A NORA Report

State of the Sector | Healthcare and Social Assistance

Identification of Research Opportunities for the Next Decade of NORA

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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DHHS (NIOSH) Publication No. 2009–139

August 2009

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Foreword

This document addresses the research needs of the occupational safety and health community within the Healthcare and Social Assistance (HCSA) industrial sector. This important industrial sector represents about 11% of the U.S. workforce—approximately 17.4 million workers in 2006—of which 80% are in healthcare. The HCSA sector contains 12 of the 20 fastest growing occupations, and the projected growth of this sector through 2014 exceeds that of any other industrial sector. Workers in the HCSA sector are exposed to a wide range of health and safety hazards including infectious, chemical, and physical agents; lifting and repetitive tasks (ergonomic hazards); stress (psychological hazards); workplace violence; and risks associated with suboptimal organization of work.

The current effort is an outgrowth of the National Occupational Research Agenda (NORA) process. The National Institute for Occupational Safety and Health (NIOSH) initiated NORA in 1996 as a partnership program to stimulate innovative research and improved workplace practices in occupational safety and health. Diverse parties collaborate to identify the most critical issues in workplace safety and health and then work together to develop goals and objectives for addressing these needs. Participation in NORA is broad, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations.

In its initial decade (1996–2006) NORA was organized along cross-cutting issues such as health effects and methodologies that affected a range of industries. For its second decade (2006–2016), NORA is organized by industrial sectors, as defined using the North American Industry Classification System (NAICS). NAICS provides definitions for 20 sectors, which NIOSH aggregated into the following eight sector groups: Agriculture, Forestry, and Fishing (NAICS code 11); Construction (NAICS code 23); Healthcare and Social Assistance (NAICS code 62); Manufacturing (NAICS code 31–33); Mining (NAICS code 21); Services (NAICS code 51–56, 61, 71–72, 81, and 92); Transportation, Warehousing, and Utilities (NAICS code 22 and 48–49); and Wholesale and Retail Trade (NAICS code 42 and 44–45).

The HCSA sector, as defined by NAICS code 62, consists of four subsectors: ambulatory healthcare services (621), hospitals (622), nursing and residential care facilities (623), and social assistance (624). Together, the first three subsectors are the healthcare industry and employed approximately 14.4 million people in 2006. The last subsector, social assistance, employed approximately 3 million people in 2006. This document focuses more specifically on occupational safety and health issues

in healthcare than those in social assistance. However, similar issues affect parts of social assistance, including individual and family services (which employed about 1.1 million people in 2006) and vocational rehabilitation services (which employed about 0.2 million people in 2006). An important part of social assistance with unique issues not addressed by this document is child day care services, which employed approximately 1.6 million people in 2006.

The second decade of NORA is being developed and implemented through NORA sector councils, which are organized according to the eight sector groups. In addition, a cross-sector council coordinates priorities that affect multiple sectors and groups of workers. Representing all stakeholders, the councils use an open process to set goals, develop strategies, encourage partnerships, and promote improved workplace practices.

This document is a first step in the HCSA Sector Council's response to its charge of developing and maintaining an HCSA sector-specific research agenda. It will provide information on the "state of the sector" including magnitude and consequences of known and emerging health and safety problems, critical research gaps, and research needs that should be addressed over the next decade of NORA. It is hoped that the document and related materials drawn from it will prove useful to practitioners, policymakers, researchers, and other stakeholders from the public and private sectors with an interest in the occupational safety and health issues affecting workers in the healthcare and social assistance sector.

Executive Summary

Public awareness of the potential for healthcare to actually be the source of harm to patients through exposure to infectious agents, unintended error or known side effects of hazardous treatments has spawned a highly visible ”patient safety” movement. Less visible, however, is the risk this same environment and these same hazards impose on the health of the women and men who work there. Although often thought of as clean and safe, workplaces in the Healthcare and Social Assistance (HCSA) sector are associated with many of the same types of exposures to chemicals and hazards found in “blue collar” industrial settings. The HCSA sector is burdened by the historical and entrenched belief that patient care issues supersede the personal safety and health of workers and that it is acceptable for HCSA workers to have less than optimal protections against the risks of hazardous exposures or injuries. Because patients and providers share the healthcare environment, efforts to protect patients and providers can be complimentary, even synergistic, when pursued through a comprehensive , integrated approach.

In order to address occupational safety and health issues of the nation, including those of the HCSA sector, the National Institute for Occupational Safety and Health (NIOSH) is working with a range of partners to develop an updated National Occupational Research Agenda (NORA). Each industrial sector is being addressed by a group of experts and stakeholders called a NORA sector council. This document was developed by the NORA HCSA Sector Council to address the “state of the sector,” including the magnitude and consequences of known and emerging health and safety problems, important knowledge gaps, and opportunities for research to improve the “state of the sector” over the next decade of NORA.

Introduction

The HCSA sector is defined by North American Industry Classification System (NAICS) Sector 62 and includes establishments which provide healthcare and social assistance to individuals. Industries in this sector are exist on a continuum starting with those establishments providing medical care exclusively, continuing with those providing healthcare and social assistance, and finally those providing only social assistance. The HCSA sector is comprised of four NAICS subsectors: ambulatory healthcare services (621), hospitals (622), nursing and residential care facilities (623), and social assistance (624). Social assistance includes establishments that provide nonresidential individual and family services for youth, elderly, and persons with disabilities; community food, housing, and emergency relief services; vocational rehabilitation services; and child day care services.

An estimated 17 million people, about 11% of the U.S. workforce, are employed within the HCSA sector. About 80% of the workers are in healthcare industries and 20% in social assistance industries. Growth of the HCSA sector through 2014 is projected to be more than any other industrial sector, including 12 of the 20 fastest growing occupations. About 80% of HCSA workers are women, a greater percentage than in any other industrial sector and nearly double that for all industrial sectors combined. Social assistance employs a greater percentage of women than healthcare, with child day care services having the greatest percentage (95%). African-Americans represent approximately 17% of HCSA workers, leading all industry sectors and 1.5 times the private industry average of nearly 11%. Asians represent approximately 5.4% of HCSA workers, ranking third among other major industry sectors and first total number of workers (0.94 million). Thus, the HCSA sector is highly diverse and any efforts to improve worker safety and health must be attentive to this diversity, to health disparities, and to the needs of a range of potentially at-risk populations including women, minorities, immigrants, and other potentially vulnerable populations.

Workers in the HCSA sector work to provide services to the sick and those in need of assistance. A partial list of these occupations includes physicians, dentists, dental hygienists and assistants, pharmacists, nurses, nursing aides, technologists and technicians, home health aides, respiratory therapists, occupational and speech therapists, social workers, child care workers, and personal and home care aides. Registered nurses constitute the largest occupation within the HCSA sector and number over 2 million, of which 70% are employed in hospitals. Nurses are perhaps the best studied group within the HCSA sector, and issues with nursing recruitment, retention, and burnout exemplify the importance of occupational safety and health issues faced by the entire sector.

The industry also employs many occupations found in other industries, such as food preparers and servers; housekeeping cleaners; ambulance, truck, and bus drivers; pilots; receptionists; billing and posting clerks; material moving workers; secretaries; and file clerks.

Comprehensive Integrated Approach to Improve Patient/Worker Safety

Promoting a culture of safety in the healthcare workplace benefits workers, patients, family members, and all who enter these facilities. The potential hazards which exist in healthcare settings—such as exposures to airborne infectious agents; spills of industrial grade disinfectants or toxic, anti-cancer drugs; or encounters with distraught, potentially violent emergency room visitors affect both patients

and workers. Similarly, safe patient lift assist equipment protects the healthcare worker's back and also prevents patient injury from skin tears or unanticipated falls during lifting. Thus, safety programs should not discriminate between patients and workers. Rather, they should promote comprehensive "systems of safety" in these organizations and promote "cultures of safety" that address all known hazards and are supported by all levels of HCSA organizations. Although many examples exist of institutions that have successfully adopted comprehensive approaches to safety and health, widespread implementation in the HCSA sector remains an important goal.

Hazards of Employment in the HCSA Sector

Providing competent, compassionate care to patients and clients in need is hard work. It is also hazardous. In 2005, there were 668,000 episodes of nonfatal occupational illness and injury in the sector, equivalent to one episode occurring every 47 seconds of that year. Compared to other industrial sectors, the HCSA sector had the second largest number of such injuries and illnesses. In 2005, the combined number of injury and illness cases involving days away from work for nursing aides, orderlies and attendants, and registered nurses accounted for over 30% of all occupational injuries and illnesses involving days away from work. In the same year, two-thirds of personal assaults and violent acts associated with occupation occurred in the HCSA sector.

Although there are many commonalities between the occupational safety and health problems faced by HCSA workers and workers in other industrial sectors, such as exposure to hazardous chemicals, there are also a number of issues that are unique to the sector. Because 8 in 10 HCSA workers are women, adverse reproductive outcomes and obligations outside of the workplace are especially prominent issues. Also unique to the sector is the stress of dealing with the highly charged HCSA environment, exacerbated by traditional patterns of work organization including long or unpredictable work hours, rotating shifts, and under-staffing. Other hazards unique to HCSA include risks associated with patient lifting and handling, work that takes place in private homes or "in the field", exposures to hazardous drugs administered to patients, and sharps injuries with their associated risk of transmitting hepatitis or other bloodborne pathogens. HCSA workers must also face the unknown exposures, as they are routinely on the front line in caring for those with emerging infectious diseases i.e. severe acute respiratory syndrome (SARS), avian influenza, pandemic influenza or the emerging threat of bioterrorism i.e.anthrax, smallpox. Workers in the social assistance sector may also come in contact with clients with undiagnosed, contagious illness, such as tuberculosis.

Workers Recognize High Risks of the Workplace

In 2001, the American Nurses Association conducted a survey of 4,826 nurses from across the United States. Eighty-eight percent of nurses participating in the survey reported that health and safety concerns influenced their decision to remain in nursing and the kind of nursing work they chose to perform. More than 70% said the acute and chronic effects of stress and overwork was one of their top three health concerns. More than two-thirds reported being required to work mandatory overtime every month. Disabling back injury and fear of contracting human immunodeficiency virus (HIV) or hepatitis infection from a needlestick injury were also among the top three health concerns. Seventeen percent had been physically assaulted, and more than half were threatened or had experienced verbal abuse in the last year. Remarkably, less than 20% of respondents felt safe in their current work environment. Similarly, a 2004 national study of licensed social workers found that 44% of respondents faced personal safety issues in their primary employment practice and of these, 30% did not think their employers adequately addressed safety issues.

Opportunities for Occupational Safety and Health Research in the HCSA Sector

A range of opportunities exist where research could lead to improved occupational safety and health in the HCSA sector. In the following discussion, these opportunities are organized into two groups. The first group of opportunities are those that can have a positive impact on many of the health and safety problems in the sector. The second group pertains to specific health and safety risks and outcomes.

Cross-cutting Research Opportunities Impacting Many Health and Safety Problems

Safety Culture and Safety Climate

A key research opportunity impacting many other health and safety issues lies in the areas of safety culture and safety climate. Safety culture refers to the underlying principles, norms, values, and beliefs of an organization with respect to safety. Safety climate refers to employees' shared perceptions about safety within their work organization, including work in the field. Safety climate is therefore a manifestation of safety culture. A strong safety culture facilitates effective responses to a range of health and safety hazards. Longitudinal studies with repeated measures of safety culture/climate and injuries/exposures, employee retention and recruitment,

and patient quality-of-care outcomes would be helpful in providing reliable estimates of these relationships. Studies are needed on the cost-effectiveness of programs that enhance and support safety culture, as evidence of this type might be beneficial in building toward a culture of safety.

Business Case for Managing Safety and Health

Successful companies recognize that safety and health must be managed like any other part of the business and, more importantly, understand that managing health and safety is the right thing to do. These companies rely on a programmatic approach to health and safety management, incorporating a culture where everyone in the organization (senior management, supervisors, and employees) values, takes responsibility for, and is accountable for health and safety performance. According to the Occupational Safety and Health Administration (OSHA), the American Society of Safety Engineers, the American Industrial Hygiene Association, Liberty Mutual Insurance Company, and others, companies with effective health and safety programs can expect a return on investment of at least $3–$6 for every $1 invested, in addition to other benefits such as reduced workplace injuries and illnesses, improved employee morale, and increased public image as a safety and health leader. Although existing information provides powerful motivation for HCSA establishments to implement effective health and safety programs, further research documenting the economic advantages and business case for managing occupational health and safety risks remains essential.

Work Organization

Work organization refers to how jobs are designed and the way jobs are performed and managed. There are six major components to work organization—work schedule, caseload size, job design, interpersonal relationships with supervisors and coworkers, career concerns, management style, organizational characteristics—and some experts also include the work-home interface as a component of work organization.

There are many opportunities for research in each component of work organization. Research opportunities include surveillance to better identify work organizational hazards, the numbers of workers exposed, and the types of negative outcomes experienced. Research is also needed to guide the development of better work strategies, interventions to reduce risk and improve cost-effectiveness, and test procedures to assess the effectiveness of interventions.

Public Health Emergencies: Mass Casualty Events

In the event of a wide range of public health emergencies, whether natural (floods, tornadoes, hurricanes, pandemics) or man made (terrorist attacks, chemical spills/

releases), the HCSA sector is part of the critical infrastructure needed to minimize morbidity and mortality. Because of the vast array of types of emergencies, HCSA workers could potentially encounter a broad range of scenarios with very different, specific needs concerning occupational safety and health. Still, there are common needs to develop and implement best practices for "surge capacity" that provide good patient care yet protect workers. These practices must promote a healthy safety culture/climate and address issues of work organization. A particular need is to develop solutions for workers' outside obligations (such as caring for family members) that might interfere with their ability to work during public health emergencies. Development of systems for worker education and implementation of prevention measures tailored to specific types of emergencies are also important needs.

Prevention through Design

The most effective way to prevent a broad range of occupational injuries, illnesses, and fatalities is to "design out" or minimize hazards and health and safety risks early in the design process. A newly coined term, "prevention through design," or PtD, describes this approach. Within the HCSA sector, PtD can be applied at all organizational levels, including the product-user interface; processes, materials, equipment, and associated work practices; work organization and policies; and design, construction, maintenance, and design, construction, maintenance, and renovation of the built environment with an emphasis on controlling airborne pathogens and manual handling. There are excellent opportunities for research in this area. Research and demonstration projects could be conducted to develop interdisciplinary collaborations between designers and HCSA workers. A clearinghouse of good practices could be developed. Training and education could be targeted to both designers and HCSA workers to improve mutual understanding and improve incorporation of health and safety concepts into new designs. Surveillance could be used to gather information about relationships between design and injury or illness and used to guide efforts for redesign/design to improve occupational safety and health. Such evidence could be used to develop or improve recommendations for standards and guidelines for design of medical facilities and social service and products to optimally protect the safety and health of healthcare and social service workers and patients/clients.

HCSA Sector and the Environment

There are important links between the HCSA sector and the environment. Environmental events, such as natural disasters or degradation of environmental quality, create burdens for the HCSA sector. Conversely, the HCSA sector creates burdens for the environment. Hospitals and other healthcare organizations are major consumers of natural resources including energy and water. The healthcare system

uses a wide variety of toxic materials with the potential for exposure and its effects on patients, workers, and visitors. The HCSA sector is also a significant source of pollution. Hospitals alone generate more than 2 million tons of waste annually and in recent years were the third highest source of pollution from dioxins and the fourth highest source of pollution from mercury. Up to the present, many of the efforts to reduce pollution by HCSA facilities have focused on reducing hazardous materials causing pollution without regard for the work environment. Research is needed to develop integrated solutions that consider occupational and environmental health and safety in concert and do not simply shift risks from one to the other. Research is also needed to demonstrate the economic advantages related to environmental health and safety in the HCSA industry. Educational programs targeted to designers and HCSA professionals are also needed.

Nursing and Other Professional Worker Shortage

Research across the broad range of areas noted in this document is relevant to addressing the shortage, retention, and burnout of nurses. The nursing shortage and its ultimate effects on nurses' fatigue, injuries, and errors need further exploration. Also important is how the work that nurses do impacts the quality of care patients receives, along with work organization issues that put nurses at risk. In addition, research should examine the role that nursing schools play in preparing nursing students to deal with occupational health and safety issues, including workplace risk and hazards associated with nursing. Students should acquire not only knowledge regarding these hazards but also how to protect themselves against exposures to these hazards. The relationship between worker safety and patient safety should be explored. Nursing curricula should also encompass other issues that exist in the real world of nursing practice. The increase of acute care in the home setting, home infusion opportunities, and other alternate-site nursing roles should be explored with nursing students. Another area worth investigating is why so many graduating students never practice in the nursing profession may provide insight into the gaps that exist in preparing the student for a realistic nursing career. Another important area for additional research is how best to support practicing nurses, in particular the aging nurse.

Nursing is not the only occupation facing workforce shortages. For example, a workforce shortage is also predicted for social workers. A recent study found that 12% of licensed social workers had plans to leave the workforce within the following two years. Seven percent of licensed social workers planned to leave due to retirement; another five percent planned to continue working, but to leave the profession. The profession identified three challenges to maintaining its workforce; replacing retiring social workers; recruiting new social workers; and retaining the current work force.

