

# Chapter 39. Personal Safety for Nurses

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## Background

The safety of nurses from workplace-induced injuries and illnesses is important to nurses themselves as well as to the patients they serve. The presence of healthy and well-rested nurses is critical to providing vigilant monitoring, empathic patient care, and vigorous advocacy. Many workplace stressors that can produce diseases and injuries are present in nursing work environments. These stressors include factors related to the immediate work context, characteristics of the organization, and changes that are occurring external to the organization but throughout the health care industry.<sup>1</sup> Nurses experience significant physical and psychological demands during their day, as well as a work safety climate that can be adverse. Pressures within organizations to downsize, use nurses employed under alternative arrangements (pool and traveling staff), and the turnaround time for patient care (early discharge, higher patient loads) are examples of factors that are determined at an organizational level. The external context within which nurses practice includes lean managed care contracts, increasing use of complex technological innovations, an older nurse workforce, and increasing numbers of very sick elderly patients (aging population). Factors at each of these levels can produce threats to nurses' safety while on the job.

The hazards of nursing work can impair health both acutely and in the long term. These health outcomes include musculoskeletal injuries/disorders, other injuries, infections, changes in mental health, and in the longer term, cardiovascular, metabolic, and neoplastic diseases. In this chapter we will present major research findings that link common work stressors and hazards to selected health outcomes. These stressors include aspects of the way work is organized in nursing (e.g., shift work, long hours, and overtime) and psychological job demands, such as work pace. In addition, aspects of direct care work that influence nurse safety will be discussed, including the impact of physical job demands such as patient lifting and awkward postures, protective devices to prevent needlesticks, chemical occupational exposures, and potential for violence. Where possible, interventions that have demonstrated effectiveness to reduce the risk of illness and injury will be presented, as well as gaps in knowledge that can spur new lines of research inquiry.

## Research Evidence

### Shift Work and Long Work Hours

The relationship between work schedules and health and safety is complex and is influenced by characteristics of the work schedule (time of shift, direction and speed of rotation, pattern of days off, shift length, rest breaks), as well as characteristics of the job, the worker, and the work environment.<sup>2</sup> While the focus is on potential negative aspects, some workers experience benefits

from shift work and prefer it (e.g., incentive pay, reduced volume of activities and personnel when compared with day shift).

Researchers theorize that shift work exerts adverse effects by disturbing circadian rhythms, sleep, and family and social life.<sup>2,3</sup> Disturbances in circadian rhythms may lead to reductions in the length and quality of sleep and may increase fatigue and sleepiness, as well as gastrointestinal, psychological, and cardiovascular symptoms. In addition, working at unusual times may make it difficult to interact with family and maintain other social contacts.<sup>4</sup> Similarly, long work hours may reduce the time available for sleep, leading to sleep deprivation or disturbed sleep and incomplete recovery from work.<sup>5-7</sup> This may adversely affect nervous, cardiovascular, metabolic, and immune functioning. Family and social contacts may also be reduced, which in turn may lead to physiological responses associated with stress. Long hours may also increase exposure times to workplace hazards such as chemicals; infectious agents; and physical, mental, and emotional demands. Long hours also may reduce time available for exercise or nutritious meals, and added job stress can increase smoking, alcohol consumption, and caffeine use.

## **Risks Associated With Shift Work**

**Sleep, sleepiness, performance, safety.** Drake and coworkers<sup>8</sup> indicated that 32 percent of night workers (majority of shift hours between 9 p.m. and 8 a.m.) and 26 percent of rotating shift workers (shifts that change periodically from days to evenings or nights) experienced long-term insomnia and excessive sleepiness and were unable to adapt their sleep adequately on these shifts. Sleep loss makes people sleepier while awake, which may affect the shift worker's ability to perform activities safely and efficiently, both on and off the job. Increased sleepiness (or decreased alertness) in shift workers on the job has been demonstrated with subjective reports,<sup>9</sup> objective performance testing,<sup>10</sup> and EEG recordings showing brief, on-the-job sleep episodes.<sup>11</sup> Sleepiness is most apparent during the night shift, and poor daytime sleep appears to be a contributing factor.<sup>12</sup> A meta-analysis combining injury data from several studies indicated that injury risk increased by 18 percent during the afternoon/evening shift and 34 percent during the night shift compared to morning/day shift.<sup>13</sup> These results are consistent with worksite observations of increased subjective sleepiness and decreased reaction time during night shifts, and progressive decreases in total sleep time from early to late in the workweek.<sup>14</sup>

**Social and familial disruptions.** Because shift workers often work in the evening and sleep during the day, they frequently sacrifice participation in social and family activities. Furthermore, shift workers in continuously operating organizations such as hospitals are regularly required to work weekends and holidays, when much social and family interaction occurs.<sup>15,16</sup> Consequently, too little time with family and friends is the most frequent and most negatively rated complaint among shift workers. The extent to which such disruptions occur depends both on the worker's schedule, type of family, gender, presence of children, and the degree of flexibility in the worker's social contacts and leisure pursuits.<sup>15-17</sup> For families, shift work often conflicts with school activities and the times when formal child care services are available, making arranging for the care of children more challenging,<sup>17</sup> affecting both the worker and the family's social adjustments.

**Long-term effects and vulnerable groups.** Although the specific contribution of shift work to other illnesses is not clear, several diseases have been associated with these work schedules. Gastrointestinal (GI) complaints are common in shift workers and could be due to changes in

circadian rhythms of GI function, sleep deprivation leading to stress response and changes in immune function, or the types of foods that are available during these shifts.<sup>18, 19</sup> Schernhammer and colleagues<sup>20</sup> reported an increased risk of colon cancer in nurses working 3 or more nights per month for 15 or more years.

Psychological complaints are frequently reported, including depression and other mood disturbances, personality changes, and relationship difficulties.<sup>21</sup> A review of 17 studies suggests that shift work increases risk for cardiovascular disease by 40 percent compared with day workers.<sup>22</sup> Possible mechanisms include decreased glucose tolerance, insulin resistance, elevated cortisol levels, and increased sympathetic activity. A systematic review of reproductive outcome studies concluded that shift work was associated with a modest increase in spontaneous abortion, preterm birth, and reduced fertility in women.<sup>23</sup> The effect on reproduction in men was not analyzed due to an inadequate number of studies. A meta-analysis of 13 studies examining night work and breast cancer reported that night work was associated with a moderately elevated risk among women.<sup>24</sup> The authors hypothesized that exposure to light at night reduces melatonin levels, increasing risks for cancer.

Shift work also may exacerbate preexisting chronic diseases, making it difficult to control symptoms and disease progression. Shift work interferes with treatment regimens that involve regular sleep times, avoiding sleep deprivation, controlling amounts and times of meals and exercise, or careful timing of medications that have circadian variations in effectiveness. Sood<sup>25</sup> suggests several conditions that may be exacerbated by shift work: unstable angina or history of myocardial infarction, hypertension, insulin-dependent diabetes, asthma, psychiatric illnesses, substance abuse, GI diseases, sleep disorders, and epilepsy requiring medication. Costa<sup>26</sup> adds to this list chronic renal impairment, thyroid and suprarenal pathologies, malignant tumors, and pregnancy. Aging is also associated with less tolerance of shift work, which may be due to age-related changes in sleep that may make it more difficult for older people to initiate and maintain sleep at different times of the day.<sup>27</sup> These sleep changes may begin as early as the 30s and 40s, so some workers who initially adapted well to shift work during their younger years may show more symptoms as they grow older.

## **Risks Associated With Long Work Hours**

The number of studies examining long work hours is less extensive, but a growing number of findings suggest possible adverse effects. A meta-analysis by Sparks and colleagues<sup>5</sup> reports that overtime was associated with small but significant increases in adverse physical and psychological outcomes. A review by Spurgeon and colleagues<sup>6</sup> concluded that the adverse overtime effects were associated with greater than 50 hours of work per week, but little data are available about schedules with fewer than 50 hours. An integrative review by Caruso and colleagues<sup>28</sup> reported that overtime was associated with poorer perceived general health, increased injury rates, more illnesses, or increased mortality in 16 of 22 recently published studies. Dembe and colleagues,<sup>29</sup> examining data from the National Longitudinal Survey of Youth, found a dose-response relationship, such that as the number of work hours increased, injury rates increased correspondingly. Trinkoff and colleagues<sup>30, 31</sup> found that long work hours were related to the incidence of musculoskeletal injuries and needlesticks in nurses. Overall, these studies indicate that caution is needed in implementing schedules with extended work hours. Determining the number of work hours critically associated with risk for a specific job would require examining how extended hours interact with other factors contributing to fatigue,

such as work load, competing responsibilities, and opportunities for rest and recovery. Additional information on the effect of long work hours can be found elsewhere in this book.

