29

Prevention of Slips, Trips, and Falls among Hospital Workers

James W. Collins, Jennifer L. Bell, and Christina Socias

CONTENTS

29.1 Fall Injuries in the Health Care and Social Assistance Industry Sector

Health Care and Social Assistance (HCSA), with over 18 million workers, is one of the largest industry sectors in the United States and is rapidly growing (Bureau of Labor Statistics, 2015). In 2013, HCSA workers, who include workers in hospitals and other patient care settings, incurred more nonfatal work-related injuries than workers in the construction and mining industries combined (Bureau of Labor Statistics, 2013a). Private employers in the HCSA industry reported that slips, trips, and falls (STFs) accounted for 24% ($n = 39{,}630$) of the total work-related injuries requiring at least 1 day away from work (Bureau of Labor

Statistics, 2013b). The incidence of STFs in hospitals was considerably higher than the STF incidence for the overall HCSA industry sector (Bureau of Labor Statistics, 2013c). The Bureau of Labor Statistics (2013c) also reported that the incidence of lost-workday injuries from same-level STFs in hospitals was 32.9 per 10,000 full-time equivalent (FTE) workers, nearly 32% greater than the STF incidence for all other private industries combined (25 per 10,000 FTE). STF injuries resulted in nine HCSA industry worker deaths in 2013 (Bureau of Labor Statistics, 2013d).

Ensuring safe, effective, and quality healthcare is a nationwide public health priority (Institute of Medicine, 1999). Extensive research, resources, and prevention efforts have been directed at preventing patient falls in healthcare settings (Wolf et al., 2013; Hignett et al., 2015). However, a key factor contributing to the delivery of quality healthcare to patients is maintaining the health and safety of healthcare workers. Although the rate of injurious STF events is excessively high among healthcare workers (Drebit et al., 2010; Bell et al., 2013; Gomaa et al., 2015), there have been relatively few research projects or systematic efforts to develop evidence-based guidance for preventing STFs for workers in healthcare settings. Historically, STF incidents have been considered largely nonpreventable and attributed to the carelessness of the fall victim (Lacroix and Dejoy, 1989; Sotter, 2000; Lehane and Stubbs, 2001).

The focus of this chapter is on understanding how to reduce STF hazards and subsequently reduce injuries. Research conducted by the Centers for Disease Control and Prevention (CDC) and the National Institute for Occupational Safety and Health (NIOSH) demonstrated that a comprehensive STF prevention program can significantly reduce same-level fall injuries among hospital staff (Bell et al., 2008). From this research, prevention strategies were evaluated empirically and implemented in the workplace.

29.2 Principal Research into Work-Related STF Injury in Hospitals

A multidisciplinary research team comprised of government, private, and university researchers collaborated to conduct laboratory and field research to identify risk factors for STF injuries among healthcare workers and evaluate the impact of that STF prevention program in three hospitals (Lombardi et al., 2007; Bell et al., 2008; Collins et al., 2008, 2010). Researchers worked with hospital staff to identify risk factors and design, implement, and evaluate a comprehensive STF prevention program over a 10 year period from 1996 through 2005. This comprehensive study included the following multiple concurrent components: (1) a descriptive analysis of 6 years of historical worker's compensation STF incident data; (2) an epidemiologic risk factor study; (3) laboratory evaluations of flooring and footwear; (4) on-site hazard assessments; and (5) a field study of prevention strategies to evaluate an STF prevention program.

29.2.1 Descriptive Analysis

During the ten year study period, a dynamic cohort of 16,900 individual employees worked 80,506,017 h, representing 40,253 worker-years across three acute-care hospitals representing approximately 6700 hospital workers. A total of 2263 workers' compensation claims were filed, and 21% ($n = 472$) involved STFs, resulting in 1.2 workers' compensation injury claims attributed to STF incidents per 100 FTEs.

The three hospitals' total STF workers' compensation claims incidence declined by 58% from a pre-intervention incidence of 1.66 claims per 100 FTEs to a post-intervention STF injury incidence of 0.76 claims per 100 FTEs (Bell et al., 2008). Worker's compensation record analysis may be limited to reported injuries and may not capture some injuries that were treated outside the worker's compensation system; however, it provides a basis for understanding which injuries and risk factors are most important to target in an STF prevention program.