Occupational Health Surveillance

Occupational health surveillance—the on-going tracking of work-related injuries, illnesses, hazards, and exposures—is an important need for the HCSA sector. Although surveillance of work-related fatalities is comprehensive in nature, existing national surveillance systems for tracking nonfatal occupational injuries and illnesses are fragmented and contain substantial data gaps. Innovative and comprehensive approaches involving multiple data sources are needed to track nonfatal work-related injuries and illnesses. Enhancing existing surveillance systems to include information on industry and occupation would permit ongoing assessment of the work-relatedness of health conditions. A national approach which focuses on the collection of data on leading indicators of work-related hazards, injuries, and disease is needed. Furthermore, robust surveillance data is needed to (1) identify new and emerging occupational health and safety problems and populations at risk, Surveillance systems must recognize diversity in the HCSA workforce and be able to identify and track health disparities across the full range of at-risk populations, including minority groups, immigrants, and other potentially vulnerable populations. (2) describe the magnitude and temporal trends of an injury or disease (or other health-related event or exposure), (3) guide immediate action for cases of occupational health importance, (4) set priorities for prevention and research activities, and (5) evaluate the effectiveness of interventions.

Research Opportunities Impacting Specific Health and Safety Problems

Work-related Musculoskeletal Disorders

Work-related musculoskeletal disorders (MSDs) are defined as an injury of the muscles, tendons, ligaments, nerves, joints, cartilage, bones, or blood vessels in the extremities or back that is caused or aggravated by manual handling work tasks such as lifting, pushing and pulling, and carrying; as well as working in awkward postures with very repetitive or static forceful exertions. MSDs occur frequently in the HCSA sector. In 2005, the incidence rate of sprains and strains involving days away from work was 82.3 cases per 10,000 workers. The part of the body most affected was the trunk, with an incidence rate of 66.8 cases per 10,000 workers, nearly 1.5 times greater than private industry as a whole. The healthcare patient was the most frequent cause of injury at a rate of 47.5 cases per 10,000 workers. Given that the average workers' compensation cost for back pain is $10,689 per case, back injury alone represents a significant health and economic burden.

While there has been much progress in recognizing the hazards of manual patient handling to both patients and staff and in developing equipment that can reduce

manual handling of patients, research is needed to address barriers to implementation of known interventions. There is still more to learn about how work system interactions between environment, technology, organization, task requirements, and individual factors can lead to MSDs and to further improve interventions at all of these levels. There is a particular need to address MSDs in the home health setting where interventions such as lifting equipment are generally unavailable. Better surveillance systems for tracking illnesses and injuries among HCSA workers in the home health setting are needed, as are interventions targeted to protect workers in that setting.

Slip, Trip, and Fall Incidents

Slip, trip, and fall (STF) incidents are another important cause of injury in the HCSA sector. In 2005, the rate for STF incidents in HCSA workers was 38.6 per 10,000, 80% greater than for private industry as a whole. Risk of STF incidents is based on a range of factors including personal factors, environmental characteristics of the workplace, and housekeeping procedures. There are known effective interventions for reducing STF incidents. Research is needed to identify effective ways to implement these interventions. In addition, more research is needed that is specifically targeted to HCSA workers, nursing homes, outpatient centers, and other areas where HCSA workers deliver services, including the home health setting. More research is needed to identify slip-resistant flooring and shoes that can be worn by staff. Public health information dissemination is needed to raise awareness and facilitate implementation of interventions.

Violence

Violence is a major problem for HCSA workers. Available data from BLS, which is already compelling, probably underestimates the true extent of the problem. Minor injuries resulting from violence, which do not result in lost time away from work, often go unreported. Failure to report is often the result of a perception that exposure to violence, often from confused, disoriented patients or clients, is part of the job and cannot be totally eliminated. Proposed interventions exist. In 1996, OSHA issued Guidelines for Preventing Workplace Violence for Healthcare and Social Services Workers. A recent evaluation suggested that, although these guidelines capture what are thought to be the essential elements of a violence prevention program, little empiric evidence exists that documents their effectiveness. An intervention additional to those presented in the guidelines, informing HCSA workers of the prior assaultive behavior of violent patients, has been suggested as very effective. Rigorous research is needed to evaluate the effectiveness of all the components of comprehensive violence prevention programs. Economics research is needed to assist employers in assessing the cost-benefit of prevention and

compare cost-effective options. Assessment of benefits should consider burn-out and workforce shortage. Methods to ensure accurate and consistent reporting of violent episodes are needed to target the development of prevention programs, to monitor trends, and to evaluate effectiveness. The implications and opportunities associated with using electronic medical records to identify patients with histories of violent behavior should be explored.

Hazardous Drugs

Drugs are classified as "hazardous" if studies in animals or humans indicate that exposures to them have a potential for causing cancer, developmental or reproductive toxicity, or other organ system damage. Most hazardous drugs are those used to treat cancer, but also include other types of drugs such as antiviral agents used to treat HIV/acquired immunodeficiency syndrome (AIDS) and other viral infections. Although the potential therapeutic benefits of hazardous drugs outweigh the risks of side effects for sick patients, exposed HCSA workers risk these same side effects (especially cancer and adverse reproductive outcomes) with no health benefits realized. Evidence for work environment contamination and worker exposure to hazardous drugs used for treating patients has steadily grown and has been well documented. The clinical significance of exposure is unclear. However, surveillance systems designed to track both cancer and adverse reproductive outcomes by occupation and specifically by specialization within an occupation (e.g., oncology nursing, oncology pharmacy practice) are sorely needed. Research is also needed to document the efficacy of healthy safety culture/climate promotion and adherence to safe handling practices in reducing exposures to hazardous drugs.

Chemical Hazards

HCSA workers are also at increased risk for many of the types of adverse health effects potentially caused by hazardous chemical exposures, including cancer, adverse reproductive outcomes, and work-related asthma and dermatitis. Although a wide range of hazards exists, a key barrier to addressing them is the misconception that HCSA work is safer than other work involving exposure to chemical and physical hazards. Improved health and hazard surveillance could help to address this issue, as would epidemiological studies to better evaluate relationships between hazardous exposures in the HCSA sector and development of work-related health outcomes such as cancer, adverse reproductive outcomes, asthma, and skin disorders. Research is needed to document a beneficial impact of improved safety culture/climate, especially with regard to implementation of measures to reduce exposure including elimination; substitution; use of appropriate work practices, engineering controls, and personal protective equipment; and adoption of a precautionary approach in dealing with exposures of uncertain toxicity.

Sharps injuries and Bloodborne Pathogens

Sharps injuries and bloodborne pathogens remain an important issue in the HCSA sector. HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) are bloodborne pathogens of special concern because of their potential for occupational transmission and the severity of illness that they cause. A vaccine exists for HBV, but vaccines are not available for HIV or HCV. Thus, prevention of transmission in HCSA workers depends on prevention of sharps injuries and other blood and body fluid exposures. Unfortunately, sharps injuries continue to occur frequently. Although surveillance data is fragmentary, it has been estimated that over 384,000 percutaneous injuries are sustained annually by hospital-based healthcare personnel. Since hospital-based personnel only account for about half of all healthcare personnel, the total number of percutaneous injuries in the HCSA sector may be considerably higher; only limited data is available to support an estimate that includes nonhospital-based personnel. Elimination of sharps injuries will require a coordinated, multifaceted, and multidisciplinary approach. Priority action items developed during a recent stakeholder meeting sponsored by CDC included improved surveillance, education and training of HCSA workers, identification of human and organizational factors that reduce adherence to safe practices and developing interventions to address them, and continued development and implementation of devices with engineered sharps injury prevention features.

Other Infectious Diseases

In addition to bloodborne pathogens, HCSA workers are also at risk for a number of other occupationally acquired infectious diseases. Depending on the specific pathogen, transmission can occur via direct contact with patients and contaminated surfaces, or airborne bio-aerosols, generated mainly by sneezing and coughing, that range from large projectile droplets to small particles remaining in the air.. The potential threats associated with new and emerging infectious hazards have caused much concern; these threats include SARS, avian influenza, pandemic influenza, and multidrug-resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) and extensively drug-resistant tuberculosis (XDR-TB). Since the anthrax attacks of 2001, there has also been great concern about the risks that HCSA workers might face in subsequent attacks using highly contagious bioterrorism agents such as smallpox. In many cases, interventions exist to prevent transmission. Hand washing, vaccination, and rapid recognition and appropriate isolation of potentially contagious patients are especially important interventions. There are a number of opportunities for research with relevance and impact.

Although routine surveillance is performed for some infectious diseases, there is no broadly representative, ongoing surveillance for all infectious diseases across

the sector. Research is needed to identify barriers to adherence and achieve better implementation of known, effective interventions such as hand washing and immunization for influenza. A particularly important need is to better understand the potential for agents, such as SARS and influenza, to be transmitted via the airborne route. A related need is to better understand how exposures to airborne infectious agents should be reduced using interventions such as engineering controls and personal protective equipment. In the case of personal protective equipment, implementation issues, such as appropriate frequency of fit testing, have been particularly controversial; research could help to resolve this. Another area for research is to better understand the risks faced by HCSA workers with illnesses or on medications that compromise their host defense systems and how best to protect them from occupational infectious diseases.

Recommendations

The NORA HCSA Sector Council identified many opportunities for a national agenda that would address the needs of the HCSA sector and have a high likelihood of impact. Examples of research in need of funding and support include hazard and health surveillance, demonstration projects to apply and refine best practices, research studies to demonstrate intervention effectiveness and to evaluate the impact of regulations (e.g., patient lifting, safe needle devices), economic studies to document the financial impact of interventions that improve HCSA worker safety and health, research to develop new interventions (e.g., safer medical devices, personal protective equipment and clothing, novel ventilation), and studies that evaluate the relationship between worker health and safety and patient outcomes. A very important need is research targeted to nonhospital settings, especially home healthcare settings and social service settings.

Health and safety culture is viewed by many as the single most important driver in achieving a positive impact on worker health and safety. Studies are needed to improve measurement of HCSA safety culture/climate and to document the relationships between safety culture/climate and occupational safety and health metrics. Development of interventions that strengthen HCSA safety culture/climate, such as education and training for management and workers, is an important need.

Public health marketing is needed to improve awareness of occupational health and safety issues within the HCSA sector and those it serves. A particularly important need is to overcome the misconception that it is appropriate, acceptable, or necessary to risk HCSA worker safety and health while treating patients. On the contrary, improving HCSA worker safety and health leads to improved patient safety.

The business case for implementing an effective health and safety program is compelling. Companies with strong health and safety programs experience a return on investment of at least $3 to every $1 invested. Many other benefits add value to an organization, such as improved employee morale and increased public image as a health and safety leader. There is a need to market the business case for health and safety to employers in the HCSA sector and to promote implementation of the key elements of effective health and safety programs.

Advancing health and safety research in the HCSA sector will require strong partnerships. Stakeholders in industry, labor, academia, and government must come together and share their different perspectives and abilities to address the problem. Similarly, addressing the needs of the sector will require partnerships between many disciplines. Involvement of industrial hygienists, epidemiologists, laboratory researchers, architects, engineers, social scientists, economists, communications experts, educators, and clinicians all are necessary to ensure that key research issues are adequately addressed. Although the challenges are great, so are the opportunities to address them through broad and inclusive partnerships.

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Acknowledgments

The National Institute for Occupational Safety and Health (NIOSH) recognizes the members of the NORA Healthcare and Social Assistance Sector Council for their contributions as writers and reviewers of this document. This document would not have been possible without the enthusiastic support and effort of the Sector Council Members. Contributing authors to the document and their organizational affiliation are listed in the individual chapters. NIOSH also wishes to acknowledge the American Nurses Association and the Association of Occupational Health Professionals for their thoughtful reviews; and Rick Ehrenberg, Ahmed Gomaa, and Sara Luckhaupt of NIOSH for their contributions to the emergency preparedness and bloodborne pathogens chapters.

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Introduction

The Healthcare and Social Assistance (HCSA) sector comprises establishments providing healthcare and social assistance for individuals. This industrial sector includes both healthcare and social assistance because it is sometimes difficult to discern the boundaries between these two activities. The specific industries within this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing healthcare and social assistance, and finally finishing with those providing only social assistance.

An estimated 17 million people are employed within the HCSA sector. About 80% of the workers are in healthcare industries and 20% in social assistance industries. About 80% of HCSA workers are women, a greater percentage than in any other industrial sector and nearly double that for all industrial sectors combined. Social assistance employs a greater percentage of women than healthcare, with child care services having the greatest percentage (95%).

The healthcare component of the HCSA sector consists of the following segments: hospitals, nursing and residential care facilities, offices of other health practitioners, outpatient care centers, other ambulatory healthcare services (e.g., transport services, blood and organ banks), and medical and diagnostic laboratories. In 2004, the HCSA sector had the largest employment of any industrial sector and had 8 of the 20 projected fastest growing occupations over the next decade. The industry is rapidly changing due to pressure to contain costs, introduction of technological and clinical advances for the diagnosis and treatment of illnesses and injuries, and changing demographics (including aging) of the U.S. population.

The social assistance component of the HCSA sector consists of the following segments: individual and family services, community food and housing, emergency and other relief services, vocational rehabilitation services, and child day care services. Some of the fastest growing occupations in the Nation are concentrated in the social assistance sector. A large number of the jobs in social assistance are part-time and low-paying service jobs.

Workers in the HCSA sector are potentially exposed to a wide range of health and safety hazards including infectious, chemical, and physical agents; ergonomic hazards associated with lifting and repetitive tasks; psychological hazards (stress); workplace violence; and risks associated with suboptimal organization of work. Although it is possible to prevent or reduce worker exposure to these hazards, workers in the HCSA sector are experiencing higher rates of nonfatal illness and injury as compared to all private industry.

A unique feature of the HCSA sector is the important role of public financing through Medicare and Medicaid and the imperative to provide charity care to those without other means of support. Under-reimbursement results in costs shifting to other payers, but this mechanism for recovering costs is limited. Tight funding is an important consideration for healthcare and social services providers and can be a barrier to implementation of interventions to improve occupational safety and health.

This document describes the "state of the HCSA sector" in occupational safety and health, focusing on the magnitude and consequences of known and emerging health and safety problems, critical research gaps, and research needs to be addressed over the next decade of NORA. It is hoped that this document and related materials drawn from it will be of use to practitioners, policymakers, researchers, and other stakeholders from the public and private sectors that have an interest in occupational safety and health issues affecting workers of the healthcare and social assistance industries.

Section I

HCSA Sector Overview

Chapter 1 ▪ Overview of Workplaces and Occupations in the HCSA Sector

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Workplaces

The Healthcare and Social Assistance (HCSA) sector is defined by North American Industry Classification System (NAICS) Sector 62 and includes establishments which provide healthcare and social assistance to individuals [U.S. Census Bureau 2002a]. Industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing healthcare and social assistance, and finally those providing only social assistance. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.

The HCSA sector is comprised of four NAICS subsectors: ambulatory healthcare services (621), hospitals (622), nursing and residential care facilities (623), and social assistance (624) (Table 1). The first three subsectors collectively represent the healthcare industry. All four subsectors are further differentiated by 18 four-digit industry groups. Additionally, there are 30 five-digit and 39 six-digit industries in this sector which are not presented in Table 1.

The industries of the HCSA sector includes both employer (i.e., with paid employees) and nonemployer (i.e., without paid employees or self-employed) establishments, with the exception of hospitals which does not include the latter. Based on 2002 Economic Census figures, there are over 704,000 employer establishments and over 1.45 million self-employed establishments in this sector, representing 10.2% and 8.2% of all establishments, respectively (Table 1) [U.S. Census Bureau 2002b,c]. Over 80% of employer establishments are in healthcare; self-employed establishments are about equally divided between healthcare and social assistance.

Within healthcare, offices of physicians, dentists or other health practitioners represent 75% of employer and 53% of self-employed establishments. Within social assistance, nearly 86% of self-employed and 50% of employer establishments are those providing child day care services. Establishments of the self-employed far outnumber employed establishments in five industries: child day care services, home healthcare services, other ambulatory health services, offices of other healthcare practitioners, and individual and family services.

Table 1. Number of employer and self-employed establishments by HCSA subsector and industry, 2002

2002 NAICS	Industry	Number of establishments employer*	Number of establishments self-employed (nonemployer)†
621	**Ambulatory healthcare services**	**489,021**	**697,239**
6211	Physician offices	203,118	171,497
6212	Dental offices	118,305	33,234
6213	Offices of other health practitioners	104,222	284,314
6214	Outpatient care centers	25,750	7,717
6215	Medical and diagnostic labs	11,079	16,461
6216	Home healthcare services	17,666	132,685
6219	Other ambulatory healthcare services	8,881	51,331
622	**Hospitals**	**6,411**	**NA‡**
6221	General medical and surgical	5,193	NA
6222	Psychiatric and substance abuse	603	NA
6223	Specialty (other than 6222)	615	NA
623	**Nursing and residential care facilities**	**69,342**	**42,571**
6231	Nursing care facilities	16,568	—
6232	Residential mental retardation, mental health, and substance abuse facilities	28,508	—
6233	Community care facilities for the elderly	17,988	—
6239	Other residential care facilities	6,278	—
624	**Social assistance**	**139,752**	**717,105**
6241	Individual and family services	49,618	85,304
6242	Community food and housing and emergency services	12,481	4,365
6243	Vocational rehabilitation services	8,526	8,489
6244	Child day care services	69,127	618,947
62	**Healthcare and social assistance**	**704,526**	**1,456,915**
	All industry sectors§	**6,891,382**	**17,646,062**

*[U.S. Census Bureau 2002b]. Includes establishments of firms with paid employees and subject to payroll tax.

