway surfaces, contaminants on the floor, projecting objects and cords, lighting, handrails, and drains inside and outside the hospitals were examined. Areas examined inside included the hospital's entrances, stairs, ramps, operating rooms, emergency room, scrub sink areas, nursing stations, pharmacy, histology laboratory, hallways, kitchen (including dishwashing areas) and cafeteria, patient rooms (including bathrooms), areas where surgical instruments are decontaminated, engineering and carpenter shops, and the morgue. Outside areas examined included the parking garage, street, handicap ramps, and sidewalks. This assessment targeted STF hazards for employees; however, eliminating some hazards also benefited patients and visitors. General and specific STF hazards were described in a written report that was provided to hospital management, safety staff, the housekeeping manager, and the groundskeeper manager. Recommendations addressed walkway repairs, degreasing some food-preparation areas, employee training, an awareness campaign, and products and procedures that can help prevent STF incidents.

Table 1. Classification of Slip Resistance Based on Measured Dynamic Coefficient of Friction

Dynamic Coefficient of Friction (DCOF)	Level of Slip Resistance
>0.30	Slip resistant
≥0.20–0.30	Moderately slip resistant
<0.20	Slippery

Table 2. Slip-Resistance Rating for Shoes Pretested on the Reference Stainless Steel Surface—Oily Condition

	Intact Heel/Sole	Abraded Heel/Sole	
Shoe Number and Type	DCOF (*SD*)	DCOF (*SD*)	*P**
1. Nursing shoe with laces	0.159 (0.001)	0.198 (0.022)	<.01
2. Slip-resistant shoe with laces (a)	0.328 (0.026)	0.375 (0.028)	<.001
3. Shoe with laces (b)	0.149 (0.015)	0.173 (0.013)	<.001
4. Clog	0.073 (0.012)	0.141 (0.008)	<.001
5. Shoe with open heel	0.084 (0.011)	0.142 (0.012)	<.001
6. Shoe with laces (c)	0.113 (0.009)	0.138 (0.019)	<.01
7. Safety shoe with laces	0.140 (0.009)	0.153 (0.010)	<.05

*Statistically significant difference between new and abraded soles (*t*-test paired 2-tailed)

Table 3. Floorings Tested in the Oily and Soapy Conditions with Two Shoes

	Shoe 2*, Oily Condition	Shoe 2*, Soapy Condition	Shoe 3**, Oily Condition	Shoe 3**, Soapy Condition
Flooring Number and Type	DCOF (*SD*)	DCOF (*SD*)	DCOF (*SD*)	DCOF (*SD*)
1. Waxed vinyl tile	0.356 (0.044)	0.263 (0.029)	0.133 (0.015)	0.163 (0.008)
2. Slip resistant (a)	0.325 (0.027)	0.452 (0.034)	0.129 (0.012)	0.254 (0.015)
3. Slip resistant (b)	0.369 (0.027)	0.353 (0.021)	0.155 (0.023)	0.283 (0.012)
4. Slip resistant (c)	0.367 (0.034)	0.378 (0.021)	0.144 (0.017)	0.290 (0.011)
5. Slip resistant (d)	0.335 (0.023)	0.277 (0.022)	0.131 (0.013)	0.202 (0.007)
6. Quarry tile	0.580 (0.026)	0.753 (0.021)	0.288 (0.021)	0.539 (0.018)
7. Safety (a)	0.352 (0.023)	0.405 (0.016)	0.163 (0.008)	0.243 (0.034)
8. Safety (b)	0.311 (0.018)	0.319 (0.012)	0.146 (0.008)	0.242 (0.023)
9. Safety (c)	0.351 (0.022)	0.483 (0.019)	0.154 (0.011)	0.248 (0.032)
10. Safety (d)	0.365 (0.020)	0.437 (0.014)	0.168 (0.008)	0.267 (0.025)

*Shoe 2: Slip-resistant shoe with laces. **Shoe 3: Common tennis shoe with laces.

Intervention Effectiveness Field Study

Researchers from NIOSH's Division of Safety Research and safety staff from the hospital corporation designed, implemented, and evaluated the impact of a comprehensive STF prevention program in three hospitals on STF-related workers' compensation injury claims. The findings from the descriptive analysis, case crossover study and case follow back study, hazard assessments, and laboratory tests were used to establish the comprehensive best practices program. The field study, conducted in conjunction with BJC Health System and the VA hospital system, compared the injuries of a cohort of approximately 17,000 hospital staff for a 10-year period from 1996–2005.