29.2.1.1 Occupations

The comprehensive prevention program included an analysis of injury records to identify common causes of STFs, including changes to housekeeping procedures and products, changes to ice- and snow-removal procedures, and campaigns to highlight the importance of STF prevention among hospital workers. Most hospitals have a food service department on the premises that provides meals around the clock for patients, visitors, and staff, and high rates of workers' compensation claims overall have been found for food service workers in the healthcare sector (Alamgir et al., 2007). According to Bell et al. (2008), food-service workers in the hospital suffered the highest rate of STF workers' compensation claims, with 4.0 claims per 100 FTEs (Table 29.1). Nursing staff incurred most STF claims ($n = 141$), but because they comprised the largest proportion of the total work hours (33.6%), they had a much lower claim rate (1.0 STF workers' compensation claim per 100 FTEs). In the Lombardi et al. (2007) study, 50% of the participants worked in an occupation that provided direct care to hospital patients, with a distribution similar to those in the Bell et al.

TABLE 29.1

Pre- and Post-Intervention Slip, Trip and Fall (STF) Workers' Compensation Claims Rates and Rate Ratios by Select Job Groups

	Person-Time (Hours)	STF Claims (*n*)	Unadjusted Rate per 100 FTEs[a]	Adjusted Rate Ratio (95% CI)	*p*-Value
Food Services, Kitchen					
Pre-intervention	1,035,298	30	5.8	0.33 (0.14, 0.75)	<0.01
Post-intervention	933,035	10	2.1		
Custodial, Housekeeping					
Pre-intervention	1,406,566	19	2.7	0.39 (0.15, 0.95)	0.04
Post-intervention	1,304,651	7	1.0		
Nursing and Nursing-Related					
Pre-intervention	9,283,525	72	1.5	0.34 (0.21, 0.55)	<0.01
Post-intervention	8,443,803	26	0.5		
Medical, Laboratory and Other Technologists/Technicians					
Pre-intervention	3,074,882	23	1.5	0.27 (0.10, 0.70)	<0.01
Post-intervention	2,935,526	7	0.4		
Office/Administrative					
Pre-intervention	6,560,805	47	1.4	0.42 (0.25, 0.70)	<0.01
Post-intervention	7,223,896	23	0.6		

Source: Bell et al., *Ergonomics*, 51(12), 1906–1925, 2008.

[a] FTE = full-time equivalent worker, 2000 h worked per year.

(2008) study. Table 29.1 lists pre- and post-intervention STF workers' compensation claims and rate ratios for occupations with the highest frequencies and rates of STF incidents.

29.2.1.2 Body Part and Nature of Injury

According to an analysis of worker's compensation claims for the whole time period of the study, the most commonly injured body part from STF events was a lower extremity (44.9%), followed by an upper extremity (17.7%), multiple body parts (16.7%), back/trunk (16.2%), and head/neck (4.5%) (Bell et al., 2008). The nature of the injury was most often sprains, strains, dislocations, and tears (48.1%). STF injuries were significantly more likely to result in fractures, multiple injuries, and bruises, contusions, and concussions than non-STF injuries, and were less likely to result in cuts, lacerations, punctures, and abrasions than non-STF injuries ($\chi^2 = 213.1$, $p < 0.0001$). Lower extremities were much more likely to be injured by an STF incident than by a non-STF incident, and upper extremities were less likely to be injured after an STF injury than after a non-STF injury ($\chi^2 = 404.0$, $p < 0.0001$).

29.2.1.3 Age Group, Length of Employment, and Gender

STF injury rates were nearly twice as high for females, older workers, and those employed for less than 6 months. Bell et al. (2008) showed that 88% of the total STF claims ($n = 412$) occurred to females, and the STF claims rate for females (1.27 per 100 workers, unadjusted) was significantly higher than for males (0.77 per 100 workers, unadjusted). Workers employed for <6 months experienced the highest claims rate (2.0 STFs per 100 workers), followed by workers employed ≥6 months and <1 year (1.7 STFs per 100 workers); both of these groups had significantly greater STF claim rates than workers employed ≥1 year (1.1 STFs per 100 workers). STF claim rates were significantly greater for employees >45 years of age (1.6 STFs per 100 workers) than for employees ≤45 years (1.0 STFs per 100 workers). Older employees of both genders had higher STF claims rates compared with younger employees (Figure 29.1), and no interaction between age and length of employment was found (Bell et al., 2008).