†[U.S Census Bureau 2002c]. Includes establishments of firms with no paid employees and not subject to payroll tax (typically self-employed individuals). Each distinct business income tax return filed by a nonemployer business is counted as an establishment. Nonemployer businesses may operate from a home address or a separate physical location.

‡Not applicable (NA); there are no self-employed establishments in this subsector.

§Excludes public administration, i.e., Federal, State, and local government agencies.

NAICS = North American Industry Classification System, U.S. Census Bureau.

Dash (-) indicates that estimates are unavailable.

Employment and Forecast

There are over 17 million private, government, and self-employed workers in the HCSA sector, the most of any industry sector, representing over 12% of all employment (Table 2) [BLS 2006]. More than 14 million (82% of the HCSA sector) are employed in healthcare. Within healthcare, ambulatory healthcare services and hospitals account for over 82% of employed persons. Within the HCSA sector, hospitals account for the largest number of government workers (0.74 million). Over half of the employed persons in ambulatory healthcare services represent offices of health practitioners (e.g., physicians, dentists). Over half of social assistance workers are employed by child day care services and over a third by individual and family services; and social assistance workers, with over 0.3 million workers, account for the largest percentage of government workers in the HCSA sector (30%).

By 2014 HCSA is expected to grow by 4.3 million jobs (30%), or 1 out of every 5 new jobs (Table 3) [Berman 2005]. Ambulatory health services lead all subsectors with a projected 42% growth, adding nearly 2.1 million new jobs. About 60% of these new jobs will be in offices of healthcare practitioners. Home healthcare services is leading the growth in this subsector (nearly 70%) and has the distinction of being the Nation's fastest growing employer by 2014. Residential care facilities represents the second largest projected growth (48%) within the four subsectors, adding 0.6 million new jobs by 2014. Within social assistance, child day care services is projected to grow 38% adding about 0.3 million new jobs; the remaining industries in this subsector are projected to grow 33%, adding more than 0.44 million jobs. HCSA accounts for 6 of the 20 fastest growing industries (Table 4) [Berman 2005]. HCSA also accounts for 7 of the 21 largest growing industries (Table 5) with representation from all four subsectors [Berman 2005].

Occupations and Forecast

Workers in the HCSA sector represent a diverse group of professional, technical, and service occupations. Table 6 lists the ten largest occupations, as defined by the standard occupational code (SOC), for each subsector of the HCSA sector. Registered nurses constitute the largest occupation with nearly 2 million, of which 70% are employed in hospitals. Other predominant occupations in this sector include nursing aides, orderlies, and attendants (1.2 million); home health aides (0.6 million); licensed practical nurses and licensed vocational nurses (0.6 million); and personal and home care aides (0.5 million). Collectively, these five occupational groups comprise one third of all HCSA workers. Within social services, predominant occupations include child care workers, preschool teachers, personal and home care aides, teachers' assistants, and home health aides (Table 6) [BLS 2005b].

Table 2. Number of private, government, and self-employed workers by HCSA subsector and industry, 2006

2002 NAICS	Industry	Total private, government and self-employed workers	Total private and government workers	Workers*	Total government employed workers	Federal government workers*	State government workers*	Local government workers*	Self-employed workers
621	**Ambulatory healthcare services[B]**	**6,133**	**5,733**	**5,457**	**275**	**22**	**104**	**148**	**393**
6211	Physician offices	1,785	1,685	1,661	23	7	11	5	99
6212	Dental offices	852	784	777	7	1	4	2	63
6213	Offices of other health practitioners	553	427	423	4	0	1	3	125
6214	Outpatient care centers	919	894	788	106	7	34	65	25
6216	Home healthcare services	928	866	801	65	1	34	29	62
6219	Other ambulatory healthcare services	1,096	1,077	1,007	70	6	20	44	19
622	**Hospitals**	**5,712**	**5,703**	**4,963**	**740**	**206**	**330**	**204**	**9**
623	Nursing and residential care facilities	2,507	2,478	2,304	173	11	85	78	28
6231	Nursing care facilities	1,807	1,798	1,696	101	6	40	55	9
6232 6233 6239	Residential care facilities, without nursing	700	680	608	72	5	45	23	19
624	**Social assistance**	**3,064**	**2,526**	**2,038**	**487**	**42**	**146**	**300**	**535**
6241	Individual and family services	1,138	1,068	743	325	13	80	232	70
6242	Community food and housing, and emergency services	107	106	91	14	0	5	9	1
6243	Vocational rehabilitation services	211	210	163	47	4	32	12	1
6244	Child day care services	1,608	1,142	1,041	101	25	29	47	463
62	**Healthcare and social assistance**	**17,416**	**16,439**	**14,762**	**1,677**	**282**	**665**	**729**	**964**
Total employed workers, 16 years and over		**144,427**	**133,736**	**113,347**	**20,389**	**3,362**	**6,099**	**10,927**	**10,586**

Source: [BLS 2006]
*Total wage and salary workers
‡Excludes medical and diagnostic labs (NAICS 6215) where data are unavailable.
NAICS = North American Industry Classification System, U.S. Census Bureau.
Note: Totals may not add up due to exclusion of unpaid family workers.

Table 3. Employment and forecast by HCSA subsector and industry, 2004–2014

2002 NAICS	Industry	Employment (in thousands) 2004	Employment (in thousands) 2014	Percent growth
621	**Ambulatory healthcare services**	**4,946**	**7,031**	**42**
6211, 6212, 6213	Offices of health practitioners	3,337	4,561	37
6216	Home healthcare services	773	1,310	69
6214, 6215, 6219	Outpatient, laboratory, and other ambulatory healthcare services	836	1,160	38
622	**Hospitals, private**	**4,294**	**4,982**	**16**
623	**Nursing and residential care facilities**	**2,815**	**3,597**	**28**
6231	Nursing care facilities	1,575	1,757	11
6232, 6233, 6239	Residential care facilities	1,240	1,840	48
624	**Social assistance**	**2,132**	**2,872**	**35**
6241, 6242, 6243	Individual, family, community, vocational rehabilitation services	1,365	1,810	33
6244	Child day care services	767	1,062	38
62	**Healthcare and social assistance**	**14,187**	**18,482**	**30**
	All industry sectors	**145,612**	**164,540**	**13**

Source: [Berman 2005]
Employment data for wage and salary workers are from the BLS establishment-based Current Employment Statistics Survey [BLS 2005a].
NAICS = North American Industry Classification System, U.S. Census Bureau.

Table 4. Industries with the fastest growing employment, 2004–2014

2002 NAICS	Industry	Employment (in thousands) 2004	Employment (in thousands) 2014	Percent growth 2004–2014
6216	**Home healthcare services**	**773**	**1,310**	**69**
5112	Software publishers	239	400	67
5416	Management, scientific, and technical consulting services	779	1,250	60
6232, 6233, 6239	**Residential care facilities**	**1,240**	**1,840**	**48**
5612	Facilities support services	116	170	46
5613	Employment services	3,470	5,050	45
7115	Independent artists, writers and performers	42	61	45
5611	Office administrative services	319	450	41
5415	Computer systems design and related services	1,147	1,600	39
6214, 6215, 6219	**Outpatient, laboratory, other ambulatory healthcare services**	**836**	**1,160**	**38**
6244	Child day care services	767	1,062	38
6114-17	Other educational services	475	650	37
6211, 6212, 6213	**Offices of health practitioners**	**3,337**	**4,561**	**37**
5412	Accounting, tax preparation, bookkeeping and payroll services	816	1,100	35
6112, 6113	Junior colleges, colleges, universities and professional schools	1,462	1,965	34
6241, 6242, 6243	**Individual, family, community, vocational rehabilitation services**	**1,365**	**1,810**	**33**
487	Scenic and sightseeing transportation	27	35	30
5622,5629	Waste treatment and disposal and waste management services	206	268	30
5419	Other professional, scientific and technical services	503	646	28
5414	Specialized design services	121	155	28

Source: [Berman 2005]
NAICS = North American Industry Classification System, U.S. Census Bureau
Bold indicates industries in HCSA sector.

Table 5. Industries with the largest employment growth, 2004–2014

2002 NAICS	Industry	Employment (in thousands) 2004	Employment (in thousands) 2014	Change 2004–2014
44,45	Retail trade	15,034	16,683	1,649
5613	Employment services	3,470	5,050	1,580
722	Food services and drinking places	8,850	10,301	1,451
6211, 6212, 6213	**Offices of health practitioners**	**3,337**	**4,561**	**1,224**
23	Construction	6,965	7,757	792
NEC	Local government educational services	7,762	8,545	783
622	**Hospitals, private**	**4,294**	**4,982**	**688**
6232, 6233, 6239	**Residential care facilities**	**1,240**	**1,840**	**600**
6216	**Home healthcare services**	**773**	**1,310**	**537**
6112, 6113	Junior colleges, colleges, universities and professional schools	1,462	1,965	503
NEC	Local government enterprises except passenger transit	4,216	4,699	483
42	Wholesale trade	5655	6131	476
5416	Management, scientific, and technical consulting services	779	1,250	471
5415	Computer systems design and related services	1,147	1,600	453
6241, 6242, 6243	**Individual, family, community, vocational rehabilitation services**	**1,365**	**1,810**	**445**
NEC	State government educational services	2,249	2,691	442
713	Amusement, gambling and recreation industries	1,351	1,710	359
5617	Services to buildings and dwellings	1,694	2,050	356
6214, 6215, 6219	**Outpatient, laboratory, other ambulatory healthcare services**	**836**	**1,160**	**324**
721	Accommodation	1,796	2,100	304
6244	**Child day care services**	**767**	**1,062**	**294**

Source: [Berman 2005]
NAICS = North American Industry Classification System, U.S. Census Bureau
Bold indicates industries in HCSA sector.
NEC = not elsewhere classified

Table 6. Ten largest HCSA occupations by industry subsector, 2005

SOC*	Occupation	Total employed†
	Ambulatory healthcare services (NAICS 621)	
29-1111	Registered nurses	408,180
31-9092	Medical assistants	306,010
43-4171	Receptionists and information clerks	282,980
43-6013	Medical secretaries	263,710
31-9091	Dental assistants	259,810
31-1011	Home health aides	232,500
39-9021	Personal and home care aides	203,150
43-9061	Office clerks, general	184,520
29-2061	Licensed practical nurses and licensed vocational nurses	164,420
29-2021	Dental hygienists	157,150
	Hospitals (NAICS 622)	
29-1111	Registered nurses	1,424,860
31-1012	Nursing aides, orderlies and attendants	403,500
29-2061	Licensed practical nurses and licensed vocational nurses	187,420
43-9061	Office clerks, general	123,420
37-2012	Maids and housekeeping cleaners	121,850
29-2034	Radiological technologists and technicians	110,710
29-2070	Medical records and health information technicians	97,270
43-6013	Medical secretaries	93,450
11-9111	Medical and health services managers	92,650
43-4111	Interviewers, except eligibility and loan	81,820
	Nursing and residential care facilities (NAICS 623)	
31-1012	Nursing aides, orderlies and attendants	759,650
31-1011	Home health aides	254,340
29-2061	Licensed practical nurses and licensed vocational nurses	234,090
29-1111	Registered nurses	157,870
37-2012	Maids and housekeeping cleaners	116,590
39-9021	Personal and home care aides	102,180
35-2012	Cooks, institutional and cafeteria	78,130
35-2021	Food preparation workers	68,570
39-9011	Child care workers	50,500
39-9032	Recreation workers	47,970
	Social assistance (NAICS 624)	
39-9011	Child care workers	261,000
25-2011	Preschool teachers	251,120
39-9021	Personal and home care aides	205,040
25-9041	Teachers assistants	120,430
31-1011	Home health aides	100,780
21-1093	Social and human service assistants	98,390
21-1021	Child, family and school social workers	64,930
21-1015	Rehabilitation counselors	48,460
43-9061	Office clerk, general	43,180
11-9151	Social and community service managers	40,920

*Standard Occupational Code, Bureau of Labor Statistics

†National industry-specific occupational employment and wage estimates [BLS 2005b]. Estimates do not include self-employed workers.

Although not among the 10 largest occupations, there are 15,580 registered nurses; 9,990 nursing aides, orderlies, and attendants; and 6,270 licensed practical and licensed vocational nurses in Social Assistance.

Rapid growth is projected for many occupations in the HCSA sector from 2004–2014. Sixteen of the 30 fastest-growing occupations are health-related, including 13 in healthcare, 6 of which are in the top 10 (Table 7) [Hecker 2005]. Home health aides, with an expected growth of 56%, is the Nation's fastest-growing occupation. Although a nonhealthcare occupation, personal and home care aides, a predominant occupation in the sector, is among the top ten fastest-growing occupations. HCSA accounts for 6 of the 30 largest-growing occupations by 2014, including four healthcare occupations (Table 8) [Hecker 2005]. The number of registered nurses is expected to grow by 0.7 million, the second largest increase across all industry sectors. Personal and home care aides and home health aides are also among the largest growing occupations, as well as being among the fastest growing.

Several healthcare occupations fall within the employment services industry (NAICS 5613) and total over 200,000 workers of which 60% are in temporary help services (NAICS 56132). These include registered nurses (77,000); nursing aides, orderlies, and attendants (62,000); licensed practical and licensed vocational nurses (50,000); and home health aides (16,000). Each of these occupations is projected to grow between 50%–56% by 2014 [BLS 2008a,b].

Combined establishment and employment figures yield the following salient facts about the HCSA sector:

Healthcare [BLS 2008c]

- Hospitals account for less than 2% of the healthcare establishments but employ 40% of all healthcare workers.
- More than 70% of hospital employees are in establishments with 1,000 or more workers.
- Over 85% of nonhospital healthcare establishments employ fewer than 20 workers, and about 50% employ five or fewer workers.
- Nearly 70% of nonhospital employees are employed in establishments with 20 or more workers.

Social Assistance [BLS 2008d,e]

- About 95% of establishments (except child day care) have fewer than 20 workers.
- 80% of workers (excluding child day care) are employed in establishments with 20 or more workers.
- More than 80% of child day care services establishments employ fewer than 20 workers.
- Nearly 50% of child care workers are employed in establishments with fewer than 20 workers.

Table 7. Thirty fastest-growing occupations, all industry sectors, 2004–2014

SOC*	Occupation	Employment (in thousands) 2004	Employment (in thousands) 2014	Percent growth
31-1011	**Home health aides**	624	974	56.0
15-1081	Network systems and data communications analysts	231	357	54.6
31-9092	**Medical assistants**	387	589	52.1
29-1071	**Physician assistants**	62	93	49.6
15-1031	Computer software engineers, applications	460	682	48.4
31-2021	**Physical therapist assistants**	59	85	44.2
29-2021	**Dental hygienists**	158	226	43.3
15-1032	Computer software engineers, systems software	340	486	43.0
31-9091	**Dental assistants**	267	382	42.7
39-9021	Personal and home care aides	701	988	41.0
15-1071	Network and computer systems administrators	278	385	38.4
15-1061	Database administrators	104	144	38.2
29-1123	**Physical therapists**	155	211	36.7
19-4092	Forensic science technicians*	10	13	36.4
29-2056	**Veterinary technologists and technicians**	60	81	35.3
29-2032	**Diagnostic medical sonographers**	42	57	34.8
31-2022	**Physical therapist aides**	43	57	34.4
31-2011	**Occupational therapist assistants**	21	29	34.1
19-1042	Medical scientists, except epidemiologists*	72	97	34.1
29-1122	**Occupational therapists**	92	123	33.6
25-2011	Preschool teachers, except special education	431	573	33.1
29-2031	**Cardiovascular technologists and technicians**	45	60	32.6
25-1000	Postsecondary teachers	1,628	2,153	32.2
19-2043	Hydrologists	8	11	31.6
15-1051	Computer systems analysts	487	640	31.4
47-4041	Hazardous materials removal workers	38	50	31.2
17-2031	Biomedical engineers*	10	13	30.7
13-1071	Employment, recruitment, and placement specialists	182	237	30.5
7-2081	Environmental engineers	49	64	30.0
23-2011	Paralegals and legal assistants	224	291	29.7

Source: [Hecker 2005]

*Standard Occupational Code, Bureau of Labor Statistics

Employment data for wage and salary workers are from the BLS establishment-based Current Employment Statistics Survey. [BLS 2005a].

Bold indicates healthcare occupations as defined by two SOC major groups: Healthcare Practitioner and Technical Occupations (29-0000) and Healthcare Support Occupations (31-0000).

Asterisk (*) denotes healthcare-related occupations.