## **Coping Strategies**

Efforts to promote adaptation to (or ease the difficulties of coping with) shift work and long work hours include strategies for employers and strategies for workers. Most suggestions to date were written for shift work, but they may also be relevant for long work hours. A sampling of strategies suggested in the literature for shift work include designing new work schedules and rest breaks during work, altering circadian rhythms with bright light or blue light, optimally timing physical activity or other work demands, improving physical conditioning, using caffeine, planning dietary regimens, stress reduction, support groups, and family counseling.<sup>32-39</sup> Caldwell and Caldwell<sup>36</sup> suggest using behavioral and administrative strategies fully before considering pharmacologic aids since these stimulants and sedatives can be addictive and questions remain about the safety and effectiveness of long-term use. Taking naps during work is another intervention that has been associated with improvements in alertness<sup>40,41</sup> and is an accepted practice in some Asian countries. More research is needed to determine the optimum length and timing of the nap and a practical environment at work to take a nap. Empirical evaluations and applications of the other techniques have begun and will be useful for some workers, but more research is needed to develop strategies that can be easily applied by workers in a wide range of demanding work schedule situations. Another type of strategy are work hour limits such as the recent Institute of Medicine recommendation<sup>42</sup> (p. 13) that work hours for nurses be limited to 60 hours per 7-day period and 12 hours per day.

## **Nurse Injury and Disease Outcomes**

### **Musculoskeletal Injuries**

Few industries in the United States have undergone more sweeping changes over the past decade than the health care industry. Changes in health care, including restructuring and redesign, have led to increasingly heavy demands on nurses and other health care workers. Extended schedules and increased work pace, along with increased physical and psychological demands, have been related to musculoskeletal injuries and disorders (MSD).<sup>43</sup> These demands have been found in laboratory and worker studies to increase the risk of musculoskeletal pain/disorders.<sup>44-47</sup>

Definitions for MSD vary, though most include pain in the affected body region (e.g., back or neck) for a specified duration or frequency,<sup>48</sup> along with other related symptoms such as numbness and tingling.<sup>49</sup> Measurement of MSD also varies from study to study, with many studies relying on self-report and others requiring seeking care or obtaining testing or clarification/diagnosis by a clinician.<sup>48</sup> Researchers are careful to rule out nonwork-related MSD from their studies.

Health care workers are at extremely high risk of MSD, especially for back injuries. Health care workers are also overrepresented for upper extremity MSDs among workers' compensation (WC) claims.<sup>50</sup> In 2001, U.S. registered nurses (RNs) had 108,000 work-related MSDs involving lost work time, a rate similar to construction workers.<sup>51</sup> In 2003, the incidence rate for nonfatal

occupational injuries, many of which were MSDs, was 7.9 per 100 full time equivalents (FTEs) for hospital workers.<sup>52</sup>

Studies have shown that MSDs lead to sick days, disability, and turnover. In a survey of more than 43,000 nursing personnel in five countries, 17–39 percent planned to leave their job in the next year due to physical and psychological demands.<sup>53</sup> In previous research, the percentage of nurses reporting job change due to MSD ranged from 6 percent to 11 percent, depending on the body part injured (neck, shoulder, or back).<sup>54</sup> Staffing has also been related to MSD, with lower staffing complements related to increased injuries. Between 1990 and 1994, the Minnesota Nurses Association collected injury and illness data from 12 hospitals in the Minneapolis-St. Paul area. The researchers found that when RN positions in the hospitals decreased by 9.2 percent, the number of work-related injuries or illnesses among RNs increased by 65.2 percent. Lower staffing ratios for nurses and higher patient loads have both been shown to result in increased exposure to hazardous conditions and insufficient recovery time.<sup>55</sup> In a review of evidence, the Institute of Medicine indicated that there was strong relationship between nursing home staffing and back injuries.<sup>56</sup> In a recent study of the relationship of health care worker injuries to staffing in nursing homes, researchers indicated that staffing levels were significantly related to health care worker injury rates in nursing homes across three States.<sup>57</sup>

**Physical/postural risk factors and MSD.** Health care work is highly physically/posturally demanding,<sup>54, 58, 59</sup> and tasks requiring heavy lifting, bending and twisting, and other manual handling have been implicated in health care worker back injuries.<sup>60</sup> In one study, nurses were found to be at particular risk of back injury during patient transfers, which require sudden movements in nonneutral postures.<sup>61, 62</sup> Patient transfers also require flexion and rotation, increasing the injury risk due to a combination of compression, rotation, and shear forces.<sup>63–65</sup> Highly demanding physical work was associated with 9–12 times the odds of having a neck, shoulder, or back MSD among nurses.<sup>54</sup> Hoogendoorn and colleagues,<sup>66</sup> using video observations and questionnaires in a 3-year study of health care workers, found that extreme flexion and frequent heavy lifting had a strong impact on worker low-back pain. Other analyses found that physical/postural risk factors were related to impaired sleep, pain medication use, and absenteeism.<sup>59</sup>

Fewer studies have examined physical/postural risk factors in relation to health care worker neck and shoulder MSDs. Risk factors related to neck and shoulder pain include body placement in awkward postures that need to be maintained for long periods of time. Using direct observation, Kant and colleagues<sup>58</sup> found that surgeons had extensive static postures, along with operating room nurses who were required to maintain tension on instruments, leading to substantial musculoskeletal stress of the head, neck, and back. Lifting and stooping were significantly associated with health care worker arm and neck complaints,<sup>67</sup> whereas shoulder complaints were associated with pushing and pulling motions.<sup>68, 69</sup> Heavy lifting and actions with arms above shoulder height were associated with shoulder pain or injury in health care workers and in other occupational groups.<sup>70–72</sup> The evidence indicates that preventive interventions for MSD need to address physical/postural risk factors.

**Work schedules and MSD.** The work schedule can affect the sleep–wake cycle, and working extended hours, such as 12+ hour shifts, can lead to MSD due to extended exposure to physical/postural risk factors and insufficient recovery time.<sup>73, 74</sup> As physical/postural demands on the job increased for nurses, the likelihood of inadequate sleep also significantly increased.<sup>59</sup> Workers on schedules requiring frequent shift rotation and long hours may also be at higher risk for MSD.<sup>75–78</sup> In a survey of 1,428 RNs, more than one-third had extended work schedules, and

such schedules were associated with an increased likelihood of MSD.<sup>79</sup> A later study found that long work hours were related to incident musculoskeletal injuries in nurses.<sup>30</sup>

In workers with employment-related myalgia, symptoms increased with each successive workday, and remitted only by the second day off.<sup>80</sup> These workers had shorter periods of muscle rest, suggesting that continuous muscle tension was associated with musculoskeletal symptoms. In a British study of doctors-in-training, the fewer hours they slept and the more hours they worked, the more somatic symptoms, including MSD, they reported.<sup>81</sup>

Schedule components significantly related to MSD include long work hours, mandatory overtime, working while sick or on days off, and having fewer than 10 hours between shifts.<sup>30</sup> The new Institute of Medicine report, *Keeping Patients Safe: Transforming the Work Environment of Nurses*,<sup>42</sup> incorporated Wave 1 findings on nurse scheduling. More than one-third of staff nurses typically worked 12 or more hours per day. Among those working 12+ hours, 37 percent rotated shifts. On-call requirements were also very common (41 percent of the sample). Despite the long hours, few nurses took breaks; two-thirds typically took one or no breaks during their shift.