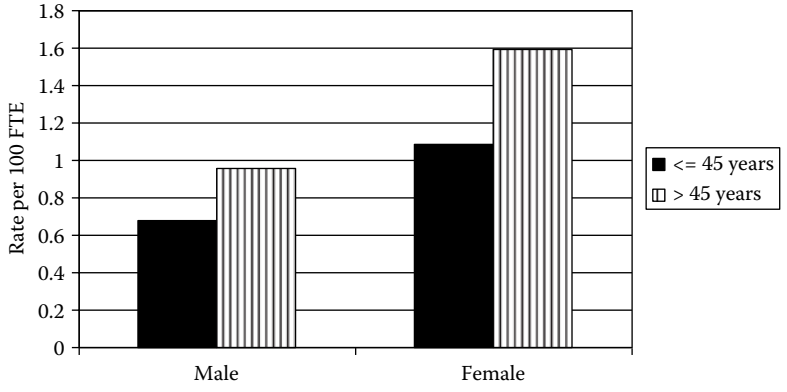

FIGURE 29.1
STF claim rates by age group and gender. (Adapted from Bell et al., *Ergonomics*, 51(12), 1906–1925, 2008.)

29.2.1.4 Circumstances of STFs

Of the 472 STF incidents, 85% ($n = 405$) were same-level STFs, and 15% ($n = 70$) were falls from elevation, which primarily occurred on stairs or from stepstools, ladders, or hospital shuttle buses (Bell et al., 2008). STFs due to liquid contamination (water, grease, ice, soapy detergent, floor stripper, or wax) were the most common cause of STF incidents. In the food services department, the most common slippery conditions consisted of food and grease on the floor in food preparation and cooking areas, spilled drinks and ice in food-serving areas, and soapy detergent on the floor in dishwashing areas.

Courtney et al. (2001) reported that slipperiness or slipping was found to contribute to between 40% and 50% of fall-related injuries across a variety of industries, and similar numbers were found specific to the hospital industry, where workers reported slipping (55%) more frequently than tripping (33%) (Lombardi et al., 2007). The direction of the fall was reported, and 41% of workers indicated that they fell forward, 23% fell to the side, and 21% fell backward. Workers who fell most often cited the hands, knees, or buttocks as the primary points of impact with the floor or ground, and the back, knees, and ankles/feet were the most frequently injured body parts. Forty-four percent of workers described the walking surface where they experienced their STF as clean and dry, while 53% reported the presence of some type of contaminant, including water, ice, or body fluids. Sixty-four percent of STFs occurred at a transitional area—wet to dry or dry to wet (32%), from one floor type to another (20%), or involving uneven surfaces (15%). Overall, 114 workers reported 228 injuries as a result of their STF event, an average of two injuries per event. Only 7% ($n = 8$) of study participants were not injured in the fall incidents. The results highlight the importance of managing surface contamination and surface transitions in hospitals (Lombardi et al., 2007).

29.2.2 Risk Factor Study

Collaborators from the Liberty Mutual Research Institute for Safety also conducted a case-crossover study of employees in seven hospitals to identify risk factors for STFs. This study is a type of epidemiology study in which the cases become their own control due to changes in exposures over time. In this case, hospital workers with injuries became their own control because they were not always exposed to STF hazards. The researchers interviewed a total of 153 hospital employees who had been injured by a work-related STF (both indoors and outdoors) to describe STF circumstances and risk factors. The respondents had a mean age of 46 (range = 19–67) years, the majority were women (86%), and they had worked for the hospital for an average of 9.3 years (Lombardi et al., 2007). The findings from this study indicate that transient, modifiable risk factors, specifically contaminated flooring, were most frequently associated with STF injuries.

29.2.3 Friction Characteristics of Footwear and Flooring

The coefficient of friction between the footwear and the floor is affected by the footwear material, the floor, and contamination conditions (Chang and Matz, 2001; Li and Chen, 2004; Li et al., 2004; Verma et al., 2011). While the slip-resistance characteristics of safety shoes and general footwear have been studied (Leclercq et al., 1995; Grönqvist, 1995), footwear commonly worn in hospital settings has not been systematically evaluated. The

slip-resistance characteristics of footwear and flooring are one of the significant considerations regarding fall prevention (Collins et al., 2008, 2010; Thorpe et al., 2007).