Table 8. Thirty largest-growing occupations, all industry sectors, 2004–2014

SOC1	Occupation	Employment (in thousands) 2004	Employment (in thousands) 2014	Change 2004–2014
41-2031	Retail salespersons	4,256	4,992	736
29-1111	**Registered nurses**	**2,394**	**3,096**	**703**
25-1000	Postsecondary teachers	1,628	2,153	524
43-4051	Customer service representatives	2,063	2,534	471
37-2011	Janitors and cleaners, except maids and housekeepers	2,374	2,813	440
35-3031	Waiters and waitresses	2,252	2,627	376
35-3021	Combined food preparation and serving workers	2,150	2,516	367
31-1011	**Home health aides**	**624**	**974**	**350**
31-1012	**Nursing aides, orderlies and attendants**	**1,455**	**1,781**	**325**
11-1021	General and operations managers	1,807	2,115	308
39-9021	**Personal and home care aides***	**701**	**988**	**287**
25-2021	Elementary school teachers, except special education	1,457	1,722	265
13-2011	Accountants and auditors	1,176	1,440	264
43-9061	Office clerks, general	3,138	3,401	263
53-7062	Laborers and freight, stock, and material movers, hand	2,430	2,678	248
43-4171	Receptionists and information clerks	1,133	1,379	246
37-3011	Landscaping and groundskeeping workers	1,177	1,407	230
53-3032	Truck drivers, heavy and tractor-trailer	1,738	1,962	223
15-1031	Computer software engineers, applications	460	682	222
49-9042	Maintenance and repair workers, general	1,332	1,533	202
31-9092	**Medical assistants**	**387**	**589**	**202**
43-6011	Executive secretaries and administrative assistants	1,547	1,739	192
41-4012	Sales representatives	1,454	1,641	187
47-2031	Carpenters	1,349	1,535	186
25-9041	Teachers assistants	1,296	1,478	183
39-9011	**Child care workers***	**1,280**	**1,456**	**176**
35-2021	Food preparation workers	889	1,064	175
37-2012	Maids and housekeeping cleaners	1,422	1,587	165
53-3033	Truck drivers, light or delivery services	1,042	1,206	164
15-1051	Computer systems analysts	487	640	153

Source: [Hecker 2005]

*Standard Occupational Code, Bureau of Labor Statistics

Employment data for wage and salary workers are from the BLS establishment-based Current Employment Statistics Survey [BLS 2005a].

Bold indicates healthcare occupations as defined by two SOC major groups: Healthcare Practitioner and Technical Occupations (29-0000) and Healthcare Support Occupations (31-0000).

Asterisk (*) denotes predominant occupation in HCSA sector.

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Chapter 2 ▪ HCSA Sector Demographics

Jim M. Boiano, MS, CIH, NIOSH

By Workplace

Selected demographic characteristics of workers in the HCSA sector are presented in Tables 9 and 10. Information on sex, race and ethnicity, and age of employed persons is provided for each of the four subsectors and constituent industries (where available) and for all industries for comparison.

About 80% (13.8 million) of the workers in this sector are women (Table 9), more than any other industry sector and nearly double that for all industries [BLS 2006a]. Social assistance employs a greater percentage of women than healthcare (85% vs. 78%), with child care services leading the way with 95%. Within healthcare, home healthcare employs the greatest percentage of women (90%), followed by nursing care facilities (86%).

Available data on sex, race, and ethnicity show that there is a greater percentage of blacks and Asians in the HCSA sector when compared to all industries, while the percentage of Hispanics is somewhat less. Blacks represent about 17% (2.9 million) of the workers in this sector, leading all industry sectors and 1.5 times the private industry average of nearly 11%. Social assistance employs a slightly greater percentage of blacks than healthcare (21% vs. 16%); however, healthcare employs over 3 times the number of blacks than the social assistance industries (2.3 million vs. 0.65 million). Hospitals employ the largest number of blacks of any subsector (0.94 million), followed by nursing and residential care facilities (0.62 million). Community food and housing, and emergency services (28%) and home healthcare services (27%) employ the largest percentages blacks of any industry group within this sector.

Hispanics represent about 9.5% (1.7 million) of the HCSA workforce (Table 9), ranking a distant second behind the construction sector (25%, 2.9 million). Social assistance employs a slightly greater percentage of Hispanics than healthcare (12.9% vs. 8.8%); however, healthcare employs more than 3 times the number (1.3 million vs. 0.4 million). Ambulatory healthcare services employ the largest number of Hispanics of any subsector (0.61 million), followed by hospitals (0.43 million). Home healthcare services (16.7%) and child day care services (15.2%) employ the greatest percentages of Hispanics of any industry group within this sector.

Asians represent over 5.4% of this sector's workforce (Table 9), ranking third among other major industry sectors and first in terms of number of employed (0.94 million). Healthcare employs double the percentage and 10 times the number of Asians than in social assistance (6.3% or 0.9 million vs. 2.9% or 0.09 million). Hospitals employ the greatest percentage of Asians of any subsector (7%) and ranks slightly behind ambulatory healthcare services (0.4 million) in terms of number employed.

Percent distribution of employed persons in the HCSA sector by age is provided for each of the four subsectors and constituent industries (Table 10) [NIOSH 2008]. When compared to all industries, the percents employed in HCSA within each of the seven age groups were similar, with exception of the 16–19 age group where the average for all industries was double that in HCSA. Among the four subsectors, the highest percents employed within the 16–19 and 55–64 age groups were in nursing and residential care facilities; in the 20–24, 25–34, and 65 and over age groups, social assistance employed the largest percents; and in the 35–44 and 45–54 age groups, hospitals employed the largest percents of workers. When focusing on industries (four-digit codes), child day care services had the highest percents employed for young workers (16–19 and 20–24 age groups) while community food and housing and emergency services had the highest percents employed for older workers (55–64 and 65 and over). Both of these industries are within the social assistance subsector.

By Occupation

Table 11 presents sex, race, and ethnicity demographics of healthcare occupations with the greatest number of employed workers [BLS 2006b]. For 18 of the 22 listed occupations, the percents of women are higher than the industry average. Dental hygienists represent the highest concentration of women (98.6%) whereas dentists represent the lowest (22.6%). Registered nurses represent the occupation with the largest number of women (over 2.3 million).

For half of the listed occupations, the percents of blacks exceed the industry average of 10.9% (Table 11) Nursing, psychiatric, and home healthcare aides represent the occupational group with the highest percent (34.8%); dental hygienists comprise the lowest percent (1.4%). The percents of Hispanics are higher than the industry average (13.6%) for only 4 of the 22 occupations, with child care workers representing the highest concentration (17.3%). By comparison, chiropractors represent the lowest percent (1.9%). For half of the listed occupations, the percents of Asians exceeds the industry average of 4.5%. Pharmacists represent the highest concentration (19.5%); physical therapy assistants and aides represent the lowest (0.6%).

Very little data is available on age distribution for most of the healthcare occupations listed in Table 11, with the exception of registered nurses. Findings from a

Table 9. Percent distribution of employment within the HCSA industry by sex, race, and ethnicity, 2006

NAICS	Industry	Total employed (in thousands)	Women % of total	Black % of total	Hispanic % of total	Asian % of total
621	**Ambulatory healthcare services***	**6,133**	**77.2**	**11.5**	**9.9**	**6.6**
6211	Physician offices	1,785	76.4	6.9	8.7	6.5
6212	Dental offices	852	79.7	3.6	9.6	6.3
6213	Offices of other health practitioners	553	69.3	3.2	5.4	4.6
6214	Outpatient care centers	919	78.4	12.2	11.0	5.4
6216	Home healthcare services	928	90.2	27.0	16.7	4.1
6219	Other ambulatory healthcare services	1,096	68.6	15.8	8.0	6.9
622	**Hospitals**	**5,712**	**76.6**	**16.4**	**7.6**	**7.0**
623	**Nursing and residential care facilities**	**2,507**	**82.0**	**24.6**	**8.6**	**4.1**
6231	Nursing care facilities	1,807	85.5	26.7	8.3	4.5
6232, 6233, 6239	Residential care facilities, without nursing	700	73.0	19.1	9.3	3.0
621,622, 623	**Healthcare**	**14,352**	**77.8**	**15.7**	**8.8**	**6.3**
624	**Social assistance**	**3,065**	**85.4**	**21.2**	**12.9**	**2.9**
6241	Individual and family services	1,138	77.3	22.3	11.1	3.9
6242	Community food and housing, and emergency services	107	66.7	28.4	13.2	3.2
6243	Vocational rehabilitation services	211	63.6	19.9	5.8	1.2
6244	Child day care services	1,608	95.3	20.0	15.2	2.4
62	**Healthcare and social assistance**	**17,416**	**79.1**	**16.7**	**9.5**	**5.4**
Total employed workers, 16 years and over		**144,427**	**46.3**	**10.9**	**13.6**	**4.5**

Source: [BLS 2006a]
*Excludes medical and diagnostic labs (NAICS 6215); data is unavailable.
NAICS = North American Industry Classification System, U.S. Census Bureau

Table 10. Percent distribution of employment in HCSA industry by age group, 2006

NAICS	Industry	Total employed (in thousands)	16–19 yr % of total	20–24 yrs % of total	25–34 yrs % of total	35–44 yrs % of total	45–54 yrs % of total	55–64 yrs % of total	65 and over yrs % of total
621	**Ambulatory healthcare services***	6,133	1.5	6.9	21.9	25.1	26.1	14.6	3.9
6211	Physician offices	1,785	1.2	6.0	20.9	25.2	27.8	14.3	4.5
6212	Dental offices	852	2.8	8.8	21.4	24.5	24.5	13.8	4.0
6213	Offices of other health practitioners	553	1.9	7.3	21.1	22.4	25.0	16.9	5.4
6214	Outpatient care centers	919	1.3	7.4	23.4	22.1	27.5	15.5	2.7
6216	Home healthcare services	928	1.2	5.6	18.9	28.5	25.3	15.9	4.5
6219	Other ambulatory healthcare services	1,096	1.2	7.3	25.4	26.1	24.9	12.5	2.3
622	**Hospitals**	5,712	0.8	7.0	21.4	25.6	27.7	14.9	2.5
623	**Nursing and residential care facilities**	2,507	4.5	10.0	20.0	21.9	24.5	15.0	4.0
6231	Nursing care facilities	1,807	4.7	9.5	20.1	22.3	24.9	14.6	3.8
6232, 6233, 6239	Residential care facilities, without nursing	700	4.1	11.2	20.0	20.6	23.6	15.7	4.8
624	**Social assistance**	3,065	3.8	11.6	22.0	22.5	22.4	13.4	4.2
6241	Individual and family services	1,138	2.0	8.0	20.8	23.6	24.4	16.0	5.1
6242	Community food and housing, and emergency services	107	1.1	6.3	23.0	20.5	21.7	20.0	7.3
6243	Vocational rehabilitation services	211	1.5	8.8	19.8	23.0	26.3	16.4	4.1
6244	Child day care services	1,608	5.6	14.9	23.1	21.7	20.5	10.7	3.4
62	**Healthcare and social assistance**	17,416	2.1	8.2	21.5	24.3	25.8	14.5	3.5
Total employed workers, 16 years and over		144,427	4.2	9.6	21.5	23.9	23.6	13.4	3.7

Source: [NIOSH 2008]
*Excludes medical and diagnostic labs (NAICS 6215); data is unavailable.
NAICS = North American Industry Classification System, U.S. Census Bureau
Values may not sum to the totals due to rounding.

Table 11. Percent distribution of women, blacks, hispanics and asians in selected healthcare occupations, 2006

Occupation	Total Employed (in thousands)	Women % of total	Black % of total	Hispanic % of total	Asian % of total
Registered nurses	2,529	91.3	10.9	4.2	7.5
Nursing, psychiatric, and home health aides	1,906	88.9	34.8	13.1	4.0
Child care workers	1,401	94.2	17.0	17.3	2.8
Physicians and surgeons	863	32.2	5.2	5.7	17.0
Personal and home care aides	703	87.3	22.4	14.9	5.8
Licensed practical nurses and licensed vocational nurses	556	94.2	23.2	7.0	3.1
Health diagnosing ands treating practitioner support technicians	425	80.1	11.8	8.2	5.6
Clinical laboratory technologists and technicians	321	78.1	14.2	7.8	9.6
Diagnostic related technologists and technicians	281	72.9	7.5	6.3	2.9
Dental assistants	274	95.4	5.4	14.9	4.2
Pharmacists	245	48.9	6.0	5.6	19.5
Physical therapists	198	62.7	5.8	5.0	13.7
Dentists	196	22.6	3.1	4.3	11.4
Emergency medical technicians and paramedics	156	31.9	11.9	7.4	2.2
Dental hygienists	144	98.6	1.4	4.6	4.2
Speech language pathologists	114	95.3	8.1	3.6	1.4
Medical records and health information technicians	98	92.0	20.5	15.1	1.4
Dieticians and nutritionists	96	91.0	21.2	4.6	7.6
Respiratory therapists	85	66.0	15.3	6.2	4.6
Occupational therapists	78	90.3	3.1	2.0	4.7
Chiropractors	69	23.1	3.3	1.9	1.8
Physical therapy assistants and aides	61	78.4	2.7	9.1	0.6
Total employed workers, 16 years and older	**144,427**	**46.3**	**10.9**	**13.6**	**4.5**

Source: [BLS 2006b]
NOTE: Data for occupations with fewer than 50,000 employed are not published.

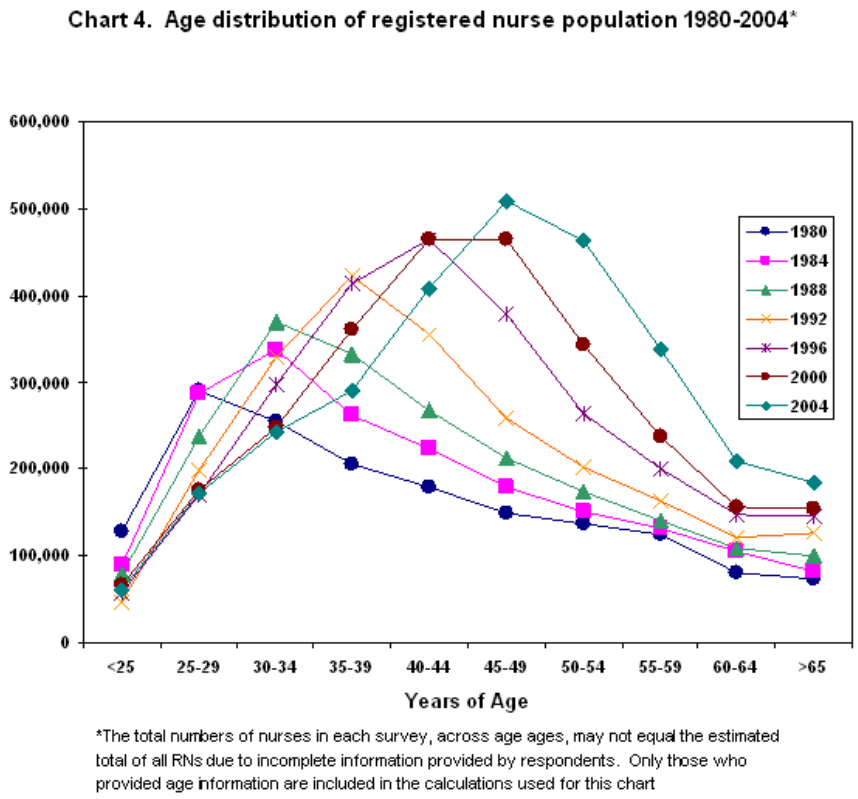

Figure 1. Age distribution of registered nurse population, 1980– 2004
Source: [HRSA 2004]

*The total number of nurses in each survey, across age ages, may not equal the estimated total of all RNs due to incomplete information provided by respondents. Only those who provided age information are included in the calculations used for this chart.

2004 national sample survey show continual movement to more registered nurses in older age groups and a general decline in the numbers of RNs in younger age groups (Figure 1) [HRSA 2004]. Based on data from seven quadrennial surveys conducted from 1980–2004, the average age of the RN population continued to climb, increasing to 46.8 years of age in 2004, compared to 44.3 years in 1996. The largest age group of RNs in 1980 was 25–29 years of age, 35–39 years in 1992, 40–44 years in 2000, and 45–49 years in 2004. By contrast, the numbers of RNs in the two youngest age groups (less than 25 and 25–29 years of age) continued to decline over this 24-year period.

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Chapter 3 ▪ Burden of Injury and Illness Documented by Surveillance Systems

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Occupational surveillance—tracking work-related injuries, illnesses, hazards and exposures—is the ongoing and systematic collection, analysis, interpretation, and dissemination of data related to either occupational exposures or adverse health outcomes such as injuries, disorders, or diseases. Surveillance systems established by the Bureau of Labor Statistics (BLS), NIOSH, other federal and state agencies are primarily used to describe the magnitude of occupational hazards, diseases, and injuries and to track temporal trends to determine whether the problem is increasing or decreasing. Data and information derived from occupational health surveillance can be used to identify new and emerging occupational health and safety problems; track trends of work-related hazards, injuries, and disease; guide immediate action for cases of occupational health importance; evaluate the impact of prevention efforts; provide a basis for epidemiologic research; prioritize allocation of health resources; and evaluate public policy.

National Statistics on Occupational Injuries, Illnesses, and Fatalities

National statistics on occupational injuries, illnesses, and fatalities are compiled by the BLS in conjunction with participating state agencies. National estimates of the numbers and rates of illnesses and injuries are compiled from the annual Survey of Occupational Injuries and Illnesses (SOII) which is based solely on private industry employer's OSHA logs [BLS 2008a]. The national estimates exclude self-employed persons, public sector workers, and workers employed on small farms, representing 22% of the U.S. workforce. Numbers of cases and incidence rates are reported by year with 2005 being the most recent year where data are presented.