**Mitigating MSD risks.** Although two decades of research have demonstrated the work-relatedness of MSD, use of single-approach intervention methods to reduce MSD exposures (e.g., engineering controls, administrative changes, or worker training only) has shown inconsistent outcomes.<sup>82</sup> This is likely due to the combination of factors related to MSD and the need for broad organizational involvement to mitigate MSD problems.<sup>83</sup> Despite these concerns, important evidence-based successes have been demonstrated in reducing MSD, especially during patient lifting and transfer.<sup>84, 85</sup> Interventions incorporating participatory ergonomics have been found to improve upon previous approaches by allowing for extensive worker input into the design and adoption of preventive practices.<sup>86, 87</sup> In a participatory ergonomics approach, employees participate in the identification of ergonomic risk factors, brainstorm alternatives and solutions, handle implementation of controls, and assess control effectiveness along with symptom identification, ultimately becoming champions for ergonomics change.<sup>86</sup> Participatory ergonomics also has the potential for changing the culture of health care organizations, as employees begin to use ergonomic principles to improve jobs and the workplace. Because participatory interventions incorporate both management commitments to reducing injuries, along with workers who are involved in developing solutions, positive and effective workplace changes can occur.<sup>88</sup>

**Interventions for MSD.** Three common interventions used to prevent work-related musculoskeletal injuries associated with patient handling are (1) classes in body mechanics, (2) training in safe lifting techniques, and (3) back belts. Despite their wide spread use, these strategies are based on tradition rather than scientific evidence; there is in fact strong evidence these strategies are not effective.<sup>85, 89</sup> Recently there has been a major paradigm shift away from these approaches toward the following evidence-based practices: (1) patient handling equipment/devices, (2) no-lift policies, (3) training on proper use of patient handling equipment/devices, and (4) patient lift teams. Table 1 describes interventions and identifies challenges that have been associated with their implementation.

**Table 1. Evidence-Based Interventions for Safe Patient Handling**

| Proposed Intervention                        | Description  | Challenges to Implementation  |
|--|--|---|
| Patient handling equipment and devices       | Patient handling technologies include height-adjustable electric beds, <sup>90-92</sup> mobile mechanical patient lifts, <sup>93-97</sup> ceiling-mounted lifts, <sup>98-100</sup> friction-reducing devices/lateral transfer aids, <sup>101-104</sup> bed repositioning, <sup>105-107</sup> etc. More complete listings of patient handling equipment and devices are available. <sup>108-110</sup>   | <ul style="list-style-type: none"> <li>▪ Cost</li> <li>▪ Assuring competency of all staff in its use</li> <li>▪ Integrating multiple technologies</li> <li>▪ Selecting the best technology to address the specific risks identified</li> <li>▪ Technology often takes more time than performing the task manually</li> </ul>  |
| No-lift policies                             | Regardless of the title, these policies focus on minimizing manual patient handling. <sup>84,111,112</sup> No-lift policies have been developed through legislation or facility-based policies. National policies have been enacted in Europe and Canada. In the United States, State legislation related to manual patient lifting was recently passed in Texas and Washington. Facility-based policies are known as “no-lift policy,” “zero lift,” “minimal lift,” “lift-free,” or “safe patient handling and movement.” | <ul style="list-style-type: none"> <li>▪ Necessary equipment needs to be in place before the policy is implemented.</li> <li>▪ Nonpunitive approach is necessary for success.</li> </ul>  |
| Training on proper use of equipment/ devices | While traditional classes in body mechanics and lifting techniques are not effective, evidence supports the need for ongoing training in use of equipment and devices. <sup>84, 109, 113-115</sup>   | <ul style="list-style-type: none"> <li>▪ Training all staff, across shifts</li> <li>▪ Training on units with high staff turnover</li> <li>▪ Need to reinforce training over time</li> <li>▪ Need for “just-in-time” training when equipment is needed sporadically, such as bariatric device.</li> </ul>  |
| Patient lift teams                           | A lifting team is defined as “two physically fit people, competent in lifting techniques, working together to accomplish high-risk patient transfers.” <sup>116</sup> This term is sometimes also referred to as “patient transfer team,” “lift team” or a combination of these phrases. <sup>116-125</sup>  | <ul style="list-style-type: none"> <li>▪ Logistics of providing lift team services 24 hours a day/ seven days a week</li> <li>▪ Cost</li> <li>▪ Managing workload and logistics of “unscheduled lifts” that emerge during typical workday</li> <li>▪ Addresses only patient lifts, ignoring other high-risk tasks such as repositioning, toileting, or bathing</li> </ul> |

Promising new interventions that are still being tested include use of unit-based peer leaders, clinical tools (algorithms and patient assessment protocols), and after-action reviews. Table 2 describes each intervention and identifies challenges associated with implementation.

**Table 2. Interventions for Safe Patient Handling With Emerging Evidence**

| Proposed Intervention                                    | Description   | Challenges to Implementation  |
|--|---|---|
| Peer leader education                                    | Traditional education approaches (didactic classes in risk, body mechanics, and training in lifting techniques) have not been effective in sustaining changes over time. Newer approaches to education and training have emerged, demonstrating early success with a need to study these trends over time. One new model that shows promise is use of local peer leaders. A peer leader is a nurse designated on each unit (or shift) who receives special training to work on site with colleagues to make practice changes to improve safety. Their roles include ongoing hazard evaluation of the work environment, assure competency in use of patient handling equipment and devices, help sustain the unit-based ergonomic program over time. <sup>109, 126</sup> In the United States, peer safety leaders have been called Back Injury Resource Nurses (BIRNs), <sup>109</sup> and Ergo Rangers, <sup>84</sup> while in the Netherlands they are called Ergo Coaches. | <ul style="list-style-type: none"> <li>▪ Selecting the “right” peer leader who is effective in coaching peers to change behaviors</li> <li>▪ Incentives for peer leaders</li> <li>▪ Support and timely response by management to issues raised by peer leader</li> </ul>  |
| Clinical tools (algorithms and patient assessment tools) | Unfortunately, nurses have become accustomed to using whatever limited lifting aids are available, if they are available, rather than carefully matching equipment to specific patient characteristics. Cognitive aids can assist clinicians to apply research to practice, thereby reducing unnecessary variation in practice. Use of patient assessment protocols and algorithms can provide a standardized way to assess patients and make appropriate decisions about how to safely perform high-risk tasks. <sup>108, 109, 112, 127–129</sup>  | <ul style="list-style-type: none"> <li>▪ Training all staff, across shifts</li> <li>▪ Training on units with high staff turnover</li> <li>▪ Need to reinforce training over time</li> <li>▪ Integrating these clinical tools into routine processes, e.g., patient admission</li> <li>▪ Timely and effective communication of the assessment and plan to all staff</li> </ul> |
| After-action reviews (AAR)                               | After-action review is a way for nurses to learn not only from their own mistakes and near misses, but also from the mishaps experienced by their coworkers. It is not unusual for many nurses on a unit to identify a hazard and work around it, only to have another nurse fall prey to this risk in the environment. Immediately after an accident or near miss, staff will meet informally to evaluate what happened and how to prevent its reoccurrence on the unit. In AARs, staff should feel free to share knowledge without fear of embarrassment or reprimand. AAR is compatible with established mechanisms for dealing with errors and near misses such as incident reporting and root-cause analysis. <sup>130, 131</sup>  | <ul style="list-style-type: none"> <li>▪ Time constraints</li> <li>▪ Support and timely response by management to issues raised by peer leader</li> </ul>   |

Given the complexity of this high-risk, high-volume, high-cost problem, multifaceted programs are more likely to be effective than any single intervention, indicating the need to build a culture/climate of safety into the organization and employ more than one evidence-based approach. A culture of safety in terms of worker injury prevention is defined somewhat differently from patient safety culture, though there is some overlap between the terms. Safety culture is considered to be the product of multiple goal-directed actions to improve safety in an organization.<sup>132</sup> Nonetheless, empirical data supporting the impact of culture alone on reducing worker injuries are limited.



## Needlesticks

Health care workers continue to be exposed to the serious and sometimes life-threatening risk of blood-borne infections in a wide variety of occupations and health care settings. An estimated 600,000 to 800,000 needlestick injuries occur annually,<sup>133, 134</sup> about half of which go unreported.<sup>133, 135</sup> It is estimated that each year more than 1,000 health care workers will contract a serious infection, such as hepatitis B or C virus or HIV, from a needlestick injury. An estimated 50 to 247 health care workers are infected with hepatitis C virus (HCV) each year from work-related needlesticks.<sup>136</sup> At an average hospital, workers incur approximately 30 needlestick injuries per 100 beds per year.<sup>133</sup> Nursing staff incur most needlesticks—54 percent of reported needlestick and sharp object injuries involve nurses.<sup>137</sup>

After a needlestick injury, the risk of developing occupationally acquired hepatitis B virus (HBV) infection for the nonimmune health care worker ranges from 6 percent to 30 percent, depending on the hepatitis B antigen status of the source patient. The risk of transmission from a positive source for hepatitis C is between 0.4 percent and 1.8 percent, and the average risk of transmission of HIV is 0.3 percent.<sup>138</sup> Risk of transmission increases if one is injured by a device visibly contaminated with blood, if the device is used to puncture the vascular system, or if the stick causes a deep injury. Health care workers, laundry workers, and housekeeping workers are often engaged in duties that expose them to high-risk needlestick injuries.