The CDC/NIOSH study to prevent falls among hospital workers included laboratory analysis of the friction characteristics of footwear and flooring to evaluate the slipperiness of shoes commonly worn by hospital workers, slip-resistant shoes, and hospital flooring. Simulations were conducted to test footwear and floor surfaces under normal, "soapy," and "oily" conditions, as commonly encountered in food service areas of hospitals (Collins et al., 2008). The laboratory testing used a slipmeter apparatus that closely simulated the movements of a human foot and the forces applied between the shoe sole and the floor during heel strike in normal gait (Grönqvist et al., 1989). The dynamic coefficient of friction (DCOF) was computed during the time interval 100–150 ms from heel strike, which represents a critical moment for a slip and fall under conditions of level walking (Grönqvist et al., 1989). A DCOF >0.30 indicates slip resistance; ≥0.20–0.30 indicates moderate slip resistance; and <0.20 indicates slippery.

Seven shoe types were first pretested on a stainless steel surface (roughness Rz 1.6 μm) under test conditions "new" (intact heel and sole) and "abraded" (after abrasion, as stipulated in the standard [European Standard EN 13287: 2004] Section 9 [preparation of the sole]). Ten different flooring surfaces were also tested using two shoe types that were determined to have significantly different slip-resistance characteristics, including separate trials for "new" and "abraded" shoe conditions.

The laboratory study identified the combination of slip-resistant shoes and flooring that performed optimally under soapy and oily conditions. Slip-resistant shoes with laces performed better than athletic shoes, nursing clogs, or other types of commonly worn shoes. This study confirmed previous results (Grönqvist, 1995) showing that heel and sole abrasion significantly improved slip resistance. Quarry tile was the only flooring tested that was slip resistant with both test shoes under all contaminant conditions.

29.2.4 Identifying STF Hazards

A review of historical injury records, on-site hazard assessments, and investigations of fall incidents can identify conditions, circumstances, locations, occupations, and patterns of work-related STF incidents. Incident investigations should interview workers who have fallen to identify potential "hot spots," or locations where multiple STF incidents have occurred. Details of STF incidents among hospital employees often reveal risk factors that can be targeted to prevent STF injuries (Collins et al., 2008).

A comprehensive hazard assessment can identify conditions that might increase the risk of STFs and includes multiple components. The hazard assessment should evaluate specific conditions such as walkway surfaces, walkway levelness, objects and contaminants on the floor, projecting objects, cords, lighting, handrails, and drains (watch for standing water where drainage is not functioning properly) both inside and outside the hospital. Areas inside the hospital that should be inspected include the hospital's entrances, stairs, ramps, operating rooms (ORs), the emergency room, scrub sink areas, nursing stations, the pharmacy, the histology laboratory, hallways, the kitchen (including dishwashing areas and the cafeteria), patient rooms (including bathrooms), surgical instrument decontamination areas, laundry rooms, engineering and carpenter shops, and the morgue. Areas outside the hospital should also be examined, including parking areas, streets, handicap ramps, and sidewalks. A comprehensive hazard assessment in combination with interviews and historical records can help target areas with the highest STF risk.

29.2.5 Prevention Strategies

The descriptive analysis, combined with the information from the risk factor study, the friction testing of the footwear and flooring, and the hazard assessment, provided the foundation to implement a comprehensive STF prevention program. The three hospital's total STF workers' compensation claims incidence declined by 58% from a pre-intervention incidence of 1.66 claims per 100 FTEs to a post-intervention STF injury incidence of 0.76 claims per 100 FTEs (Bell et al., 2008).

The following prevention strategies developed during this comprehensive study may help reduce STF incidents in other hospitals. Hospital safety and health staff, housekeepers, and all hospital staff can use this information to take preventive action to mitigate hazardous environmental conditions in and around their hospitals and to minimize STF hazards to their coworkers. Additionally, visitors and patients can benefit from many of the elements of a comprehensive STF prevention program (Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 2010). This section presents a variety of strategies to reduce the risk of STF injuries in hospital settings.

29.2.5.1 Create a Written Housekeeping Program

A written housekeeping program should be provided to all employees to help ensure the quality and consistency of housekeeping procedures. The program should describe

- Procedures for routine floor care
- Procedure to contact the housekeeping department so that spills or other contaminants on floor surfaces can be cleaned up promptly
- Storage of cleaning materials and housekeeping products
- Use and storage of "wet floor" signs and barriers
- Cleaning schedules
- Appropriate cleaning methods and procedures

29.2.5.2 Maintain Floors Clean and Dry

Contaminants such as water, body fluids, spilled drinks, and grease are the most common hazards that make walking surfaces slippery and lead to STF incidents for hospital employees. These hazards primarily occur at building entrances, where rain and snow are tracked in; in food service areas, such as the kitchen, cafeteria, serving line, freezers, and dishwashing areas; and near sinks, ice machines, soap dispensers, and water fountains. Floors can also be wet in areas where surgical instruments are decontaminated. Most walking surfaces are slip resistant when they are clean and dry. The following prevention strategies can help keep floors clean and dry.