Statistics on fatal occupational injuries are from the Census of Fatal Occupational Injuries (CFOI) which, unlike SOII, is a complete census that uses multiple data sources for tracking traumatic workplace fatalities resulting from intentional and

unintentional injuries [BLS 2008b]. BLS began CFOI in 1992 in response to a 1987 National Academy of Sciences report which showed that BLS national estimates missed 50% of acute work-related deaths. BLS data quantify events that have already occurred and represent retrospective (or lagging) indicators for work-related hazards, injuries, and disease. Less often used, but much more desirable, are prospective (or leading) indicators which measure the precursors to serious worker accidents, injuries, and illnesses. Examples of leading indicators include number of near misses, percent of locations evaluated for use of safer needle devices, number of risk factors reported by employees in specific jobs or tasks, and percent of processes for which exposure assessments have been completed. A national approach which focuses on the collection of data on leading indicators is currently lacking.

Total Nonfatal Occupational Injuries and Illnesses

Of the 4.2 million nonfatal occupational injuries and illnesses reported by private industry employers in 2005, the Healthcare and Social Services (HCSA) sector represents the second largest share of injuries and illnesses (668,000 or 15.9% of total recordable cases, equivalent to one case being reported every 47 seconds) (Figure 2) [BLS 2006h]. In fact, three of the four HCSA subsectors—hospitals, nursing and residential care facilities, and ambulatory healthcare services—are ranked first, second, and twelfth, respectively, and are among 14 industries with 100,000 or more injuries and illnesses in 2005 (Table 12) [BLS 2006h]. Hospitals have led this group for the past 3 years, since 2003 when the North American Industry Classification (NAICS) System was first used for tabulations [BLS 2006h]. Occupational illnesses account for only 7% of all total reportable injury and illness cases in the HCSA sector and was not different from private industry as a whole. Compared to injuries, illnesses are often difficult to relate to the workplace and more likely to be underreported due to less direct association with an exposure or event. The issue of underreporting will be discussed later in this chapter.

Figure 3 compares incidence rates of nonfatal occupational injuries and illnesses for the HCSA sector and by subsector for 2003–2005 to those for private industry and service-providing industries [BLS 2005d]. In 2005, the incidence rate of injuries and illnesses in the HCSA sector was 5.9 cases per 100 full-time workers, nearly 1.3 and 1.4 times higher than in private and service-providing industries, respectively. Injury and illness incidence rates in the sector were driven by nursing and residential facilities and hospitals. These rates declined for all HCSA subsectors, as well as in private and service-providing industries, for each year since 2003 (when NAICS-based tabulations began), with the exception of social assistance which increased from 2004 to 2005.

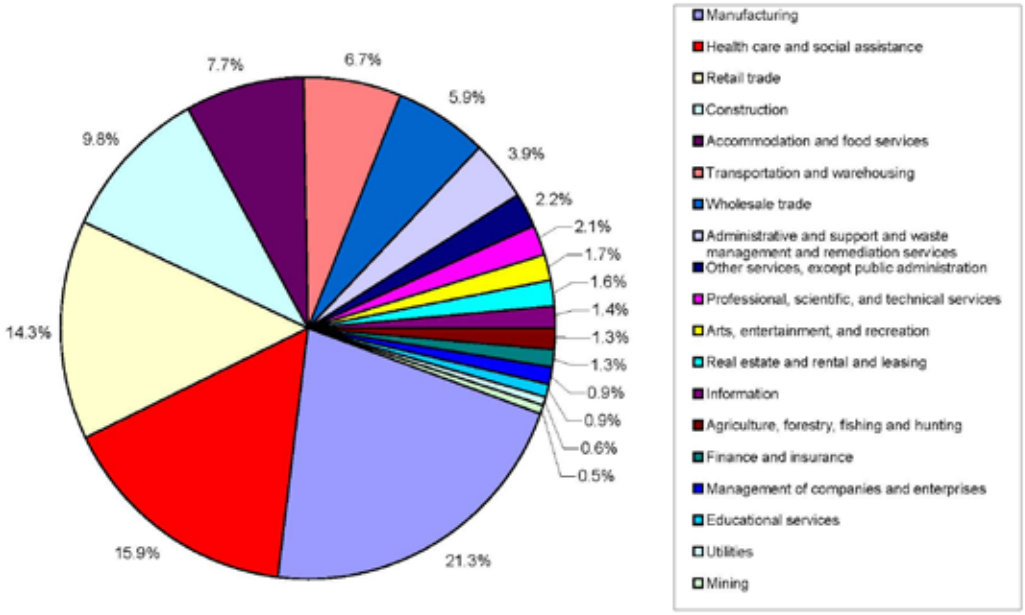


Figure 2. Percent distribution of nonfatal occupational injuries and illnesses by industry sector, 2005

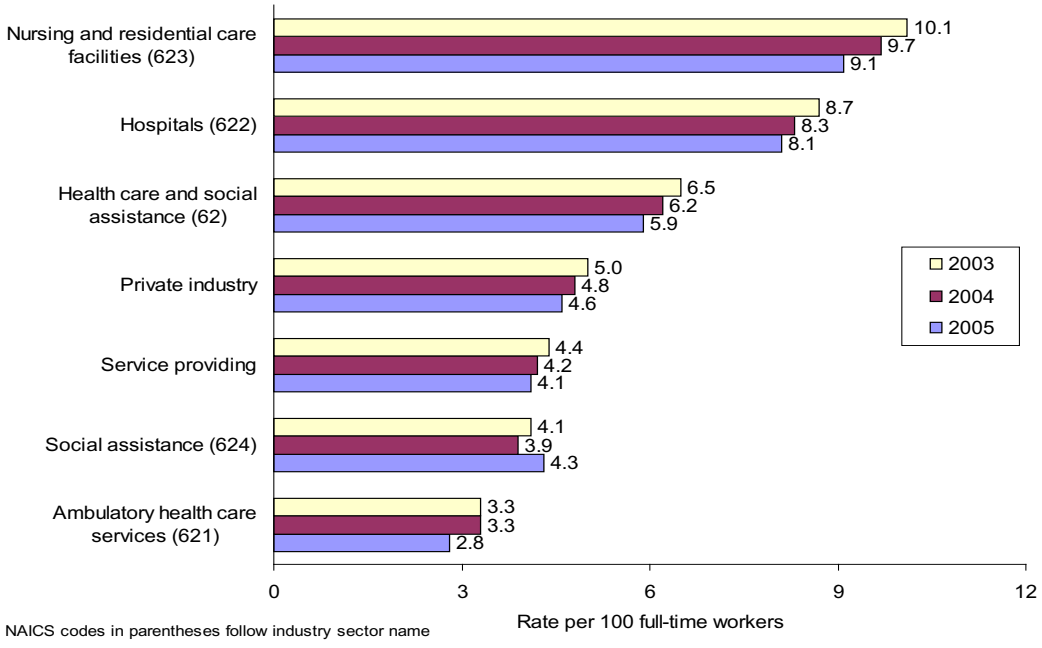


Figure 3. Incidence rates of nonfatal occupational injuries and illnesses, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2005d])

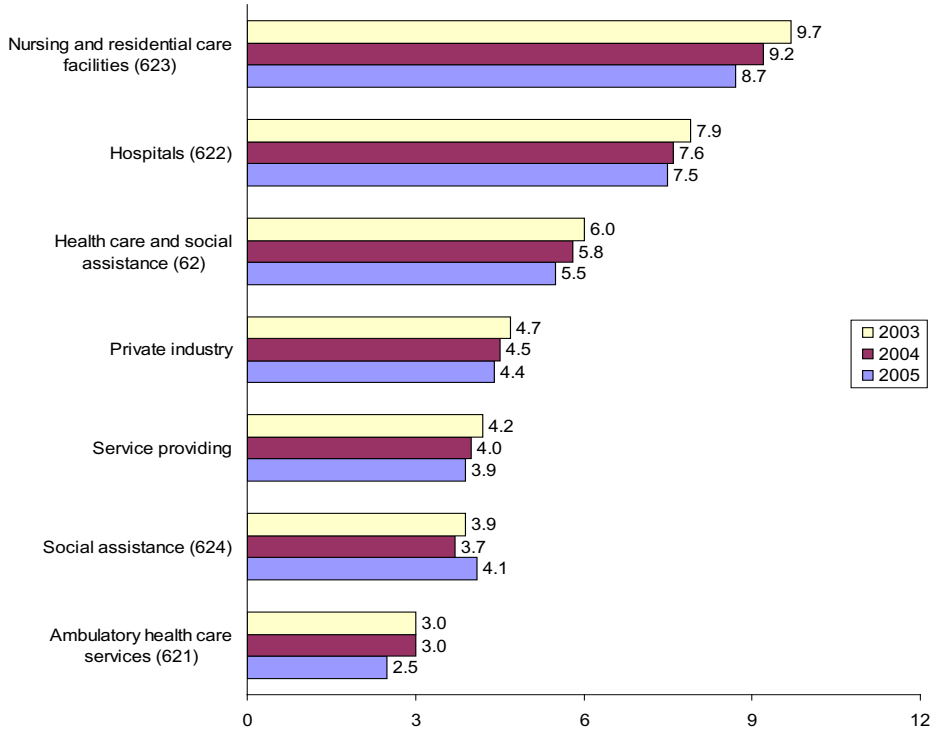
Table 12. Number of cases and incidence rate* of nonfatal occupational injuries and illnesses for industries with 100,000 or more cases, 2005

2002 NAICS	Industry†	Total cases (in thousands)	Incidence rate
622	**Hospitals**	**281.5**	**8.1**
623	**Nursing and residential care facilities**	**209.1**	**9.1**
452	General merchandise stores	147.2	6.7
336	Transportation equipment manufacturing	146.8	8.3
561	Administrative and support services	141.1	3.4
332	Fabricated metal product manufacturing	121.8	8.0
423	Merchant wholesalers, durable goods	119.5	4.1
2382	Building equipment contractors	117.8	6.7
311	Food manufacturing	114.2	7.7
7221	Full-service restaurants	111.7	3.9
44511	Supermarkets and other grocery (except convenience) stores	110.7	6.5
621	**Ambulatory healthcare services**	**110.6**	**2.8**
424	Merchant wholesalers, durable goods	110.0	5.7
7222	Limited-service eating places	103.3	4.1
	Private industry‡	**4,214.2**	**4.6**

Source: [BLS 2006h]
*The incidence rates represent the number of injuries and illnesses per 100 full-time workers.
†Totals include data for industries not shown separately.
‡Excludes farms with fewer than 11 employees.
Bold indicates industries in HCSA sector.
Not making the list was social assistance (NAICS 624) which accounted for 67,700 total cases and an incidence rate of 4.3.
NAICS = North American Industry Classification System, U.S. Census Bureau

Nonfatal Occupational Injuries

In 2005, the incidence of nonfatal occupational injuries for the HCSA sector was 5.5 cases per 100 full-time workers, compared to 4.4 and 3.9 cases per 100 full-time workers in the private and service-providing industries, respectively (Figure 4) [BLS 2005a]. The number of nonfatal injuries for this sector (624,000) accounted for 15.7% of the total number of injury cases in private industry [BLS 2005a]. Incidence rates declined for all HCSA subsectors, as well as in private and service-providing industries, for each year since 2003, with the exception of social assistance which increased from 2004 to 2005. Nursing and residential care facilities had the highest incidence rate (8.7 cases per 100 full-time workers) with nearly 200,000 injury cases, followed by hospitals with an incidence rate of 7.5 and the highest number of injury cases (259,000) among the four subsectors [BLS 2005a]. These two subsectors accounted for nearly three-quarters of the total injury cases for the sector.



NAICS codes in parentheses follow industry sector name

Figure 4. Incidence rates of nonfatal occupational injuries, healthcare, social assistance sector and private industry, 2003–2005 (Source: [BLS 2005a])

Nonfatal Occupational Illnesses

In 2005, the incidence of nonfatal occupational illnesses for the HCSA sector was 39.9 cases per 10,000 full-time workers, compared to 26.7 and 19.6 cases in the private and service-providing industries, respectively (Figure 5) [BLS 2006a]. The number of nonfatal illnesses for this sector (45,000) accounted for almost 20% of the total number of illness cases in private industry [BLS 2005c]. Incidence rates declined for all HCSA subsectors, as well as in both comparison industries for each year since 2003, with the exception of social assistance and ambulatory healthcare services whose rates increased and remained unchanged from 2004 to 2005, respectively [BLS 2006a]. In 2005, hospitals had the highest incidence rate (66.2 cases per 10,000 full-time workers) and number of reported cases (22,900) among the four subsectors. Nursing and residential care facilities accounted for the second highest incidence rate (40.3 cases per 10,000 full-time workers) and the third highest number of reported cases (9,200) behind ambulatory healthcare services. Hospitals accounted for over half of the 45,000 total illness cases for the sector [BLS 2005c].

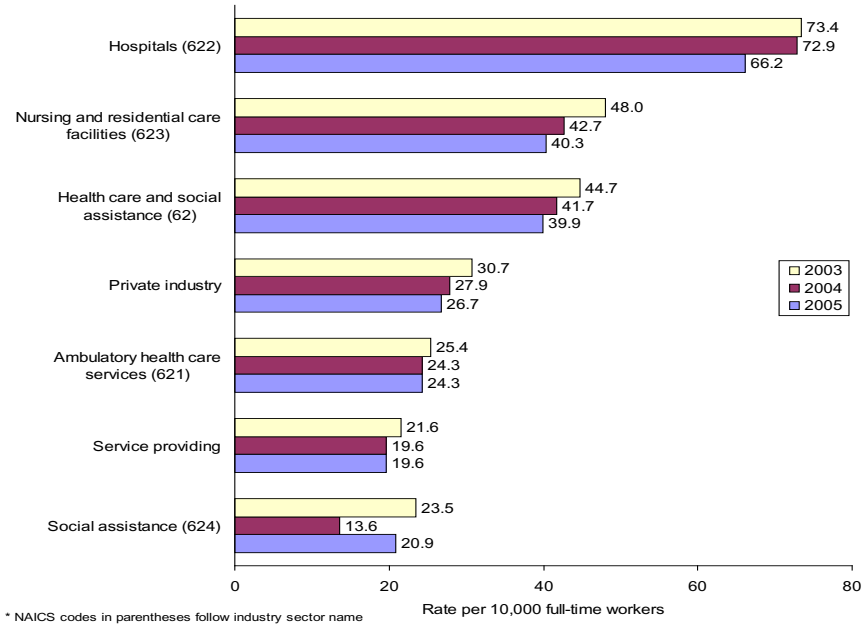


Figure 5. Incidence rates of nonfatal occupational illness, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006a])

In 2005, nonfatal occupational skin diseases/disorders and respiratory conditions represented the most frequently reported illness categories in HCSA, with incidence rates of 7.0 and 5.2 cases, respectively, per 10,000 full-time workers (Figures 6 and 7) [BLS 2006a]. By comparison, incidence rates in private industry were 4.4 and 2.2, respectively [BLS 2005b]. Nursing and residential care facilities had the highest incidence rate (12.6) and second highest number of skin disease cases (2,900) among the subsectors. Hospitals accounted for the second highest incidence rate (10.6) and the highest number of skin disease cases (3,700). Relative to nonfatal occupational respiratory conditions, hospitals had the highest incidence rate (8.0) and number of cases (2,800). Most (80%) of the illness cases involving skin and respiratory disorders were associated with hospitals and nursing and residential care facilities.

The incidence rate of occupational poisonings in the HCSA sector was 0.2 cases per 10,000 workers in 2005. The social assistance subsector had the highest incidence rate, four times higher than the HCSA sector average and the rate in 2004 (Figure 8) [BLS 2006a]. The incidence rate for "all other illnesses" (primarily repetitive trauma) was 27.4 cases per 10,000 full-time workers, accounting for nearly 70% of the total illness cases in the sector (Figure 9) [BLS 2006a]. Hospitals had an incidence rate of 47.3, nearly three times higher than in private industry, with over half of the 'all other illnesses" cases for the sector [BLS 2006a].