The number of occupationally acquired HIV infections is underestimated by the national case surveillance system. This is related to the Centers for Disease Control and Prevention's (CDC's) strict definition of a documented HIV seroconversion temporally associated with an occupational HIV exposure and the fact that these are voluntary reports. CDC U.S. surveillance data over 20 years include 57 health care workers with documented occupationally acquired HIV infection.<sup>139</sup> A total of 88 percent of these infections resulted from percutaneous injuries. Of these infections, 41 percent occurred after the procedure, 35 percent during a procedure, and 20 percent during disposal.<sup>139</sup> Recent State-based surveillance programs in California and Massachusetts will provide more complete estimates of the incidents, devices involved, and circumstances surrounding sharp exposures.<sup>140</sup>

Despite the promulgation of the original bloodborne pathogen (BBP) standard in 1991 by the Occupational Safety and Health Administration (OSHA), percutaneous injuries continue to occur in unacceptably high numbers in health care workers. The requirement under the BBP standard that HBV vaccine be made available free of charge to health care workers has greatly reduced the consequences of exposure to this pathogen. Advances in the treatment of HIV infection with prophylaxis has improved the prognosis for those health care workers infected with HIV-contaminated blood. Tragically, there is no vaccine or treatment for HCV, so nurses and other health care workers exposed to HCV-contaminated blood suffer from the potential of contracting a life-threatening illness. As such, it is imperative that all health care workers, not only those working in the acute care setting or those who traditionally handle needles on a regular basis, receive every available protection from occupational exposure to blood and body fluids.

The passage of the Federal Needlestick Safety and Prevention Act in 2000 has begun to afford health care workers better protection from this unnecessary and deadly hazard. Not only does the act amend the 1991 BBP standard to require that safer needles be made available, it also requires employers to solicit the input of front-line health care workers when making safe needle purchasing decisions.

Use of conventional needles in health care today has been compared with the use of unguarded machinery decades ago in the industrial workplace. Safer needle devices have integrated safety features designed into the product to prevent needlestick injuries. The term “safer needle device” is broad and includes many different devices, from those with a protective shield over the needle to those that are completely needle-free. Safer devices are categorized from passive to active, with passive devices offering the greatest protection because the safety feature is automatically triggered after use, without the need for health care workers to take any additional steps. An example of a passive device is a spring-loaded retractable syringe or self-blunting blood collection device. An example of an active safety mechanism is a sheathing needle that requires the worker to manually engage the safety sheath, frequently using their second hand and potentially resulting in more injuries.

A comparison of 1993 and 2001 percutaneous injury rates for nurses documented a 51 percent reduction in needlestick injuries, supporting the use of new technology in reducing percutaneous injury risk.<sup>141</sup> More recently, results from a number of intervention studies have found the use of safer needles systems reduced injury.<sup>142–146</sup> A study of safety needles at a tertiary-care hospital in Manhattan found a statistically significant reduction in the mean annual incidence of percutaneous injuries from 34.08 to 14.25 per 1,000 FTE pre- versus postintervention. The reductions were observed across occupations, activities, times of injury, and devices.<sup>146</sup> Other factors related to working conditions also may need to be addressed to prevent and reduce needlesticks.<sup>31</sup>

While there has been widespread conversion to safer phlebotomy needles and intravenous catheters, for other devices such as laboratory equipment and surgical instruments, relatively small numbers of safer devices are in use.

## **Chemical Occupational Exposures**

There are thousands of chemicals and other toxic substances to which nurses are exposed in practice. Hazardous chemical exposures can occur in a variety of forms—including aerosols, gases, and skin contaminants—from medications used in practice. Exposures can occur on an acute basis, up to chronic long-term exposures, depending upon practice sites and compounds administered; primary exposure routes are pulmonary and dermal.<sup>147</sup> Substances commonly used in the health care setting can cause asthma or trigger asthma attacks, according to a recent report.<sup>148</sup> The report explores the scientific evidence linking 11 substances to asthma, including cleaners and disinfectants, sterilants, latex, pesticides, volatile organic compounds (including formaldehyde), and pharmaceuticals. An important criterion for the selection of the substances in the report was the presence of safer alternative products or processes. The evidence is derived from an array of peer-reviewed sources of scientific information, such as the National Academy of Science Institute of Medicine. In this section, we will discuss some of the hazardous substances currently in use and provide references to obtain evidence on others, as well as for identifying safer alternatives.

**Volatile organic compounds.** Volatile organic compounds (VOCs) are chemicals that readily evaporate at room temperature, thus allowing the chemicals to be easily inhaled. Formaldehyde and artificial fragrances are two such sources that have a ubiquitous presence in hospitals. A study of occupational exposure to artificial fragrances found that health care workers had the highest rate of allergic sensitivity.<sup>149</sup> The fragrances are typically contained in devices that either aerosolize the chemicals into rooms or evaporate the fragrances from a solid form,

thus producing VOCs. Although the Food and Drug Administration is responsible for regulating fragrances and other chemicals in personal care products, the majority of these compounds have not been tested for potential toxic human health effects.<sup>150</sup> Strong odors, fumes, and perfumes are also potent triggers of asthma.<sup>151</sup> Formaldehyde, a known carcinogen,<sup>152</sup> is used in pathology and lab settings and is contained in bedding, drapes, carpets, acoustic ceiling tiles, and fabricated furniture. Artificial fragrances are used to address unpleasant odors. Purchasing low- and no-VOC products, which are readily available (e.g., no-VOC paint), is a key to addressing this problem. Also ensuring adequate indoor air circulation, which can decrease the concentration of VOCs in the air, effectively decreases the “dose” of the chemicals being inhaled.

**Sterilants.** As an example, ethylene oxide (EtO) and glutaraldehyde are commonly used in medical settings for sterilization. Nurses and other medical staff are exposed while cleaning equipment and work surfaces. Although both of these chemicals are powerful and effective, they are associated with serious human health risks. Glutaraldehyde is associated with respiratory irritation including asthma, skin irritation and dermatitis, and eye irritation and conjunctivitis.<sup>153</sup> In fact, in a review of health effects of glutaraldehyde exposure, almost all case reports of occupational asthma were of endoscopy nurses.<sup>154</sup>

The National Institute for Environmental Health Sciences<sup>152</sup> produces a report on carcinogens that summarizes the latest scientific evidence on the cancer-causing properties of many chemicals, including EtO,<sup>155</sup> formaldehyde, and others that are present in health care. In this report, EtO is also listed as a known human carcinogen. EtO has been associated with increased incidence of certain types of cancer in workers with long-term exposures.<sup>156</sup> Additionally, EtO is an eye and skin irritant and also may damage the central nervous system, liver, and kidneys.<sup>157</sup>

**Medications.** Many medications and compounds in use in personal care products have known toxic effects. These have been comprehensively reviewed with a detailed summary of the evidence of environmental and personal hazards associated with these compounds by Daughton and Ternes.<sup>149</sup> Although many medications can be hazardous to workers, those most commonly identified as hazardous to health care workers include antineoplastics and anesthesia. Anesthetic gases have been identified as particularly problematic, as gases escape into the air and can be inhaled by workers. Methods of induction have been studied in terms of worker exposure,<sup>158</sup> with findings indicating that such exposures (measured by urinary metabolites) frequently exceed National Institute for Occupational Safety and Health (NIOSH) recommended limits.<sup>159</sup> Hasei and colleagues<sup>160</sup> found that intravenous induction posed a far lower risk of exposure to health care workers.