- Encourage workers to cover, clean, or report spills promptly.
- Advertise telephone/pager numbers for housekeeping through e-mails, posters, and general awareness campaigns, so that all hospital staff know the number to call to have spills cleaned up quickly.
- Conveniently locate wall-mounted paper towels or other cleanup materials throughout the hospital (near elevators, in nursing stations, outside the cafeteria, by water fountains) so that all employees have easy access to cleanup materials.

- Conveniently locate pop-up warning signs so that staff can quickly place them over a spill while waiting for housekeeping to clean up the spill. For large spills, it is important to block off the area rather than just place unconnected cones that may be ignored by pedestrians.
- Optimal floor-cleaning procedures can prevent slips and falls. Research by Quirion et al. (2008) found that damp mopping alone is not the best floor-cleaning method. A two-step immersion mopping process was found to be superior to damp mopping. In the two-step process, (1) cleaning solution is applied to a section of the floor with a dripping mop and (2) after a few minutes, the cleaning solution is removed with a wrung mop, before the solution has had a chance to dry.
- Not all floor-cleaning products are equally effective. Make sure the product used is suited to the environmental contamination conditions.
- Make sure cleaning products are mixed according to the manufacturer's recommendations, including water and product temperature.
- Effective procedures to degrease floors should be implemented in areas where food is prepared, cooked, and served. The appropriate degreaser/cleaner should be used, and the manufacturer's instructions should be carefully followed. Common mistakes include not letting the cleaner stay on the floor for the proper length of time, not using a stiff deck brush to loosen contaminants, and not providing a thorough clean rinse (for cleaning products that require it).
- Place umbrella bags by building entrances to prevent water from dripping on the hospital floor.
- Provide a sufficient number of 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. As a general rule, when a person steps off the last mat, the soles of their shoes should not leave tracks on the floor. During inclement weather, it may be necessary to add additional mats or replace mats that have become saturated.

29.2.5.3 Prevent Pedestrian Access to Wet Floors

Mopping, disinfecting, stripping, and waxing floor surfaces in hallways, patient rooms, med rooms, bathrooms, kitchens, and cafeterias create slipping hazards for hospital staff. Simple steps to reduce this risk include

- Barrier signs (tension rod across bathroom doorways, cones with chains, hallway barriers) can be effective for blocking access to public bathrooms in the hospital during cleaning.
- Use high-visibility, taller "wet floor" caution signs/cones that can be joined by plastic chains or warning ribbons/tape to warn pedestrians of slippery conditions. Cordon off slippery areas, and direct pedestrian traffic to a clear dry lane. Cones alone are not effective for keeping pedestrians off wet floors.
- "Wet floor" signs should be promptly removed after the floor is clean and dry to prevent staff from becoming complacent about the sign's intended warning.
- Completely block off pedestrian access when stripping or applying wax.

29.2.5.4 Use Slip-Resistant Shoes

Slip-resistant shoes are an important component of a comprehensive STF prevention program, and staff who work on walking surfaces that are continually wet, greasy, or slippery may benefit from slip-resistant shoes. Job classifications at highest risk of an STF injury that may benefit from slip-resistant shoes are food service workers, housekeepers, custodians, maintenance workers, dishwashers, and instrument-decontamination workers. Because nursing personnel suffer the highest total number of STF claims in hospital settings (Bell et al., 2008), they should also be included in a slip-resistant footwear program. Specialized shoes, designed to reduce the risk of slipping while stripping or applying wax, should be provided to housekeeping staff.

Anecdotal evidence suggests that use of slip-resistant shoes by employees is enhanced when the employer provides either the shoes or a payroll deduction for approved shoe purchases. Shoe fit, comfort, and style are important factors that determine whether employees will wear slip-resistant shoes. It may be useful for employees to have the opportunity to try on shoes to obtain the proper fit before purchasing. Some shoe vendors will make periodic site visits so that employees may try on shoes at their workplace to ensure a proper fit. Slip-resistant shoes are a low-cost way to provide slip resistance to staff.