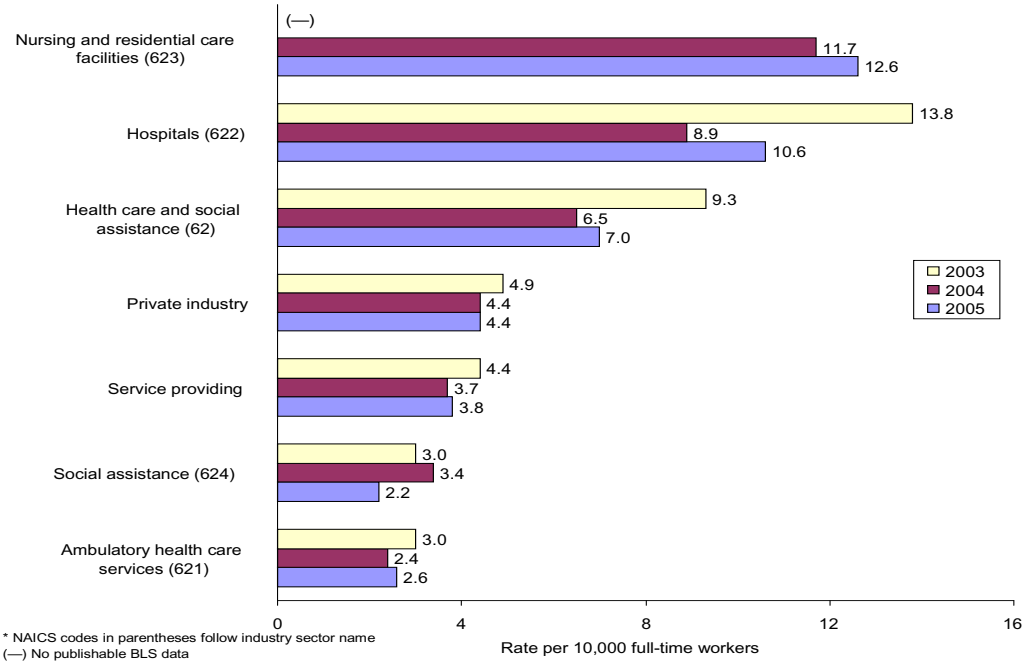


Figure 6. Incidence rates of nonfatal occupational skin diseases or disorders, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006a])

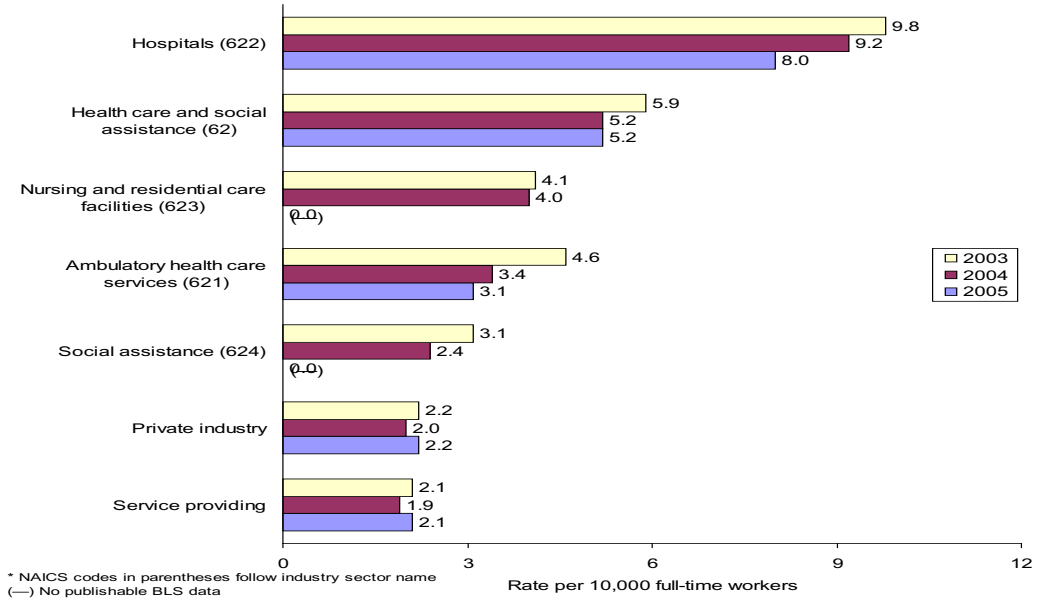


Figure 7. Incidence rates of nonfatal occupational respiratory conditions, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006a])

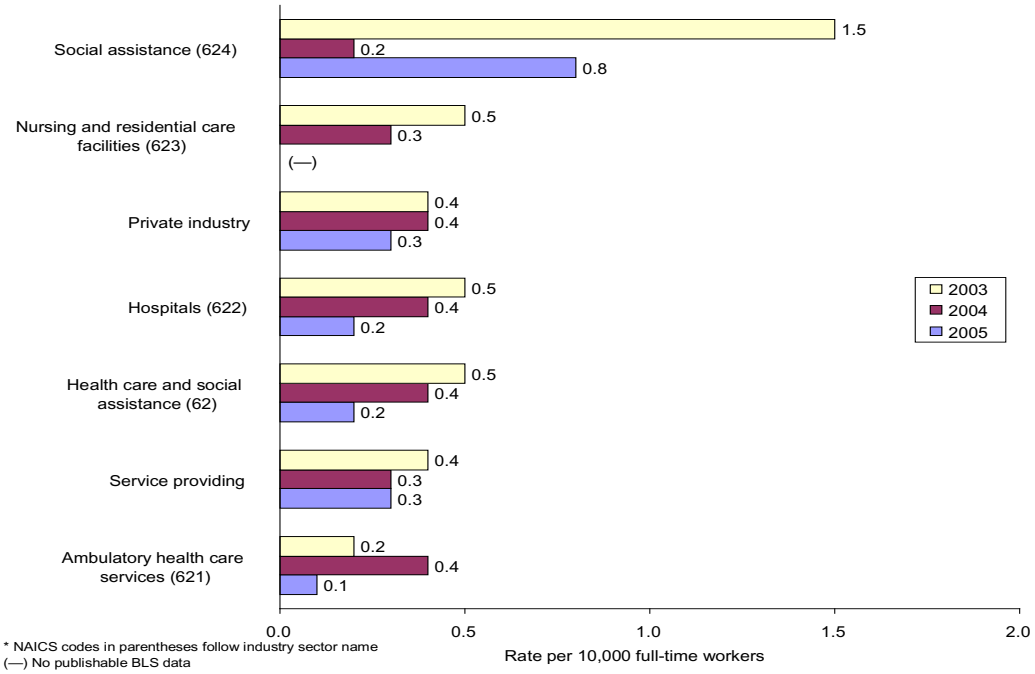


Figure 8. Incidence rates of nonfatal occupational poisonings, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006a])

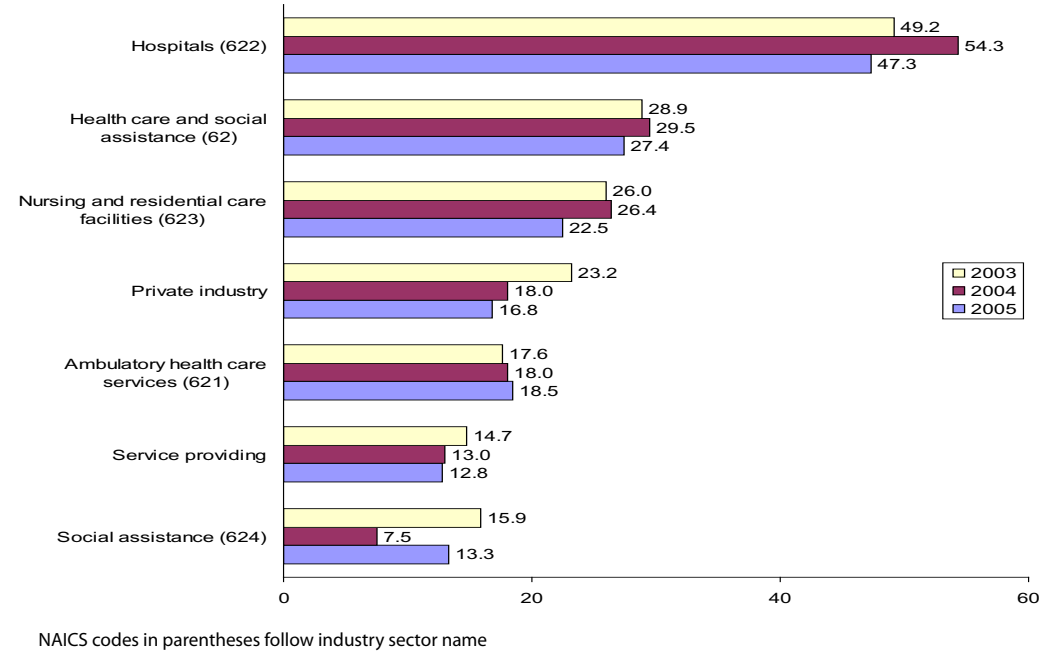


Figure 9. Incidence rates of other nonfatal occupational illnesses, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006a])

Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work

Of the 4.2 million nonfatal occupational injuries and illnesses reported by private industry employers in 2005, 1.2 million (28%) involved one or more days away from work [BLS 2006g]. The HCSA sector accounted for 175,900 (14.2%) of these 1.2 million cases. Within HCSA, healthcare accounted for 154,940 (88%) of the 175,900 cases, and social assistance accounted for the remaining 20,960 (12%) [BLS 2006d]. Nursing and residential care facilities (66,620 cases) and hospitals (62,930 cases) accounted for over 73% of the total number of injury and illness cases involving days away from work.

Figure 10 compares incidence rates of nonfatal occupational injuries and illnesses involving days away from work for the HCSA sector and by subsector for 2003–2005 to those for all private industry and service-providing industries [BLS 2006e]. In 2005, the incidence rate for the HCSA sector was 1.6 cases per 10,000 full-time workers, slightly higher than in private and service-providing industries. These data show that about one in four total injury and illness cases involve days away from work for this sector (Figures 3 and 10). Nursing and residential care facilities and, to a lesser extent, hospitals were primary drivers for the increased incidence rates for the sector.

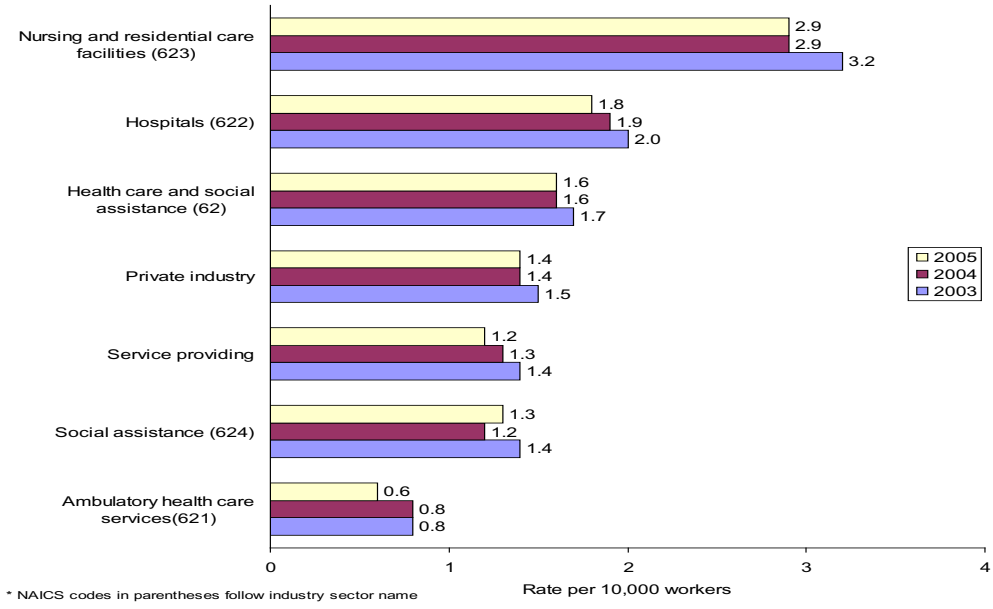


Figure 10. Incidence rates of nonfatal occupational injuries and illnesses cases involving days away from work, healthcare and social assistance sector and private industry, 2003–2005 (Source: [BLS 2006e])

Cases involving days away from work are typically characterized by the nature of the injury or illness, the part of body affected, the source that caused the injury or illness, or the event that led to exposure resulting in illness or injury. In 2005, sprains and strains (82.3 cases per 10,000 workers) were the most likely type of injury or illness in HCSA, nearly 1.5 times more likely to occur among workers in HCSA than in private industry and about 5 times more likely than the next highest category of soreness and pain (Figure 11) [BLS 2005e]. The part of the body affected most was the trunk (66.8 cases per 10,000 workers), with an incident rate nearly 1.5 times higher than in private industry, followed by lower extremities, upper extremities, and then multiple body parts (Figure 12) [BLS 2005f]. The healthcare patient (47.5 cases per 10,000 workers) was the most likely source of injury or illness for HCSA workers, followed by floor/walkways/ground surfaces and worker motion/position (Figure 13) [BLS 2005g]. Overexertion, fall on the same level, contact with object/equipment, and assaults/violent acts represent the top events or exposures leading to injury or illness in HCSA (Figure 14) [BLS 2005h]. The average incidence rate for assaults/violent acts in the HCSA sector (8.8 cases per 10,000 workers) was nearly 4 times higher than in all private industry.

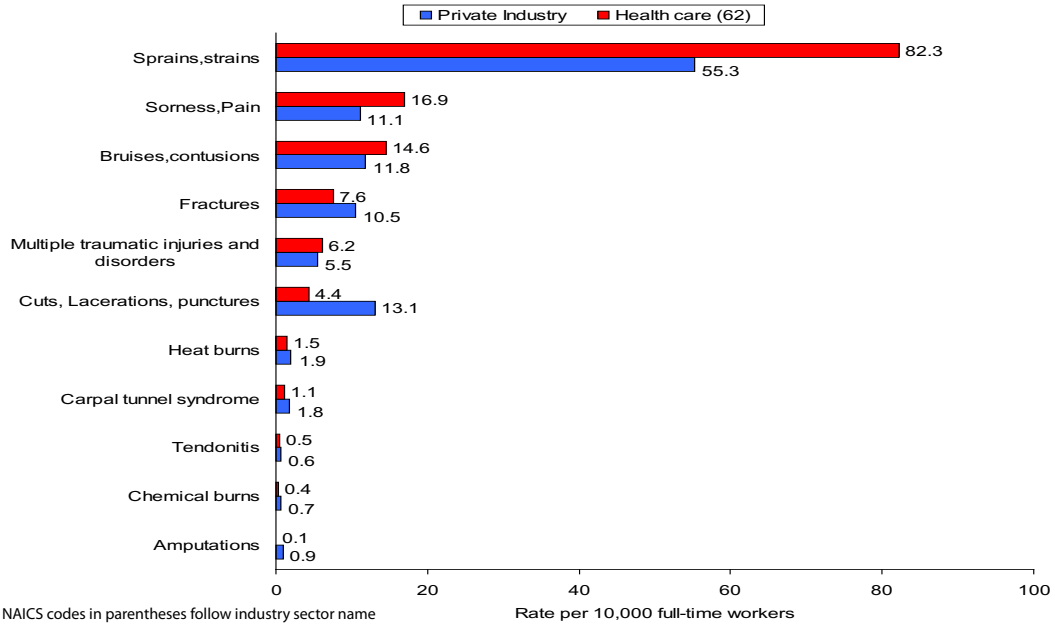


Figure 11. Incidence rates of nonfatal occupational injuries and illnesses involving days away from work by selected nature of injury or illness, healthcare and social assistance sector (62)* and private industry, 2005 (Source: [BLS 2005e])

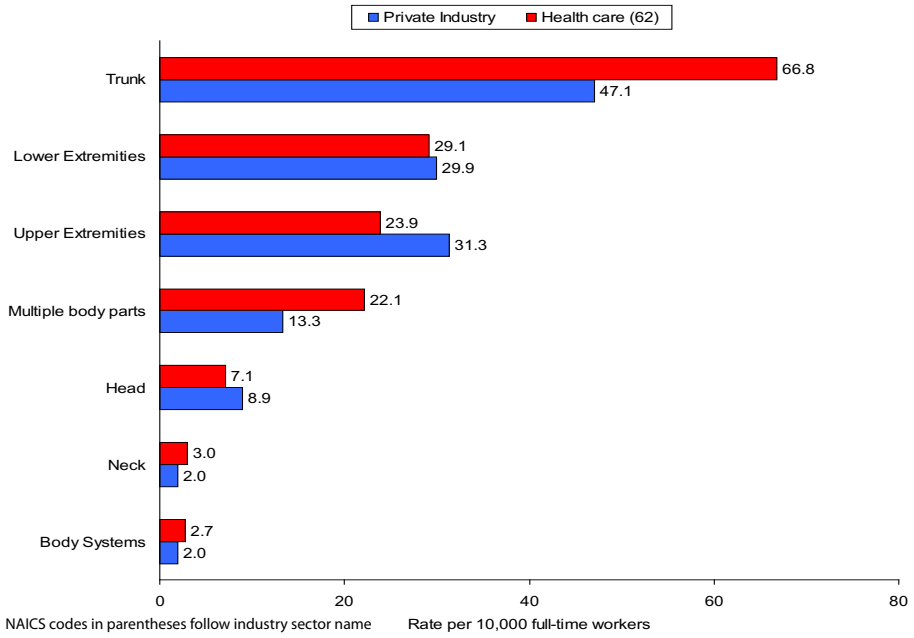


Figure 12. Incidence rates of nonfatal occupational injuries and illnesses involving days away from work by selected parts of body affected, healthcare and social assistance sector and private industry, 2005 (Source: [BLS 2005f])