According to Bell and colleauges (2008), who reported on the results of the intervention evaluation study, the hospitals' total STF workers' compensation claims rate declined by 58% from the preintervention (1996–1999) rate of 1.66 claims per 100 FTE to the postintervention (2003–2005) time period rate of 0.76 claims per 100 FTE (adjusted rate ratio 0.42, 95% CI: 0.33–0.54). STFs caused by liquid contamination (water, fluid, slippery, greasy and slick spots) were the most common cause (24%) of STF claims for the entire study period 1996–2005. Food services, transport and emergency medical service, and housekeeping staff were at highest risk of an STF claim in the hospital environment. Nursing and office administrative staff represented the largest number of hospital staff and also generated the largest numbers of STF claims. STF injury events in hospitals have myriad causes and the work conditions in hospitals are diverse.

Examining the detailed circumstances of STF incidents among hospital employees revealed that many of these injuries are preventable. Although each component of the prevention program may seem insignificant (e.g., replacing shorter "wet floor" signs with taller, more noticeable signs), they all contribute to a comprehensive program that can have a substantial impact (**Table 4**; Bell et al., 2008). Given the diverse circumstances contributing to STFs, a comprehensive approach to prevention seemed to be the most logical starting point with the highest likelihood of reducing STFs for the hospital workforce. There were many similarities among hospitals' patterns of STF incidents; however, the patterns were not identical. Each hospital is likely to have some unique features and processes, which underscore the importance of on-site hazard-assessment walkthroughs and reviews of injury incident information. Intervention evaluation research for occupational STFs is limited. This study evaluated the effectiveness of a comprehensive STF prevention program for hospital workers in a field setting. Safety professionals working in hospitals may be encouraged by the positive findings of this research to implement such a program in their own facilities. A key component of this prevention program was the sustained commitment and upkeep by hospital staff. Replication of this intervention study in other hospitals and healthcare facilities is warranted, because replication (in addition to the use of control facilities) will provide stronger evidence for the effectiveness of a comprehensive STF prevention program.

This effort brought together a first-of-its-kind collaboration between private and public sector hospitals throughout the United States, organized labor, private and public sector health and safety researchers, and international researchers with cooperation from manufacturers of footwear, flooring, and floor wax. The goal of this collaboration was to research, develop, and test a program to prevent STF injuries among healthcare workers. Through analyses of historical STF work-injury data, telephone interviews of injured workers, laboratory studies evaluating flooring and shoes, and field studies in select hospitals, the group was able to establish a comprehensive best practices injury-prevention program. A user-friendly document is in development for distribution to all hospitals in the United States, and the results of various component studies have been presented at multiple national and international conferences.

Conclusions

An evidence base of scientific research demonstrates that multifaceted safety and health initiatives can be highly effective in reducing injuries associated with patient handling and STFs. In addition, the best-practice programs evaluated in these intervention trials provide practical information for owners of healthcare facilities, administrators, nurse managers, and safety and health professionals who are interested in replicating these types of programs in their facilities. Research has shown that incorporating mechanical lifting devices into a safe patient lifting program decreases caregiver injuries, lost workdays, and workers' compensation costs and improves employee recruitment and retention, employee morale, and quality of care for residents (Collins et al., 2004; Nelson et al., 2006). Safe patient handling programs also make good business sense. Cost-benefit analyses have demonstrated that the initial investment in lifting equipment and employee training can be recovered in less than 3 years through reductions in workers' compensation expenses (Collins et al., 2004; Nelson et al., 2006).

Intervention evaluation research for occupational STF prevention is limited. However, recent research has demonstrated that a comprehensive program can

Table 4. Main Strategies of the Slips, Trips, and Falls (STF) Prevention Program Implemented at the Study Hospitals