29.2.5.5 Minimize Tripping Hazards

Exposed cords stretched across walkways and under workstations can catch an employee's foot and lead to a trip and fall incident. Clutter in walkways, storage areas, and hallways can potentially lead to a trip and fall incident. The following should be considered to minimize tripping hazards inside the hospital:

- Keep hallways, work areas, and walkways clear of objects and clutter.
- Use cord organizers to bundle and secure loose cords and wires under nursing stations, computer workstations, and patient rooms.
- Reroute cords so that they do not cross walking paths.
- Organize ORs to minimize equipment cords across walkways.
- Consider retractable cord holders on phones in patient rooms and nursing stations.
- Replace or restretch loose or buckled carpet.
- Replace mats with curled or ripped edges; secure edges with carpet tape.
- Remove, patch underneath, and replace indented or blistered floor tiles.
- Patch or fill cracks in walkways greater than a quarter inch in width (¼″).
- Create visual cues for pedestrians by highlighting changes in walkway elevation with yellow warning paint or tape.
- Consider replacing smooth flooring materials with rougher-surfaced flooring with a higher coefficient of friction when renovating or replacing hospital flooring.

To minimize tripping hazards outside hospitals, the following strategies should be considered:

- Patch and repair holes, deep grooves, and cracks greater than ½″ in cement, asphalt, or other surfaces in parking areas and sidewalks.

- For adjoining walkway surfaces with changes in walkway level greater than ¼″, bevel the surface by providing a ramp, or provide a visual cue by painting uneven floor surfaces a bright contrasting color (i.e., yellow).

29.2.5.6 Safer Operating Rooms

Although STFs occur throughout a hospital, the OR is of special interest, because a fall in the OR can cause direct patient injury, disrupt the surgical procedure, contribute to surgical errors, or delay future surgeries (Brogmus et al., 2007). The following features of a well-designed OR may reduce the risk of STFs:

- Slip-resistant flooring
- Procedures to control contaminants
- Proper floor-cleaning methods
- Minimized tripping hazards through securing and routing walking paths with cords
- Preplanned placement of low-profile equipment and supplies so that equipment and supplies remain off the floor and are accessible from mobile utility booms
- Use of slip-resistant absorptive mats to control contaminants, and removal of mats when they become saturated
- An unobstructed view of the walking pathways in the OR
- Use of enhanced OR lights so that general lighting corresponds to the lighting level needed at the surgical site
- Efficient placement of equipment and supplies to minimize the walking distance to obtain instruments and supplies and to access waste containers
- Ample waste receptacle systems and contaminant cleanup materials placed in strategic locations
- Mandated planning briefings to discuss cleanup duty assignments and equipment and tube arrangement and routing to ensure OR team efficiency
- Minimized fatigue by ensuring all OR personnel are well rested for each procedure and receive scheduled time off and breaks during the work shift
- Participative architectural design; have architects, engineers, builders, and hospital administrators collaborate on OR-design decisions with end users such as surgeons, circulating nurses, and scrub technicians
- Policies and procedures to investigate fall incidents

29.2.5.7 Facilitate Ice and Snow Removal

The most important aspect of controlling risks during winter weather is to remove snow and ice as soon as possible after they have accumulated. According to Drebit and colleagues (2010), in their study of falls among workers in the HCSA sector, weather was a consistent contributor to employee falls across all healthcare subsectors, with the greatest number of weather-related falls in the community health subsector. Hospital administrators should work with their snow removal staff or vendors to ensure frequent removal when needed. In addition:

- Encourage employees to report icy conditions; prominently display phone or pager numbers for staff to report icy conditions.
- Provide ice cleats or slip-resistant shoe covers for home health workers, maintenance workers, and other workers who work outdoors.
- Distribute winter weather warnings by e-mail when ice and snow storms are predicted.
- Conveniently place bins containing ice-melting chemicals near the top and bottom of outdoor stairways, parking garage exits, and heavily traveled walkways that are prone to refreezing, so that any employee can apply ice-melting chemicals when they notice icy patches.
- Provide a sufficient number of 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. As a general rule, when a person steps off the last mat, the soles of their shoes should not leave tracks on the floor. During inclement weather, it may be necessary to add additional mats or replace mats that have become saturated.
- When renovating exterior entrances, build well-lit, well-draining, covered walkways leading to entrances to provide walk-off areas that allow water, snow, and other contaminants to be removed from footwear before entering the building.