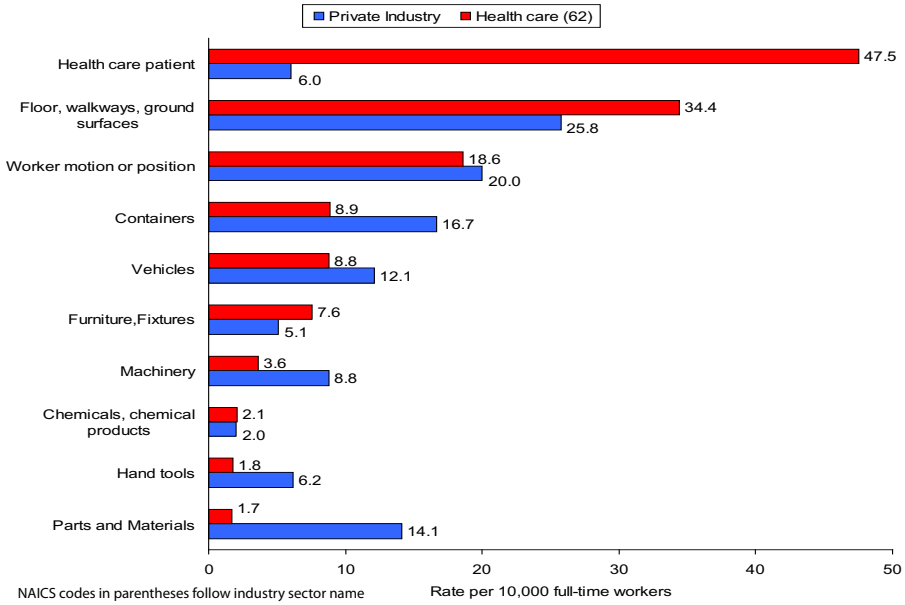


Figure 13. Incidence rates of nonfatal occupational injuries and illnesses involving days away from work by selected sources of injury or illness, healthcare and social assistance sector and private industry, 2005 (Source: [BLS 2005g])

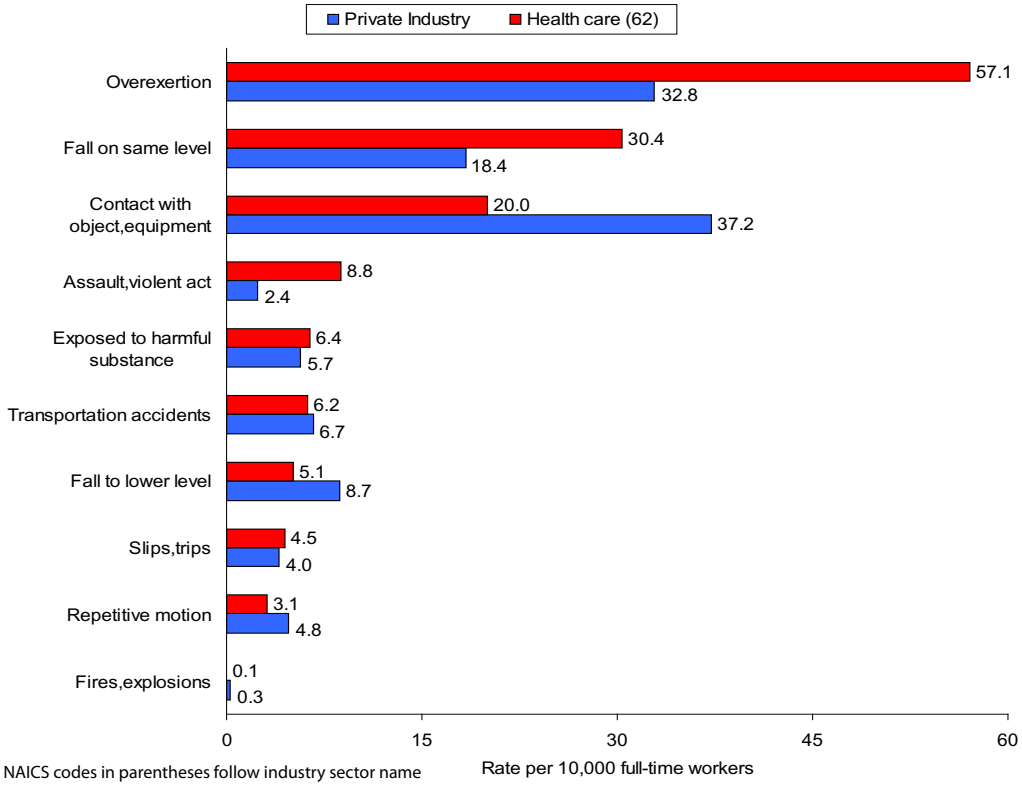


Figure 14. Incidence rates of nonfatal occupational injuries and illnesses involving days away from work by selected events of exposures leading to injury or illness, healthcare and social assistance sector and private industry, 2005 (Source: [BLS 2005h])

In 2005, nursing and residential care facilities experienced the highest incidence rates (per 10,000 workers) in the sector for the following injuries:

- Musculoskeletal disorders (MSDs) with an incidence rate of 131.4 cases, followed by other ambulatory healthcare services (89.0) and hospitals (82.7) [BLS 2006c].
- Overexertion including lifting with an incidence rate of 122.8, followed by other ambulatory healthcare services (90.2) and hospitals (71.9) [BLS 2006e].
- Falls on the same level with an incidence rate of 56.5, followed by social assistance (34.3) and hospitals (30.1) [BLS 2006e].
- Personal assaults and violent acts with an incidence rate of 20.1, followed by social assistance (9.7) and outpatient care centers (9.5) [BLS 2006e].

In nursing and residential care facilities, incidence rates for MSDs, overexertion, falls on the same level, and personal assaults and violent acts were 3.2, 3.7, 3.1, and 12.5 times higher, respectively, in HCSA than in private industry and 1.8–2.4 times higher than the sector average [BLS 2006c,e].

In 2005, home healthcare services experienced the highest incidence rates (per 10,000 workers) in the sector for the following injuries:

- Falls to lower level with an incidence rate of 10.9 cases, followed by nursing and residential care facilities (7.7) and social assistance (7.3) [BLS 2006e].
- Transportation (highway) accidents with an incidence rate of 22.4, followed by other ambulatory healthcare services (20.9) and social assistance (11.9) [BLS 2006e].

Special Populations

This section provides data describing the distribution of nonfatal injuries and illnesses for selected special populations at risk within the HCSA sector (i.e., those workers who experience a disproportionate share of injury and disease due to sex, age, race, ethnicity, etc). The section focuses on women, young workers (16 to19 years of age), minorities, and older workers (45 years and over). Reported figures are based on 2005 employment and injury and illness data.

Industry Level Data. Table 13 displays the 2005 percent distribution of nonfatal injuries and illnesses involving days away from work by the sex, race, and ethnic origin of workers in the HCSA sector and private industry. Women experienced 80.7% of the lost workday injury and illness cases in this sector, with no less than 75% in any of the four subsectors. By comparison, women in private industry experienced about a third of the lost workday injury and illness cases. Available data by four-digit industry groups reveals that women represented the minority of the cases in only one industry, "other ambulatory healthcare services." Blacks experienced 23% of the number of lost workday injury and illness cases, nearly twice that of their counterparts in private industry. Blacks accounted for 29.3% of the cases in nursing and residential care facilities and about 17% of the cases for each of the remaining three subsectors. Hispanics experienced 9.6% of the number of lost workday injury and illness cases, about half of that of their counterparts in private industry. The percent distribution of Hispanics among the four subsectors ranged from 7.7% to 10.3%, with the highest percent in hospitals. Asians experienced 2.4% of the number of lost workday injury and illness cases in this sector, about 1.6 times that of their counterparts in private industry. The percent distribution of Asians among the four subsectors ranged from 0.8% to 4.2%, with the highest percent of cases experienced in hospitals.

Table 13. Percent distribution of nonfatal injuries and illnesses involving days away from work by HCSA subsector, sex, race, and ethnic origin of worker, 2005

NAICS	Industry	Total cases	Women*	Black*	Hispanic *	Asian*
621	**Ambulatory healthcare services†**	**25,390**	**84.2**	**17.6**	**7.7**	**1.1**
6211	Physician offices	5,420	91.0	10.5	14.5	0.5
6212	Dental offices	1,010	100	—	—	—
6213	Offices of other health practitioners	900	96.7	30.9	7.1	—
6214	Outpatient care centers	4,380	75.8	29.9	4.2	0.2
6216	Home healthcare services	9,660	95.3	20.1	5.7	1.0
6219	Other ambulatory healthcare services	3,180	45.6	7.1	8.4	0.8
622	**Hospitals**	**62,930**	**77.1**	**17.1**	**10.3**	**4.2**
623	**Nursing and residential care facilities**	**66,620**	**84.5**	**29.3**	**9.2**	**1.9**
624	**Social assistance**	**20,960**	**75.6**	**16.5**	**9.0**	**0.8**
62	**Healthcare and social assistance**	**175,900**	**80.7**	**23.0**	**9.6**	**2.4**
	Total, private industry, 16 years and over	**1,234,680**	**33.7**	**11.8**	**19.0**	**1.5**

Source: [BLS 2006i]
*Percent of nonfatal injuries and illnesses involving days away from work.
†Excludes medical and diagnostic labs (NAICS 6215) where data is unavailable.
Dash (-) indicates data are unavailable.
Because of rounding and data exclusion of nonclassifiable responses, data may not sum to the totals.
NAICS = North American Industry Classification System, U.S. Census Bureau

Table 14 displays the 2005 percent distribution of nonfatal injuries and illnesses involving days away from work by age category of workers in the HCSA sector and private industry. HCSA workers in the 16–19, 20–24, 25–34, and 35–44 age groups experienced lower percent of lost workday injury and illness cases than their counterparts in private industry. However, the reverse was true for workers ages 45 and over. Among the four subsectors, workers in the 16–19, 20–24, and 25–34 age groups experienced the highest percents in nursing and residential care facilities. In the 35–44, 45–54, and 55–54 age groups, workers in hospitals experienced the highest percents. Workers in social assistance experienced the highest percent in the 65 and over age group. Workers in the 45–54 age group experienced the highest percent of cases in three of the four HCSA subsectors; the 25–34 age group experienced the highest percent of cases in nursing and residential care facilities. Within ambulatory healthcare services where the data is available at the four-digit industry level, there are many cases where the average for the subsector is exceeded. Unfortunately, similar data for the remaining three HCSA subsectors are unavailable.

Table 14. Percent distribution of nonfatal injuries and illnesses involving days away from work by HCSA subsector and industry, and age of worker, 2005

NAICS	Industry	Total cases	16–19 years*	20–24 years*	25–34 years*	35–44 years*	45–54 years*	55–64 years*	65 years and over*
621	Ambulatory healthcare services†	25,390	0.6	7.4	21.4	25.4	26.7	15.8	2.7
6211	Physician offices	5,420	1.1	3.2	15.6	30.0	36.5	11.6	1.9
6212	Dental offices	1,010	—	18.8	13.9	45.5	16.8	—	—
6213	Offices of other health practitioners	900	—	—	18.9	44.4	26.7	7.8	—
6214	Outpatient care centers	4,380	1.1	10.3	21.9	19.6	24.6	16.7	5.5
6216	Home healthcare services	9,660	0.3	5.8	17.2	23.1	29.0	21.7	2.9
6219	Other ambulatory healthcare services	3,180	—	12.9	47.8	18.9	10.7	8.5	1.2
622	Hospitals	62,930	0.8	6.5	18.8	26.7	29.0	16.4	1.7
623	Nursing and residential care facilities	66,620	3.4	12.1	25.1	24.8	22.5	10.1	2.0
624	Social assistance	20,960	1.7	9.8	20.7	21.5	27.0	14.8	4.4
62	Heathcare and social assistance	175,900	1.8	9.2	21.8	25.2	25.9	13.7	2.3
	Total, Private Industry, 16 years and over	**1,234,680**	**3.4**	**10.9**	**23.8**	**25.5**	**23.1**	**11.1**	**2.2**

Source: [BLS 2007a]
*Percent of nonfatal injury and illness cases involving days away from work
†Excludes medical and diagnostic labs (NAICS 6215) where data is unavailable.
Dash (—) indicates data are unavailable.
Because of rounding and data exclusion of nonclassifiable responses, data may not sum to the totals.
NAICS = North American Industry Classification System, U.S. Census Bureau

Data by Selected Occupations. This section focuses on selected healthcare occupational groups, specifically those which experienced the highest number of nonfatal injuries and illnesses involving days away from work in 2005. These include nursing aides, orderlies, and attendants; registered nurses; licensed practical and vocational nurses; home health aides; personal and home care aides; and child care workers.

Tables 15 and 16 display the 2005 percent distribution of nonfatal injuries and illnesses involving days away from work by the sex, race, ethnic origin, and the age group of workers in these six occupations and private industry. Women in these occupations experienced most of the injury and illness burden, representing 84%–98% of the reported cases. With exception of registered nurses, blacks in these occupations also experienced a disproportionately higher number of cases as compared to their counterparts in private industry. Registered nurses represented the only occupational group which experienced a disproportionately higher number of cases for Asian workers as compared to private industry. The percents

Table 15. Percent distribution of nonfatal injuries and illnesses involving days away from work by healthcare occupation, sex, race, and ethnic origin of worker, 2005

Occupation with highest number of cases	Total cases	Women*	Black*	Hispanic*	Asian*
Nursing aides, orderlies, and attendants	52,150	88.8	31.6	8.6	2.1
Registered nurses	20,100	91.8	7.8	3.5	6.6
Licensed practical nurses and licensed vocational nurses	7,190	93.3	17.1	3.7	1.4
Home health aides	7,110	96.0	23.4	11.4	1.0
Personal and home care aides	4,420	84.4	33.2	10.2	—
Child care workers	2,560	86.3	33.9	10.2	—
Total, private industry, 16 years and over	**1,234,680**	**33.7**	**11.8**	**19.0**	**1.5**

Source: [BLS 2006j]
*Percent of nonfatal injury and illness cases involving days away from work
Dash (-) indicates data are unavailable.
Because of rounding and data exclusion of nonclassifiable responses, data may not sum to the totals.

Table 16. Percent distribution of nonfatal injuries and illnesses involving days away from work by healthcare occupation and age of worker, 2005

Occupation with highest number of cases	Total cases	16–19 years*	20–24 years*	25–34 years*	35–44 years*	45–54 years*	55–64 years*	65 years and over*
Nursing aides, orderlies, and attendants	52,150	3.1	15.0	26.7	26.3	19.6	8.2	1.0
Registered nurses	20,100	0.6	2.2	0.7	26.6	34.8	17.2	2.6
Licensed practical nurses and licensed vocational nurses	7,190	0.3	2.8	21.3	27.9	30.5	15.8	1.1
Home health aides	7,110	0.4	8.0	18.5	20.3	30.8	19.2	2.7
Personal and home care aides	4,420	1.4	12.9	15.2	23.9	25.9	16.4	4.3
Child care workers	2,560	2.3	27.7	27.3	16.8	20.3	4.7	1.2
Total, private industry, 16 years and over	**1,234,680**	**3.4**	**10.9**	**23.8**	**25.5**	**23.1**	**11.1**	**2.2**

Source: [BLS 2007b]
*Percent of nonfatal injury and illness cases involving days away from work

for Hispanics in each of the six occupations were less than their counterparts in private industry.

Within each age group, at least one of the six occupations had a percent greater than their counterparts in all occupations in private industry, with the exception of the 16–19 age group (Table 16). The greatest discrepancy was observed for child care workers in the 20–24 age group where the percent was 2.5 times higher for workers in this age group in all private industry occupations. The 45–54 age group represented the highest percent of cases for registered nurses, licensed practical and vocational nurses, home health aides, and personal and home care aides; the 25–34 age group represented the highest for nursing aides, orderlies, and attendants; and the 20–24 age group represented the highest for child care workers.

Fatal Occupational Injuries

In 2005, HCSA accounted for 104 work-related fatalities [BLS 2006a]. Fifty-seven percent of these fatalities involved transportation accidents (mostly highway accidents). Assaults and violent acts accounted for 21% of the fatal occupational injuries within HCSA, with about the same percent of homicides (9.6%) and suicides (11.5%).

In 2005, the incidence rate of fatal work-related injuries in the HCSA sector was 0.7 per 100,000 workers, compared to an incidence rate of 4.3 in private industry (Figure 15) [BLS 2005i]. Among the four subsectors, ambulatory care services and social assistance experienced the highest incidence rate (0.9) and hospitals accounted for the lowest rate (0.4).

Other Key Facts [BLS 2006f,g]

- In 2005, strains and sprains was the leading nature of injury in every major industry sector. HCSA accounted for nearly one in five cases of all sprains and strains.
- In 2005, HCSA accounted for one in five cases of all falls on the same level. Two-thirds of these cases were reported by nursing and residential care facilities and hospitals.
- Nursing aides, orderlies, and attendants experienced the third highest number of injuries and illnesses involving days away from work in 2005 (52,150 cases) among all occupational groups and the highest among healthcare occupations, with the majority (89%) of the cases involving women. Injuries to these workers involved healthcare patients 58% of the time and were due to overexertion for 54% of the cases. The median number of days away from work for this occupation was 5 days.