There are also data to support the deleterious effects of exposure to antineoplastic drugs, especially an increased risk of spontaneous abortions among health care workers.<sup>161</sup> Cytotoxicity, genotoxicity, teratogenicity, and carcinogenicity are associated with such exposures.<sup>152</sup> For the past few decades, awareness of the risk of antineoplastic agents has been available, including guidelines for handling them published by the Occupational Safety and Health Administration.<sup>162</sup> Nursing functions of particular risk, according to NIOSH, include medication administration, handling contaminated linens, exposure to human wastes, handling drug containers, cleaning drug preparation areas, being involved with special procedures, and disposal of containers and other wastes.<sup>163</sup> Other research indicates that antineoplastics and cytostatics have been found in locations beyond the confines of the designated handling areas such as air vents, desks, countertops, and floors.<sup>164, 165</sup>

**Pesticides.** Pesticide use, both inside and outside of hospitals and health facilities, is another cause for concern. Because of the special vulnerabilities of children and pregnant women to pesticide exposures, control of pesticide use in health care settings is particularly important. In a survey conducted by Health Care Without Harm, all hospitals surveyed reported some regular applications of pesticides inside the hospital building, outside on the grounds, or both.<sup>166</sup> This report, *Healthy Hospitals: Controlling Pests Without Harmful Pesticides*, offers guidance on reducing pesticides and implementing safer integrated pest management techniques. Integrated pest management is a comprehensive approach to pest management that employs nontoxic and least-toxic products and processes to control pests. Beyond Pesticides, a 25-year-old organization that has been working with Health Care Without Harm on pesticide issues in the United States, is currently orchestrating several hospital-based pilot programs in Maryland.<sup>167</sup> They are working with hospital environmental services to implement an integrated pest management approach that will work for hospitals. These collaborations will result in a set of best practices for a range of facility types—small community hospitals, inner-city university health centers, and others.

**Latex exposure.** Latex allergy due to exposure to natural proteins in rubber latex is also a serious problem in health care workers. Diepgen<sup>168</sup> estimated that the annual incidence rate among all workers is 0.5 to 1.9 cases per 1,000 full-time workers per year. Symptoms may start with contact dermatitis located in the glove area, and symptoms can become more severe, such as asthma or anaphylaxis. The course of latex allergy as described by Amr and Bollinger<sup>169</sup> involves progressive impairment of nurses from continued exposure to latex, leading to an inability to continue working as nurses. In fact, the hazard from aerosolizing of latex particles attached to powder in latex gloves or from latex balloons bursting is of great concern, as these exposures can lead to occupational asthma.<sup>170</sup> The American Nurses Association has issued a position statement to suggest actions to protect patients and nurses from latex allergy in all health care settings. These include use of low-allergen powder-free gloves and removal of latex-containing products from the worksite throughout the facility to reduce the exposure at that institution.<sup>171</sup> Hospital environments that have gone latex-free need to ensure that they are not allowing balloons into the facility. As balloons break they can contribute latex into the air that remains for up to 5 hours.<sup>172</sup>

## **Summary of Key Issues Regarding Harmful Exposures**

An awareness of the repercussions of exposure to chemicals and toxins has prompted action to reduce such exposures in health care settings. Promotion of the availability of safer alternatives has gained momentum as a means to reduce exposures. There are resources available to assist advocates and decisionmakers. The *Green Guide for Health Care* is an extensive toolkit providing recommendations for design, construction, renovation, operations, and management of sustainable (causing reduced occupational and environmental effects) and healthier buildings.<sup>173</sup> Also, a clearinghouse of nontoxic alternatives to various medical and health care products is available from the Sustainable Hospitals Project.<sup>174</sup> *Green Link*, a recently inaugurated newsletter, promotes healthier buildings and sustainable hospitals for patients and health care workers.<sup>175</sup> In addition, the American Hospital Association and the Environmental Protection Agency have partnered, forming Hospitals for a Healthy Environment, promoting purchasing of environmentally preferable products.<sup>176</sup> The focus on reducing chemical exposures will be increasingly important over the next decade, especially as the benefits for patient and worker health continue to be recognized.

## Mental Health Effects of Nursing Work

Working in nursing increases the risk of experiencing both minor and major psychiatric morbidity<sup>177, 178</sup> with job strain contributing to this outcome.<sup>179–183</sup> Minor psychiatric morbidities include feelings of tension, anger, anxiety, depressed mood, mental fatigue, and sleep disturbance;<sup>184</sup> these are classified variously as burnout, subthreshold depression, or adjustment disorders. Mental disorders such as major depression, anxiety disorders, and psychotic disorders are less common, but they can be induced or exacerbated by work stress.<sup>184</sup> A variety of exposure types are associated with psychiatric morbidity. These fall into two categories: the overall allostatic load demanded by the work, and the organization of the work, including schedule and such job demands as the emotional toll when caring for patients.

Allostatic load is a theoretical concept whereby excessive demands and a persistent sympathetic (adrenergic) load on the body produce changes in neuronal, immune, and cardiovascular system structure and function, thus having a detrimental impact on bodily processes.<sup>183, 185–188</sup> Changes in neuronal function are associated with anxiety and depression.<sup>185</sup> Several types of psychosocial risk factors can contribute to this overall allostatic burden. High physical demands, fast-paced work, adverse work schedules, role stressors, career insecurity, difficult interpersonal relationships, nonstimulating jobs, and lack of autonomy have been associated with symptoms of anxiety and depression, several psychoses, and with substance use disorders.<sup>183, 189, 190</sup> Some studies have even provided longitudinal evidence linking job demands, lack of autonomy, and monotony at work to affective and substance use disorders.<sup>183, 191, 193</sup> Mental disorders in the workplace—depression in particular—have important consequences for quality of life, the costs and utilization of health care, safety, and productivity.<sup>190, 194</sup>

Extended work schedules have been associated with a variety of mental health indicators in nursing and in other occupations where these schedules are common. Proctor and colleagues<sup>195</sup> found that both the number of overtime hours and the number of cumulative days worked by automotive workers were associated with changes in mood States such as depression and tension. Hospital interns reported subjective deterioration in mood after long shifts.<sup>196</sup> Japanese managers reported decreased quality of life (validated by comparison to a measure of psychiatric distress) when working more than 10 hours per day consistently.<sup>197</sup> French customs workers used antidepressants at a higher rate when assigned to shift schedules with rapid rotation.<sup>198</sup> Shift work has been associated with more mental stress<sup>199</sup> and higher levels of burnout<sup>200</sup> among health care workers. Depression and anxiety have also been shown to vary with the level of work pace, variety, control, social support, and conflicting demands made on workers.<sup>191, 201</sup> Thus with both unfavorable work conditions and extended work hours, the effect on mental health may be multiplied. Fatigue is thought to be a central nervous system stressor.<sup>195</sup>

Nursing is emotionally demanding, with both emotional labor and the need to witness and bear with suffering taking its toll. Emotional labor is necessary to display socially appropriate emotions that are congruent with the job requirements in face-to-face interactions with patients. The more frequent and intense the interpersonal interactions are with others (staff, visitors, patients), requiring the nurse to expend emotional effort, the more likely the nurse will experience symptoms of burnout, including depersonalization and emotional exhaustion.<sup>202, 203</sup> Witnessing the suffering of others occurs in a variety of nursing care settings, but is common when end-of-life suffering is unrelieved.<sup>205</sup> Intense feelings of emotional pain can result and, if unresolved, can affect both physical health and family life.<sup>204, 205</sup>

Interventions to reduce work-related mental changes have focused on either changing the organization of work to reduce the stressors, or changing the workers' ability to cope with stress by providing cognitive-behavioral interventions, relaxation techniques of various types, or multimodal strategies.<sup>184, 206</sup> Although several nationwide initiatives on the prevention of mental disorders have emphasized the importance of addressing work organization factors,<sup>190, 194</sup> only a small number of studies have evaluated this approach, and results have not shown an overall strong relationship.<sup>185</sup> In nursing, Mimura and Griffiths<sup>206</sup> conducted a systematic review of interventions for nurses to reduce their work stress. Two of the reviewed studies used organizational interventions (changing to individualized nursing care and primary nursing), and only one of the two was deemed "potentially effective." Seven studies of strategies to help nurses manage their stress were presented; music, relaxation, exercise, humor, role-playing assertiveness, social support education, and cognitive techniques were among the stress-reducing strategies studied. The authors stated that no recommendations on the most effective approach were possible due to the small number of studies. In a larger meta-analysis of both nurses and other workers,<sup>183</sup> a moderate effect for cognitive-behavioral interventions and multimodal interventions was found, along with a small but significant overall effect for relaxation techniques. Organizational interventions were not significant; however, the authors posit that combining individual-level skills (e.g., cognitive-behavioral) with organizational changes may be a fruitful area for future research.