29.2.5.8 Ensure Adequate Lighting

Inadequate lighting impairs vision and ability to see hazards. The hazard can occur anywhere, but particular attention should be paid to lighting levels in parking structures, storage rooms, hallways, and stairwells. Adequate lighting helps to illuminate areas, which makes walking safer and easier and allows employees to see their surroundings. Prevention strategies include

- Installing more light fixtures in poorly lit areas
- Verifying that light bulbs have an appropriate brightness
- Installing light fixtures that emit light from all sides

29.2.5.9 Increase Safety of Stairs and Handrails

Uneven and poorly marked stairs can lead to missteps and can cause employees to trip and fall. Handrails that are not of the appropriate height or poorly maintained can also lead to a fall. Prevention strategies should

- Confirm that all handrails are up to code (34″–38″ from flooring)
- Ensure that discontinuous handrails are of a consistent height
- Paint the edge (nosing) of each step, including the top and bottom, to provide a visual cue of a change in elevation
- Ensure that stairwells and steps have adequate lighting

29.3 Conclusion

STF events can cause serious injuries to hospital staff and are one of the leading causes of workers' compensation claims in hospital settings. Little emphasis has been placed on fall prevention among hospital staff because of the widespread perception that these incidents are not preventable. However, examination of the details surrounding STF incidents among hospital staff indicates that many of these incidents are preventable. Research provides evidence that implementation of a comprehensive STF prevention program can significantly reduce STF injury claims involving diverse hospital staff. Because STFs result from a wide variety of circumstances, a coordinated effort is required by the safety department, the housekeeping staff, and essentially every hospital staff member to prevent STF incidents.

In addition to all the products and procedures that can be implemented to reduce known hazards, one of the key components of a successful STF prevention program is to raise awareness regarding the importance of STF prevention among hospital staff and to empower every employee to share in the responsibility of eliminating STF hazards. Whether this involves cleaning spills, applying ice-melting chemicals to icy patches in parking areas or sidewalks, or cordoning off an area to alert fellow employees while waiting for housekeeping staff to arrive, a successful STF program requires that all hospital staff share the responsibility for prevention. Implementing a comprehensive STF prevention program in combination with other safety programs can lead to a significant reduction in workers' compensation costs and improve the well-being of our healthcare workforce.

29.4 Disclaimer

The findings and conclusions in this chapter are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health (NIOSH). Mention of company names or products does not constitute endorsement by NIOSH.

References

Alamgir H, Swink H, Yu S, Yassi A. 2007. Occupational injury among cooks and food service workers in the healthcare sector. *American Journal of Industrial Medicine* 50:528–535.

Bell JL, Collins JW, Tiesman HM, et al. 2013. Slip, trip, and fall injuries among nursing care facility workers. *Workplace Health & Safety* 61:147–152.

Bell JL, Collins JW, Wolf L, et al. 2008. Evaluation of a comprehensive slip, trip and fall prevention programme for hospital employees. *Ergonomics* 51(12):1906–1925.

Brogmus G, Leone W, Butler L, Hernandez E. 2007. Best practices in OR suite layout and equipment choices to reduce slips, trips, and falls. *AORN Journal* 86(3):384–398.

Bureau of Labor Statistics. 2013a. Incidence rate and number of nonfatal occupational injuries by industry and ownership. Accessed February 4, 2015, http://www.bls.gov/iif/oshwc/osh/os/ostb3966.pdf.

Bureau of Labor Statistics. 2013b. Occupational injuries and illnesses and fatal injuries profiles. Case and demographic numbers for health care and social assistance industry. Accessed February 4, 2015, http://data.bls.gov/gqt/InitialPage.

Bureau of Labor Statistics. 2013c. Occupational injuries and illnesses and fatal injuries profiles. Case and demographic incidence for health care and social assistance industry. Accessed February 4, 2015, http://data.bls.gov/gqt/InitialPage.

Bureau of Labor Statistics. 2013d. Occupational injuries and illnesses and fatal injuries profiles. Fatal injuries numbers for health care and social assistance industry. Accessed February 4, 2015, http://data.bls.gov/gqt/.

Bureau of Labor Statistics. 2015. Health care and social assistance: NAICS 62. Accessed October 15, 2015, http://www.bls.gov/iag/tgs/iag62.htm.

Chang WR, Matz S. 2001. The slip resistance of common footwear materials measured with two slipmeters. *Applied Ergonomics* 32:540–558.