Keep floors clean and dry.
- Encourage workers to clean up, cover, and report floor contaminants promptly.
- Install wall-mounted spill pads or paper towel holders conveniently located throughout the hospital to provide easy access to cleaning materials.
- Advertise the phone/pager numbers for housekeeping through e-mails, posters, and general awareness campaigns.
- Install pop-up tent-style wet floor signs in wall-mounted tubes in easily accessible locations throughout the hospital to provide easy access to products to cover/identify a spill.
- Provide walk-off mats, paper towel holders, trash cans, and umbrella bags near entrances to minimize wet floors.
- Place water-absorbent walk-off mats with beveled edges at hospital entrances. The mats should be large enough for multiple steps to fall on the mat and wide enough to cover the entire doorway. Ideally, the soles of shoes should not deposit ice or water on the floor when they step off the mat. Consider use of these mats in areas where employees may be continually exposed to wet conditions.
- Use appropriate methods for cleaning and degreasing kitchen floors; choose appropriate cleaning products for the conditions and mix according to manufacturer's directions.
- Check that pipes are correctly aligned with the drain they are emptying into.
- Unclog drains, particularly in kitchens.
- Prevent entry into areas with contaminated walking surfaces.
- Use barrier signs that block off areas (tension rod with hanging sign across doorways, tall cones with chains, hallway barriers).
- Use taller, more noticeable STF signage (48'-tall wet-floor signs, flashing lights on top of signs, pop-up tent style signs).
- Promptly remove wet floor signs after the floor is dry to avoid habituation.
- Completely block off area during floor waxing or stripping; use door-stopper barrier to prevent wax from overflowing into adjacent areas during waxing.

Use slip-resistant shoes, remove clutter, and maintain adequate lighting.
- Implement a slip-resistant shoe program for food service workers and housekeeping staff and ice cleats for home health nurses.
- Keep walkways clear of objects and clutter.
- Maintain adequate lighting in all work areas including stairwells and parking garages.

Secure loose cords, wires, and tubing.
- Use cord bundlers and cord containers to secure cords under desks and computers and around medical and kitchen equipment.
- Cover cords on floor with a beveled protective cover.
- Organize operating rooms so that equipment cords are not stretched across walkways.
- Consider retractable cord holders on phones in patient rooms and nursing stations.

Eliminate outdoor surface irregularities.
- Consider eliminating wheel stops in parking areas.
- Patch, fill, or slope cracks, holes, or changes in level in walkways and parking areas that are greater than 0.5".
- Create visual cues to highlight curbs and changes in walkway height with yellow warning paint.

Eliminate indoor surface irregularities.
- Replace or restretch loose or buckled carpeting.
- Replace mats that are curled or ripped; secure edges with carpet tape.
- Remove, patch underneath, and replace indented or blistered tile.
- Consider replacing smooth flooring materials with rougher surfaces with a higher coefficient of friction.
- Patch or fill cracks in walkways that are greater than 0.25".
- Highlight changes in curb or walkway elevation with yellow warning paint.

Check stairs and handrails.
- Ensure stairs and handrails are in compliance with safety codes and recommendations.
- Highlight the nosing of each step with contrasting paint or strips.

Prepare for ice and snow.
- Provide ice cleats (or similar product) for home health and maintenance workers to put over regular shoes.
- Distribute winter weather e-mail warnings to all workers with e-mail access.
- Provide bins that anyone can use to spread ice melting chemicals on icy patches.

Create general awareness campaign.
- Prominently display phone and pager numbers for maintenance and housekeeping departments and e-mail this information intermittently to staff or reporting spills, slippery conditions, ice, and other STF hazards.
- STF hazard awareness campaign can be promoted through health fairs, posters, paycheck inserts, and e-mails.

Review past injury records.
- Review several years of past STF-related workers' compensation claims or incident reports to identify the most common STF patterns and circumstances and identify job groups at highest risk.
- Identify potential STF "hot spots" by reviewing the description of the incidents to identify locations where multiple STF incidents have occurred.

Hazard assessments

Conduct hazard assessments to identify environmental conditions that might increase the risk of STF incidents. Specific hazardous conditions to be assessed include the condition of walkway surfaces, objects and contaminants on the floor, protruding objects, cords, lighting, handrails, and drains. Areas inside the hospital that should be inspected include the hospital's entrances; stairs; ramps; operating rooms; the emergency room; scrub sink areas; nursing stations; the pharmacy; the histology lab; hallways; the kitchen, including dishwashing areas and the cafeteria; patient rooms, including bathrooms; surgical instrument decontamination areas; engineering and carpenter shops; and the morgue. Areas outside the hospital that should be examined include parking areas, streets, handicap ramps, and sidewalks.

reduce STFs among hospital workers by approximately 60% (Bell et al., 2008). A key component to both the safe patient handling and STF prevention programs is sustained commitment by the hospital management and staff. Because the scientific evidence demonstrates that STF and patient lifting prevention programs can be highly effective, it is hoped that these results will facilitate widespread replication of these types of programs in other healthcare facilities.

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