## **Violence**

From 1993 to 1999, 1.7 million incidents of workplace violence occurred annually in the United States, with 12 percent of all victims reporting physical injuries.<sup>207</sup> Six percent of the workplace crimes resulted in injury that required medical treatment. Yet, only about half (46 percent) of all incidents were reported to the police. The health care sector leads all other industries, with 45 percent of all nonfatal assaults against workers resulting in lost workdays in the United States, according to the U.S. Bureau of Labor Statistics (BLS).<sup>208</sup> The BLS rate of nonfatal assaults to workers in "nursing and personal care facilities" was 31.1 per 10,000, vs. only 2.8 per 10,000 in the private sector as a whole.<sup>208</sup> In two Washington State psychiatric forensic facilities, 73 percent of staff surveyed had reported at least a minor injury related to an assault by a patient during the previous year; only 43 percent of those reporting moderate, severe, or disabling injuries related to such assaults had filed for WC. In these two facilities, the survey found an assault incidence rate of 415 per 100 employees per year, compared to hospital incident report rates of only 35 per 100.<sup>219</sup>

Environmental and organizational factors have been associated with patient and family assaults on health care workers, including understaffing (especially during times of increased activity such as meal times), poor workplace security, unrestricted movement by the public around the facility, and transporting patients. The presence of security personnel reduces the rate of assaults, while increased risk is associated with the perception that administrators consider assaults to be part of the job, receiving assault prevention training, a high patient/personnel ratio, working primarily with mental health patients, and working with patients who have long hospital stays.

Emergency department personnel also face a significant risk of injuries from assaults by patients or their families. Those carrying weapons in emergency departments create the opportunity for severe or fatal injuries. California and Washington State have enacted standards

requiring safeguards for emergency department workers. Although mental health and emergency departments have been the focus of attention and research on the subject, no department within a health care setting is immune from workplace violence. Consequently, violence prevention programs would be useful for all departments.

The first report to the Nation on workplace violence underscores the lack of systematic national data collection on workplace assaults, the paucity of data evaluating violence prevention strategies, and the methodological flaws in published intervention research to date.<sup>210</sup> As background to this report, Runyan and colleagues<sup>211</sup> reviewed the violence prevention intervention literature and found five studies that evaluated violence prevention training interventions,<sup>212-216</sup> two that examined postincident psychological debriefing programs,<sup>217, 218</sup> and two that evaluated administrative controls to prevent violence.<sup>220-221</sup> Findings from the studies were mixed, with six reporting a positive impact and three reporting no or a negative impact. All were quasi-experimental and without a formal control group. Runyan and colleagues criticized the design of published violence prevention interventions to date because of their lack of systematic rigor in the evaluation. She calls for greater reliance on conceptual and theoretical models to guide research as well as stronger evaluation designs. She further suggests that studies must evaluate “process, impact and outcome measures.”<sup>211</sup>

Since Runyan’s review paper, Arnetz and Arnetz<sup>219</sup> reported on a randomized controlled trial of 47 health care workplaces examining a violence prevention intervention involving “continuous registration” of violent events for 1 year with “structured feedback” from supervisors. This study found that the intervention hospitals reported significantly more violence incidents than the control hospitals. The authors attributed this finding to increased awareness of the violence and improved supervisory support at the intervention facilities.

There is no Federal standard that requires workplace violence protections. California and Washington State both have legislation addressing workplace violence in health care settings. In 1996, OSHA published *Guidelines for Preventing Workplace Violence for Health Care and Social Service Workers*.<sup>222</sup> The 1996 Federal guidelines provide a framework for addressing the problem of workplace violence and include the basic elements of any proactive health and safety program: management commitment and employee involvement, worksite analysis, hazard prevention and control, and training and education. The OSHA guidelines provide an outline for developing a violence prevention program, but since they are “performance based,” the challenge of developing a specific process for implementing the guidelines in a manner that will yield results is left to the employer.

Between 2000 and 2004, Lipscomb and colleagues<sup>223</sup> conducted an intervention effectiveness study to describe a comprehensive process for implementing the OSHA Violence Prevention Guidelines and evaluate its impact in the mental health setting. Program impact was evaluated by a combination of quantitative and qualitative assessments. A comparison of pre- and postintervention survey data indicated an improvement in staff perception of the quality of the facility’s violence prevention program as defined by the OSHA elements in both intervention and comparison facilities over the course of the project. Results of the comparison of the change in staff-reported physical assaults were equivocal.

Many psychiatric settings now require that all patient care providers receive annual training in the management of aggressive patients, but few studies have examined the effectiveness of such training. Those investigators that have done so have generally found improvement in nurses’ knowledge, confidence, and safety after taking an aggressive behavior management program. However, implementation of comprehensive violence prevention programs that go

beyond staff training will improve safety of the health care workplace for all workers. These advanced programs include the use of currently available engineering and administrative controls such as security alarm systems, adequate staffing, and training.

## **Research Implications**

### **Challenges in Measuring Nursing Working Conditions and Nurse Safety Outcomes**

While there is increasing evidence linking nursing work environments to nurse health, much more effort has focused on understanding how work influences satisfaction and performance. Improving data and measures will allow better comparisons across studies and build evidence of which relationships are most important. Varied approaches are used to compile data about the nursing work environment. Measures of work characteristics have varied considerably and are most often related to the particular discipline and study objectives. In occupational health, the traditional assessments of exposure have expanded from obvious physical and chemical exposures to include psychosocial demands, physical demands, and leadership quality.<sup>224</sup> These measures are used in individual studies or translated to a job exposure matrix where estimated levels of exposure to an agent or stressor are assigned to an occupation or group of occupations.<sup>225, 226</sup> These approaches are more fully developed and utilized in Scandinavia and Europe, although the O\*NET database describes job requirements, worker attributes, and the context of work ([www.onetcenter.org](http://www.onetcenter.org)).

A self-administered paper-and-pencil or electronic questionnaire is probably the most common approach to gathering information from nurses. The advantages over observation or interviews are obvious: they are generally less costly, can be administered over a broader population, are more uniform and standardized, and confidentiality and anonymity can be more efficiently assured. Yet, these same advantages can also be disadvantages: nurses have varying motivations to respond, leading to response bias; questionnaires are often developed by researchers based on particular study goals, limiting comparison across studies; and there is no opportunity to clarify questions or solicit rich detail. The level of the data may also be unclear. Some items may explicitly reflect the work group or organization, while others may reflect both. Clarity is needed about how many respondents is optimum to represent a particular level of analysis. Where multiple nurses' perceptions are solicited, all responses may be used to form an index or an average score.

### **Nurse Health Outcomes**

Worker outcome data may be solicited from an individual through self-report interviews or questionnaires. These data are subject to the same limitations noted above, although nurse reports are more likely to yield detailed information about potential factors contributing to their health. Measuring nurse health outcomes also is challenging. No matter how data are collected, there can be some measurement error in assessing adverse health outcomes—and attributing them to the work environment. Many of these issues have been discussed in the sections on adverse health outcomes. For example, musculoskeletal injuries become chronic conditions and may not be attributed to the work. Likewise, mental health and substance abuse may be considered in isolation from the individual's work experience.



Another source that is rarely used is administrative data (e.g., incident reports, OSHA logs, WC data).<sup>227</sup> The Occupational Safety and Health Act (1970) requires employers to maintain records of serious workplace injuries and illnesses (29 USC section 657 c[2]). Unfortunately, these statistics may not reflect minor injuries requiring only first aid or injuries that can be episodic and remitting, such as back injuries, majors concerns for nurses. Data sources include logs maintained at the organizational level (OSHA Form 300), first reports of injury (FROI) documenting details of the injury (OSHA Form 301), and WC claims, when filed. The FROI may be used as the baseline data for entry into a WC system, although the two reports may be distinct. The FROIs serve as a more complete source of potentially claimable injuries to health care workers than WC data<sup>228</sup> as they represent all reported injuries, even those that do not lead to lost work time or a medical claim. Relying on WC claims data without using FROI data may introduce systematic selection biases because studies have shown that WC claims are more likely to be filed by workers who are unionized, working for a company too small to be self-insured, or who are more severely injured.<sup>229</sup> FROI data have been used to study injury in a population of home health workers<sup>230</sup> and to find that staffing was related to injuries in nursing home staff.<sup>57</sup> Yet FROI data are often unavailable to researchers or may contain injuries of limited severity.