Collins JW, Bell JL, Grönqvist R. 2010. Developing evidence-based interventions to address the leading causes of workers' compensation among healthcare workers. *Rehabilitation Nursing* 35(6):225–235, 261.

Collins JW, Bell JL, Grönqvist R, et al. 2008. Multi-disciplinary research to prevent slip, trip, and fall (STF) incidents among hospital workers. *Contemporary Ergonomics* 2008:693–698.

Courtney TK, Sorock GS, Manning DP, et al. 2001. Occupational slip, trip, and fall-related injuries: Can the contribution of slipperiness be isolated? *Ergonomics* 44:1118–1137.

Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. 2010. Bell JL, Collins JW, Dalsey E, Sublet V. Slip, trip, and fall prevention for healthcare workers. DHHS (NIOSH) Publication Number 2011–123.

Drebit S, Sharjari S, Alamgir H, Yu S, Keen D. 2010. Occupational and environmental risk factors for falls among workers in the healthcare sector. *Ergonomics* 53:525–536.

European Standard EN 13287. 2004. Personal protective equipment: Footwear—Test method for slip resistance.

Gomaa AE, Tapp LC, Luckhaupt SE, et al. 2015. Occupational traumatic injuries among workers in health care facilities—United States, 2012–2014. *Morbidity and Mortality Weekly Report* 64(15):405–410.

Grönqvist R. 1995. Mechanisms of friction and assessment of slip resistance of new and used footwear soles on contaminated floors. *Ergonomics* 38(2):224–241.

Grönqvist R, Roine J, Järvinen E, Korhonen E. 1989. An apparatus and method for determining the slip resistance of shoes and floors by simulation of human foot motions. *Ergonomics* 32:979–995.

Hignett S, Wolf L, Taylor E, Griffiths P. 2015. Firefighting to innovation: Using human factors and ergonomics to tackle slip, trip, and fall risks in hospitals. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 57:1195–1207.

Institute of Medicine. 1999. *To Err Is Human: Building a Safer Health System*. Washington, DC: Institute of Medicine of the National Academies, http://www.iom.edu/Reports/1999/To-Err-is-Human-Building-A-Safer-Health-System.aspx.

Lacroix D, Dejoy D. 1989. Causal attribution to effort and supervisory response to workplace accidents. *Journal of Occupational Accidents* 11:97–109.

Leclercq S, Tisserand M, Saulinier H. 1995. Assessment of slipping resistance of footwear and floor surface. Influence of manufacture and utilization of the products. *Ergonomics* 38:209–219.

Lehane P, Stubbs D. 2001. The perceptions of managers and accident subjects in the service industries towards slip and trip accidents. *Applied Ergonomics* 32:119–126.

Li KW, Chang WR, Leamon TB, Chen CJ. 2004. Floor slipperiness measurement friction coefficient, roughness of floors, and subjective perception under spillage conditions. *Safety Science* 42(6):547–565.

Li KW, Chen CJ. 2004. The effect of shoe soling tread groove width on the coefficient of friction with different sole materials, floors, and contaminants. *Applied Ergonomics* 35(6):499–507.

Lombardi DA, Courtney TK, Verma SK, et al. 2007. Risk factors for slips, trips, and falls: A case-crossover study of U.S. health care workers. *Oral Presentation at the Annual Meeting of the American Public Health Association*, Washington, DC, November 3–7, 2007.

Quirion F, Poirier P, Lehane P. 2008. Improving the cleaning procedure to make kitchen floors less slippery. *Ergonomics* 51(12):2013–2029.

Sotter G. 2000. *Stop Slip and Fall Accidents*. Mission Viejo, CA: Sotter Engineering Corporation.

Thorpe S, Loo-Morrey M, Houlihan R, Lemon P. 2007. Slip and fall accidents in workplace environments – the role of footwear. *Presented at the International Conference on Slips, Trips, and Falls Research to Practice*, Hopkinton, MA, August 23–24, 2007.

Verma SK, Chang WR, Courtney TK, et al. 2011. A prospective study of floor surface, shoes, floor cleaning and slipping in US limited-service restaurant workers. *Occupational and Environmental Medicine* 68:279–285.

Wolf L, Costantinou E, Limbaugh C, Rensing K, Gabbart P, Matt P. 2013. Fall prevention for inpatient oncology using lean and rapid improvement event techniques. *Health Environment Research & Design Journal* 7:85–101.