Somewhat distinct from the OSHA reporting requirements, employers are required to comply with State WC regulations. WC is concerned with compensating injured or ill workers, while the OSHA Occupational Injury and Illness Recording and Reporting Requirements Act is designed to develop a database that can improve understanding of injury and illness, with the intent to prevent them. Thus, certain injuries and illnesses may be reportable under both systems, while others will be reportable under State WC law or under the OSHA recordkeeping rule. State WC benefit requirements also vary, with some States not requiring lost time, but requiring that the employee sought medical care. Other States require a certain number of days of lost time before filing a FROI. Unfortunately, ascertainment of nursing health outcomes varies across these data. Even when analyzing WC claims or FROI data with presumably broader inclusion, some injuries will be missed. For example, injured workers may seek care from their regular health provider and fail to mention the work-relatedness of the injury. In a cross-sectional study of unionized autoworkers diagnosed with work-related MSDs, only 25 percent filed WC claims.<sup>231</sup> In a population-based telephone survey, only 10.6 percent of workers reporting work-related MSDs had filed a WC claim.<sup>232</sup>

The need for standardization in data collection and measuring both work environment and worker outcomes is not new. As noted by NIOSH,<sup>233</sup> insufficient job data to link work factors to health outcomes is a barrier to research. An international conference on linked employer-employee data was held in 1998 to address issues of confidentiality, levels of analysis, and the need for coordination across Federal and State agencies.<sup>234</sup> The work in Europe and Scandinavia builds upon international work and could become a model across many countries. Unfortunately, data policy changes at the Federal and local levels are often slow to occur, as modifications to existing systems require long and arduous lobbying, legislation, and procedure and policy development before implementation. Moreover, the WC regulations are primarily State driven, and this is unlikely to change.

Researchers are encouraged to use established instruments and items, with established reliability and validity. If they are developing their own instruments, psychometric testing is essential. Findings benchmarked with other similar populations are useful to determine variation and explore sources of measurement error. When assessing work environments, the level of

analysis for the measure must be explicit (e.g., work group, organization, or system). Analytical strategies should be used to account for the multilevel nature of the data.

Administrative data for worker injuries can be very useful. Many health care organizations are implementing programs that are likely to affect both patient and worker safety, yet it may be difficult to efficiently evaluate the effectiveness of these programs. Ohio, for example, has used the claims data to support issuance and evaluation of safety grants used in lifting and other mechanical equipment purchases to reduce employee injuries.<sup>235</sup>

## **Conclusion**

In this chapter, we have focused on the major injury and safety issues for working nurses. Some of these issues have been thoroughly researched, with extensive evidence-based findings available for epidemiology and prevention, whereas others remain to be studied and explained. As indicated, there is great potential for preventing nurse injury, even though many risk factors have yet to be addressed. The benefits of improvements to nurse safety are great, both for retaining nurses and attracting new nurses into the profession. For example, work hours that are excessive adversely affect nurses' health and thus can in turn adversely impact patient care. As many facilities are making important financial investments and system-level improvements to promote patient safety, it is important to leverage these efforts to improve worker safety as well. In the long run, these improvements will also benefit patients, as measures that are taken to improve safety for nurses should lead to a healthier and more effective workforce.

## **Search Strategy**

Relevant papers for this review were identified from Pubmed,<sup>®</sup> CINAHL,<sup>®</sup> as well as from cited literature, and from NIOSH publications up through 2007. Searches were also performed examining journals such as the *American Journal of Industrial Medicine*, *American Journal of Public Health*, and *Scandinavian Journal of Work and Environmental Health*. As our chapter encompassed multiple outcomes, search terms varied depending on the category, and included but were not limited to, e.g., occupational health, organization of work, shiftwork, back injuries, musculoskeletal disorders, chemical exposures, mental health, work stress, and workplace violence.

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\* Disclaimer: The findings and conclusions in this chapter are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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**The**

**Evidence Table. Personal Safety for Nurses**

| Author, year                          | Safety issue                | Design type | Outcome measure                            | Setting population | Intervention | Findings reported by authors   |
|---------------------------------------|-----------------------------|-------------|--|--------------------|--------------|--|
| <b>Shift work and long work hours</b> |                             |             |  |                    |              |  |
| Caldwell 2005 <sup>36</sup>           | Shift work, long work hours | Review      | Fatigue                                    |                    | Medications  | Provides a short overview of hypnotics such as temazepam, zolpidem, or zaleplon and alertness-enhancing compounds such as caffeine, modafinil, or dextroamphetamine these compounds as well as factors to be considered before choosing one or more to help manage fatigue.  |
| Caruso 2004 <sup>28</sup>             | Long work hours             | Review      | Health disorders, safety, health behaviors |                    |              | In 16 of 22 studies, overtime was associated with poorer perceived general health, increased injury rates, more illnesses, or increased mortality. One meta-analysis of long work hours suggested a possible weak relationship with preterm birth. Overtime was associated with unhealthy weight gain in two studies, increased alcohol use in two of three studies, increased smoking in one of two studies, and poorer neuropsychological test performance in one study. |
| Costa 2003 <sup>26</sup>              | Shift work                  | Review      | Health disorders                           |                    |              | Organization of shift schedules according to ergonomic criteria and on specific medical surveillance are required to mitigate the adverse effects and ensure that the worker can cope satisfactorily. Consider very carefully psycho-physiological, pathological, and social factors that can influence tolerance and/or maladaptation.  |
| Folkard 2005 <sup>13</sup>            | Shift work, long shifts     | Review      | Safety                                     |                    |              | Three main trends in risk are discussed: (i) risk is higher on the night shift, and to a lesser extent the afternoon shift, than on the morning shift; (ii) risk increases over a span of shifts, especially so if they are night shifts; and (iii) risk increases with increasing shift length over 8 hours.  |

| Author, year                | Safety issue                               | Design type               | Outcome measure  | Setting population | Intervention                      | Findings reported by authors  |
|-----------------------------|--|---------------------------|--|--------------------|-----------------------------------|---|
| Knauth 2003 <sup>34</sup>   | Shift work                                 | Review                    | Health, safety   |                    | Prevention, compensatory measures | Discusses measures that can be taken to optimize the well-being of shift workers and to identify ill-health at an early stage: the design of shift systems, taking account of variation in the views and circumstances of employees, and strategies to combat sleepiness at work and elsewhere.   |
| Knutsson 2003 <sup>18</sup> | Shift work                                 | Review                    | Health disorders   |                    |                                   | The strongest evidence exists for an association of shift work with peptic ulcer disease, coronary heart disease, and compromised pregnancy outcome.  |
| Megdal 2005 <sup>24</sup>   | Night work                                 | Meta-analysis             | Breast cancer  | 13 studies         |                                   | Studies on night shift work and breast cancer risk collectively show a modest increased breast cancer risk among women (aggregate estimate 1.48, 95% CI = 1.36–1.61).   |
| Revell 2005 <sup>35</sup>   | Shift work, long work hours                | Review                    | Circadian adaptation   |                    | Light treatment                   | Reviews studies in which bright light and melatonin were administered to try to counteract jet lag or to produce circadian adaptation to night work. Demonstrates how jet lag could be prevented entirely if rhythms are shifted before the flight using their preflight plan and discusses the combination of interventions that they now recommend for night shift workers. |
| <b>MSD epidemiology</b>     |  |                           |  |                    |                                   |   |
| Ariens 2002 <sup>44</sup>   | Work-related neck musculoskeletal problems | Longitudinal cohort study | Frequency of sickness absence due to neck pain x3 days or more | 758 workers        |                                   | Found “work-related neck flexion, neck rotation, low decision authority, and medium discretion over work activities” as measured by the Job Content Questionnaire to be significant risk factors for absence from work due to neck pain.  |

| Author, year                    | Safety issue  | Design type   | Outcome measure  | Setting population  | Intervention | Findings reported by authors  |
|---------------------------------|---|---|--|---|--------------|---|
| Fredriksson 2002 <sup>236</sup> | Work environment  | Population-based case control study                   | Persons seeking health care for neck or shoulder pain                                    | 17,000 men and women ages 20–59, living in Norrtälje district, central Sweden |              | There were associations between seeking care and the physical and psychosocial factors in the work environment. In women, “long term perceived high workload, long term exposure to frequent hand or finger work, and frequent bending and twisting and hindrance at work was associated with seeking care for neck or shoulder pain,” whereas, in men long-term exposure to vibrating tools was found. For women, high perceived workload and hindrance (risk of injury, risk to work quality or of extra work) combined to increase risk of seeking care. |
| Maul 2003 <sup>237</sup>        | Course of work-related low-back pain over up to 8 years of followup | Longitudinal study                                    | Low-back pain occurring in the past 12 months. 1–7 days = mild 8+ days = mod/severe pain | Nurses working at a university hospital in Switzerland                        |              | The prevalence of low-back pain was 73–76% over the 8-year period. Over the 8-year period, about half reported the same number of days of back pain at followup, with about half of those remaining experiencing more days of back pain, and rest fewer days with back pain.  |
| Bernard 1997 <sup>48</sup>      | Work activities related to musculoskeletal problems                 | An extensive review of over 600 epidemiologic studies | Neck, shoulder, upper extremity (wrist, arm, hand) and back MSDs                         | Variety of occupations  |              | Summarized evidence for work relatedness of MSD. Findings include strong causal evidence for awkward and static work postures related to back MSD and posture related to neck MSD. Tendinitis, hand, elbow/wrist MSD strongly related to repetition, force, and posture combined. There is evidence for a causal relationship between highly repetitive work and neck and neck/shoulder MSDs, and for forceful exertion and repetition in relation to shoulder MSD.   |



| Author, year                           | Safety issue   | Design type   | Outcome measure   | Setting population   | Intervention | Findings reported by authors  |
|--|--|---|---|--|--------------|---|
| Punnett and Wegman 2004 <sup>238</sup> | Work-related MSDs  | Review of studies with 94 article citations   | MSDs  | Variety of occupations   |              | Despite numerous studies on the relationship between MSD and occupation, there continues to be debate. From a review of the epidemiologic literature, the authors, along with the Institute of Medicine and others internationally, conclude there are adequate data to support the impact of physical work demands on MSD. Risk factors for MSD with sufficient evidentiary support include repetitive motion, forceful exertions, nonneutral postures, and vibration. Nursing is noted as one of the "high-risk sectors" for MSDs "with rates up to 3–4 times higher than the overall frequency." |
| Rogers 2005 <sup>239</sup>             | Work-related injuries  | Literature review<br>Best practices<br>Focus groups with hospital nurses<br>Observation of hospital ergonomic hazards | Nurse MSD   | Hospital nurses in North Carolina  |              | Evidence on MSD epidemiology and prevention summarized, along with best practices for addressing many ergonomic hazards that lead to nurse MSD. Preventive interventions proposed and recommendations provided.   |
| Trinkoff 2006 <sup>30</sup>            | Work schedule including work hours, mandatory overtime and on-call | Three-wave longitudinal study   | Reported neck, shoulder, and back MSD cases<br>Nordic questionnaire | 2,617 registered nurses working in nursing in the past year                      |              | Hours/days per week were significantly related to increased MSD; working 13+ hours/day, on days off/vacation days, mandatory overtime, on-call, with <10 hrs between shifts all significantly related to increased MSD. This was largely due to exposure to physical demands of the work.   |
| <b>Needlesticks and sharps</b>         |  |   |   |  |              |   |
| Dement 2004 <sup>240</sup>             | Sharps exposure  | Surveillance  | Blood and body fluids   | 24,000 health care workers employed in a university-based tertiary care hospital |              | 2,730 BBF exposures between 1998 and 2002, resulting in an overall annual rate of 5.5 events/100 FTEs and a rate of 3.9 for percutaneous exposures. Much higher rates were observed for house staff, nurse anesthetists, inpatient nurses, phlebotomists, and surgical/operating room technicians. Rates of percutaneous exposures from hollow needles were found to decrease over the study period; however, exposure rates from suture needles appear to be increasing.   |

| Author, year                      | Safety issue  | Design type                   | Outcome measure   | Setting population  | Intervention  | Findings reported by authors   |
|-----------------------------------|---|-------------------------------|---|---|---|--|
| Sohn 2004 <sup>145, 146</sup>     | Sharps exposure   | Research report               | Percutaneous injuries   | New York City tertiary care hospital                        | Safer needle system composed of various safety-engineered devices   | A statistically significant reduction in the mean annual number of percutaneous injuries from 34.08 to 14.25 per 1,000 FTE pre- versus postintervention.   |
| Trinkoff 2007 <sup>31</sup>       | Needlestick injuries and consequences, sharps exposure by positions specialty and work setting, work schedule | Three-wave longitudinal study | Reported prevalent (past year) and incident needlesticks (measured longitudinally)                          | 2,273 registered nurses working in nursing in the past year |   | Specialties with highest percentage of past year needlesticks: emergency, critical care, OR, and cath lab/diagnostics (≥ 21%). Working increased hours/day, weekends/month, and nonday shifts significantly increased the risk of needlesticks.  |
| Vaughn 2004 <sup>241</sup>        | Sharps exposure   | Research report               | Adherence to safe needle precautions  | Non-Federal general hospitals in Iowa                       |   | Survey of infection control professionals and health care workers found that positive predictors of consistent adherence included infection control hours/FTE (OR = 1.03), frequency of standard precaution education (OR = 1.11), providing personal protective equipment (OR = 1.82), use of needleless IV systems (OR = 1.42), and management support for safety (OR = 1.05). |
| <b>Mental health</b>              |   |                               |   |   |   |  |
| Van der Klink 2001 <sup>184</sup> | Stress-related psychological problems; intervention studies   |                               | Outcomes include quality of worklife, psychologic resources, physiologic responses, complaints, absenteeism | 48 experimental studies                                     | Cognitive-behavioral interventions, multimodal interventions, relaxation techniques, organization-focused interventions | Moderate effect for cognitive-behavioral and multimodal interventions. Small effect for relaxation techniques. No significant effect for organization-focused intervention.  |

| Author, year                  | Safety issue   | Design type               | Outcome measure         | Setting population   | Intervention | Findings reported by authors  |
|-------------------------------|--|---------------------------|-------------------------|----------------------|--------------|---|
| <b>Violence</b>               |  |                           |                         |                      |              |   |
| Duhart 2001 <sup>207</sup>    | Violence   | Survey report             | Workplace violent crime | National survey      |              | Department of Justice, National Crime Victimization Survey, a population-based survey assessing the incidents of criminal acts of workplace violence, reported 1.7 million incidents per year. Rates are reported by occupation, demographic variables, as well as the relationship of victim to perpetrator.   |
| Gerberich 2004 <sup>242</sup> | Violence in health care                                | Nested case-control study | Assault                 | MN RNs               |              | Incidence of physical assault was 13.2 per 100 persons per year. Among 310 cases and 946 control subjects, odds ratios for assault were increased in nursing homes or long-term care facilities (2.6; 95% confidence interval [CI] = 1.9–3.6), emergency departments (4.2; 95% CI = 1.3–12.8), and psychiatric departments (2.0; 95% CI = 1.1–3.7); in environments not "bright as daylight" (2.2; 95% CI = 1.6–2.8); and for each additional hour of shift duration (1.05; 95% CI = 0.99–1.11). Risks were decreased when carrying cellular telephones or personal alarms (0.3; 95% CI = 0.2–0.7). |
| Runyan, 2000 <sup>211</sup>   | Violence   | Review                    | Workplace assault       |                      |              | Literature search and review of workplace violence intervention studies yielded 137 articles including the term intervention, while only 9 studies involving the evaluation of interventions. Results of intervention studies were equivocal. Research employing rigorous methods studying interventions to prevent workplace violence are needed   |
| <b>Chemical exposures</b>     |  |                           |                         |                      |              |   |
| Buckley 2002 <sup>149</sup>   | Fragrance exposures                                    | Physiological assessment  | Allergic reactions      | Multiple occupations |              | Health care workers had the highest prevalence of allergic sensitivity to fragrances.   |
| Daughton 1999 <sup>150</sup>  | Exposure to pharmaceuticals and personal care products | Review                    | Adverse effects         |                      |              | Review of toxic pharmaceuticals and personal care products in the environment. This includes various drugs, disinfectants, fragrances, sun screen, nutritional supplements, etc.  |

| <b>Author, year</b>             | <b>Safety issue</b>        | <b>Design type</b> | <b>Outcome measure</b>  | <b>Setting population</b>                        | <b>Intervention</b> | <b>Findings reported by authors</b>   |
|---------------------------------|----------------------------|--------------------|---|--|---------------------|---|
| Dranitsaris 2005 <sup>161</sup> | Cytotoxic drug exposure    | Meta-analysis      | Adverse health effects<br>Spontaneous abortion, congenital malformations, stillbirths | Health care workers                              |                     | Risk of spontaneous abortions for workers handling cytotoxic drugs was elevated.  |
| Sattler 2007 <sup>243</sup>     | Hospital environment       | Literature review  | Adverse health effects, compromise of the environment                                 | Patients, health care workers, and the community |                     | Review of products used in the hospital setting and their adverse health effects. Explores alternative product selection.   |
| Takigawa 2006 <sup>154</sup>    | Exposure to glutaraldehyde | Review             | Adverse health effects  | Multiple occupations                             |                     | Review of toxicity of glutaraldehyde and workplace exposure. Includes case series for asthma and skin reactions that incorporate many findings from exposed nurses. |