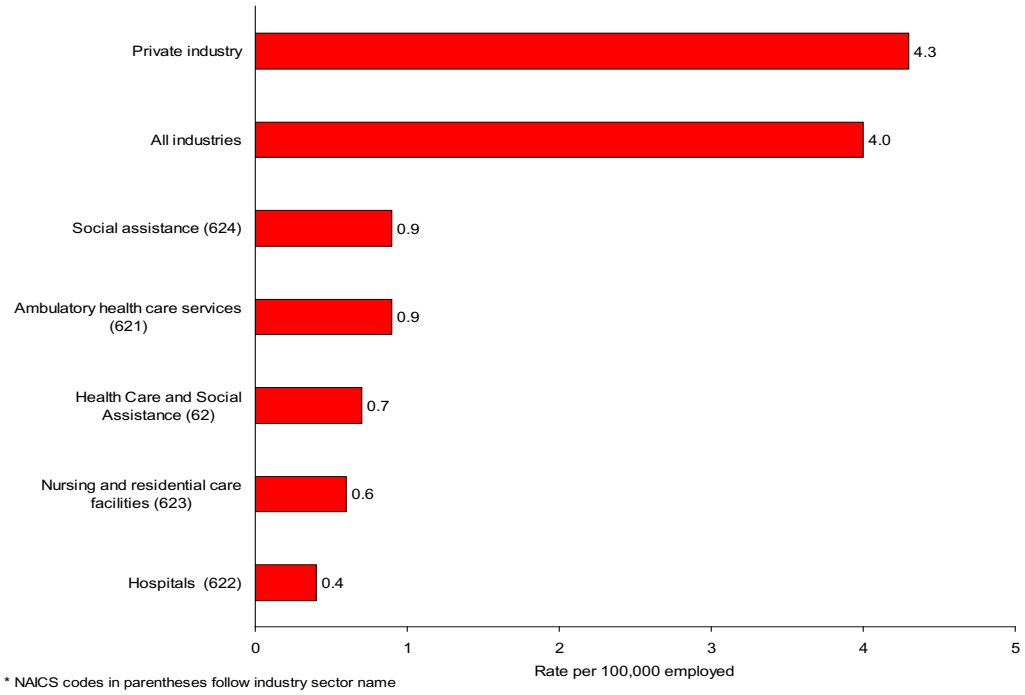


Figure 15. Rate of fatal occupational injuries, healthcare and social assistance sector and private industry, 2005 (Source: [BLS 2005i])

- Registered nurses accounted for the eleventh highest number of injuries and illnesses involving days away from work in 2005 (20,100) among all occupational groups and the second highest among healthcare occupations. The median number of lost workdays for this occupation was 6 days.
- The combined number of injury and illness cases involving days away from work for nursing aides, orderlies, and attendants and registered nurses accounted for over 40% of all injuries and illnesses involving days away from work in 2005 in the HCSA sector.
- The HCSA sector accounted for nearly 20% (n = 72,780) of all work-related MSDs involving days away from work in 2005, leading all industry sectors. This number is equivalent to one case being reported about every 7 minutes. Nursing aides, orderlies, and attendants had the highest number of MSD cases among healthcare occupations (28,920) and the second highest among all occupational groups. Registered nurses had the second highest number of cases among healthcare occupations (9,060) and the eighth highest number among all occupational groups. Home health aides and licensed practical and vocational nurses had the next highest number of MSD cases among healthcare occupations, ranking in the top 25 of all occupations.

- In 2005, two-thirds of personal assaults and violent acts occurred in the HCSA sector.

Workers' Compensation Data

Workers' compensation data can provide a partial estimate of the burden of workplace injuries and illnesses in terms of workers' compensation medical and lost days costs. An example of such data is that maintained by Washington State Department of Labor and Industries. As administrator of this state's exclusive workers' compensation system, this agency maintains data on companies who are either insured by state funds or self-insured.

Summary data are provided in Tables 17, 18, and 19 for years 2001–2005 by subsector and for two selected healthcare industry-related risk classes: agencies who provide home healthcare services (risk class 6511) and temporary staffing agencies who furnish employers with healthcare workers (risk class 7111) [WA L&I 2007]. Table 17 shows number of workers' compensation claims, average cost per claim (both medical and time loss costs), and average number of lost days per claim. Table 18 shows workers' compensation incidence rates by type of injury. Not shown in this table is the close agreement between the overall HCSA sector workers' compensation incidence rate (2.18 per 100 full-time workers) and the Washington State BLS estimates (2.13 per 100 full-time workers). Table 19 shows the average cost per claim and the average number of lost days per claim by injury type.

Reported BLS Cases Underestimate Magnitude of Occupational Injuries and Illnesses

Several studies have shown that the BLS Survey of Occupational Injuries and Illnesses (SOII) fails to capture a large proportion of job-related injuries and illnesses of private sector employers [Rosenman et al. 2006; Leigh et al. 2004; Azaroff et al. 2002]. A recent study of injury and illness reporting in Michigan found that the SOII missed more than two-thirds of job-related injuries and illnesses [Rosenman et al. 2006] while another study estimated that the SOII missed between 33% and 69% of all injuries [Leigh et al. 2004]. Additionally, major changes in OSHA recordkeeping rules in 1995 and 2002 have been shown to correspond directly to substantial declines in the number of SOII recordable injuries and illnesses [Friedman and Forst 2007]. For example, starting in 2002 MSDs were recorded in the "all other illnesses" illness category on OSHA Form 300 which, in effect, lumped MSDs in with all reported illnesses not categorized as skin disorders, respiratory ailments, poisonings, or hearing loss. The change has been perceived by many to obscure the magnitude of MSD cases in the HCSA sector and other industry sectors where MSDs represent a major problem.

Table 17. Washington state workers' compensation: compensable claims, average costs, and lost days for the healthcare and social assistance sector, 2001–2005

2002 NAICS	Industry	Number of claims*	Average cost per claim†	Average lost days per claim‡
621	Ambulatory healthcare	5,558	$30,200	168
622	Hospitals	10,262	$25,100	129
623	Nursing and residential care facilities	7,550	$21,500	145
624	Social assistance	4,120	$24,700	159
—	Agency home care§	112	$19,500	186
—	Temporary worker: healthcare¶	228	$35,900	208

Source: [WA L&I 2007]
*Claim counts include state-funded and self-insured compensable claims only.
†Cost figures adjusted to 2005 (consumer price index urban wage for Seattle-Tacoma-Bremerton); rounded to nearest hundred.
‡Calendar days (rounded to nearest whole number) are based on state-funded experience only. Self-insured reports do not include costs break-down by fund or number of lost time days.
§Washington State Workers' Compensation Risk Class 6511: agencies who provide home healthcare services.
¶Washington State Workers' Compensation Risk Class 7111: temporary staffing agencies who provide providing healthcare services.

Apart from regulatory changes, causes of underreporting of nonfatal injuries and illnesses are many and diverse [Azaroff et al. 2002]. Causes for underreporting by employers include the following: neglect for or lack of knowledge of recordkeeping requirements, negative impact of injury records on management bonuses, control increase of workers' compensation/insurance rates, avoid targeted OSHA inspections, or maintain eligibility for contracts requiring a good safety record. Likewise, workers may not report safety or health problems to their employers for many reasons, such as fear of disciplinary action, not wanting supervisor to think worker was careless, injury too minor to report, unable to afford lost work time, lack of awareness that problem is work-related (particularly true for diseases with long latency periods), injury is considered part of the job (particularly true of healthcare workers), frustration with workers' compensation procedures, or negative impact on company goal of a perfect safety record (especially when reinforced by incentive programs that inadvertently result in peer pressure and are perceived to offer large rewards for not reporting injuries).

Compared to injuries and illnesses, underreporting of work-related fatalities is not considered a problem because the CFOI is a complete census that collects data from multiple data sources.

Table 18. Washington state workers' compensation: comparison of state funded and self-insured incidence rates[*] by injury type[†] for the healthcare and social assistance sector, 2001–2005

Liability	2002 NAICS	Industry	WMSDs[‡]	Struck[§]	Falls same level	WMSDs[‡] lower limb	Falls from elevation	Overexertion (excluding WMSDs[‡])	Toxics (chemical and infectious agents)	Vehicles
Self-Insured	621	Ambulatory Healthcare	2.47	0.33	0.28	0.30	0.06	0.14	0.18	0.07
	622	Hospitals	1.58	0.27	0.23	0.23	0.04	0.09	0.06	0.02
	623	Nursing and residential care facilities	2.78	0.61	0.54	0.54	0.08	0.19	0.07	0.01
	624	Social Assistance	0.93	0.53	0.18	0.18	0.11	0.11	0.04	0.00
State Funded	621	Ambulatory Healthcare	0.52	0.08	0.10	0.10	0.05	0.02	0.01	0.03
	622	Hospitals	0.96	1.04	0.26	0.26	0.05	0.04	0.02	0.00
	623	Nursing and residential care facilities	2.26	0.61	0.45	0.45	0.08	0.09	0.03	0.02
	624	Social Assistance	0.72	0.20	0.25	0.25	0.09	0.03	0.01	0.05
State Funded	NA	Agency homecare[¶]	1.19	0.06	0.26	0.26	0.04	0.06	0.02	0.17
	NA	Temporary worker: healthcare[**]	1.38	0.25	0.14	0.14	0.05	0.07	0.05	0.03
Percent of total compensable claims			**54.4**	**13.2**	**10.5**	**6.7**	**2.7**	**2.6**	**1.6**	**1.4**

Source: [WA L&I 2007]

[*]Incidence rates are per 100 full-time workers, with highest value for each injury type in bold.

[†]Does not include the following injury types: caught by/in; temperature, abraded, electrical, shot, or exploded. Each represented less than 1% of total claims.

[‡]Work-related musculoskeletal disorders.

[§]Primary sources include other persons (assaults) or needles (i.e., needlesticks).

[¶]Represents Washington State Workers' Compensation Risk Class 6511 – Agencies who provide home healthcare services.

[**]Represents Washington State Workers' Compensation Risk Class 7111—Temporary staffing agencies who provide healthcare services.

Bold denotes highest incidence rate for each injury type.

Table 19. Washington state workers' compensation: average costs[*] and lost days[†] per compensable claim by injury type[‡] for the healthcare and social assistance sector, 2001–2005

2002 NAICS	Industry	WMSDs[§] (upper extremity)	Struck[¶]	Falls (same level)	WMSDs[§] (lower extremity)	Falls (from elevation)	Overexertion (excluding WMSDs[§])	Toxics (infectious and chemical agents)	Vehicles
621	Ambulatory healthcare	$31,500 184	$24,500 148	$32,500 167	$24,400 117	$35,900 162	$17,200 93	$7,600 37	$38,200 159
622	Hospitals	$23,700 133	$26,800 136	$30,800 126	$18,700 91	$20,700 106	$17,500 121	$7,000 67	$2,700 22
623	Nursing and residential care facilities	$22,000 155	$21,800 142	$22,700 144	$20,200 131	$24,400 138	$9,800 73	$13,700 108	$34,300 140
624	Social assistance	$26,100 185	$20,800 125	$26,900 161	$16,800 124	$32,500 192	$13,700 71	$8,900 34	$32,700 142
NA	Agency home care[**]	$17,900 159	$47,100 594	$33,400 278	$15,600 136	$13,400 178	$1,500 43	$30,200 409	$19,200 222
NA	Temporary worker: healthcare[††]	$39,600 219	$36,700 225	$47,500 285	$32,700 247	$7,400 52	$31,600 168	$4,200 35	$10,000 140

Source: [WA L&I 2007]

[*]Average costs per claim adjusted to 2005 (consumer price index urban wage for Seattle-Tacoma-Bremerton); rounded to nearest hundred.

[†]Calendar days rounded to nearest whole number

[‡]Does not include the following injury types: caught by/in; temperature, abrasion, electrical, shot, or exploded. Each represented less than 1% of total compensable claims.

[§]Work-related musculoskeletal disorders

[¶]Primary sources include other persons (assaults) or needles (i.e., needlesticks).

[**]Represents Washington State Workers' Compensation Risk Class 6511: agencies who provide home healthcare services

[††]Represents Washington State Workers' Compensation Risk Class 7111: temporary staffing agencies who provide healthcare services

Mortality Data

Death certificate data from the NOMS (National Occupational Mortality Surveillance) System, with multiple cause-of-death, coded usual or lifetime occupation, and industry information, were used to assess whether any associations exist between cause-specific mortality and occupation and industry. For this surveillance system 28 states have provided coded data from 1984 through 1998 and multiple-cause analysis was conducted. The measure of association used most often was the proportionate mortality ratio (PMR), defined as the ratio of the proportion of deaths due to a specific cause for a specified occupation or industry during a

specified time period divided by the proportion of deaths due to that cause for all deaths during the same period, multiplied by 100. A PMR is considered to be significantly elevated when its value is greater than 100 and the lower 95% confidence interval (CI) exceeds 100. A significantly elevated PMR suggests that more deaths than expected are associated with a given cause of death in a specified occupation or industry. PMRs should be interpreted as flags or indicators that describe gaps, trends, and elevated risks for serious, acute, and chronic disease and fatal injuries. The NOMS system is available on the Web as an interactive query system for access to calculated PMRs by occupation or industry [NIOSH 2008a].

NOMS data were analyzed to produce mortality estimates for each of the four HCSA industry subsectors and for 18 major healthcare occupations. PMRs for the top ten causes of death (i.e., most highly and significantly elevated causes of death), excluding those associated with small numbers of deaths, are reported in Tables 20 and 21.

Table 21 presents significantly elevated PMRs for the top 10 causes of death in each of the four HCSA subsectors [NIOSH 2008b]. Three causes of death (AIDS; non-A, non-B viral hepatitis; and various cancers) were observed in all four subsectors. Drug-related deaths were observed in three healthcare subsectors. The following causes of death were observed in two of the subsectors: viral hepatitis B (ambulatory healthcare services and hospitals), sarcoidosis (hospitals and social assistance), and malignant melanoma of the skin and polyarteritis nodosa and allied conditions (ambulatory healthcare services and social assistance). Of the top 10 causes of death in ambulatory healthcare services, those unique to this subsector included air and space transport accidents, other lung diseases due to external agents, and myoneural disorders. Of the top 10 causes of death in hospitals, those unique to this subsector included asthma, disorders of the peripheral nervous system, diffuse diseases of connective tissue, and acute myeloid leukemia. Of the top 10 causes of death in nursing and residential care facilities, those unique to this subsector included accidents caused by nature; diabetes mellitus; endocrine, nutritional, metabolic and immunity disorders; and motor vehicle traffic accidents. Of the top 10 causes of death in social assistance, those unique to this subsector included neurotic and personality disorders, mental disorders associated with solvent exposure, and infectious and parasitic diseases.

Table 21 presents the top three significantly elevated PMRs for each of the 18 major healthcare occupations [NIOSH 2008c]. Infectious diseases (AIDS, hepatitis) were among the top three significantly elevated PMRs for 11 of the 18 occupations with AIDS being the most prevalent, accounting for thousands of deaths. Several cancers (small intestine, female genital organs, pancreas, bone, and Hodgkin's disease) were also among the top three significantly elevated PMRs for 11 of the 18

Table 20. Top ten significantly elevated PMRs by HCSA industry subsector, 1984–1998

NAICS	CIC	Industry	Cause of death (ICD-9 code(s))A	PMRB	No. of deaths	95% CI LCL, UCL
621	**812, 820–822, 830, 840**	**Ambulatory healthcare services**	Air and space transport accidents (840–845)	380†	97	308, 464
			Other lung diseases due to external agents, excluding inhalation (506, 5071–508)	219†	37	154, 302
			Viral hepatitis B (0701, 0703)	186†	69	144, 235
			(AIDS) Human immunodeficiency virus infection (042–044)	176†	940	165, 187
			Non-A, non-B viral hepatitis (0704–0709)	159†	103	130, 193
			Myoneural disorders (358)	155†	53	116, 203
			Polyarteritis nodosa and allied conditions (446)	147†	97	120, 180
			Hodgkin's disease (201)	145†	127	121, 172
			Drug-related deaths (292,304,3052–3059, 850–858,9500–9505,9620,9800–9805)	143†	760	134, 154
			Malignant melanoma of skin (172)	142†	418	129, 156
622	**831**	**Hospitals**	(AIDS) Human immunodeficiency virus infection (042–044)	163†	2,875	158, 167
			Sarcoidosis (135)	149†	269	132, 169
			Viral hepatitis B (0701, 0703)	145†	155	123, 169
			Non-A, non-B viral hepatitis (0704–0709)	121†	231	106, 137
			Drug-related deaths (292,304,3052–3059, 850–858,9500–9505,9620,9800–9805)	119†	1,760	114, 124
			Cancer of small intestine, including duodenum (152)	119†	147	101, 140
			Asthma (493)	118†	1,575	113, 123
			Disorders of the peripheral nervous system (350–357)	118*	249	104, 134
			Diffuse diseases of connective tissue (710)	115*	927	108, 123
			Acute myeloid leukemia (205)	114†	681	105, 123
623	**832, 870**	**Nursing and residential care facilities**	Accidents caused by storms, floods, and earth eruption (908–909)	209‡	10	100, 384
			Human immunodeficiency virus infection (AIDS) (042–044)	148§	945	139, 158
			Cancer of unspecified female genital organs (184)	141§	83	112, 175

See footnotes at end of table.

Continued

Table 20 (Continued). Top ten significantly elevated PMRs by HCSA industry subsector, 1984–1998

NAICS	CIC	Industry	Cause of death (ICD-9 code(s))*	PMR†	No. of deaths	95% CI LCL, UCL
			Non–A, non–B viral hepatitis (0704–0709)	135‡	74	106, 170
			Cancer of cervix uteri (180)	123§	440	111, 135
			Diabetes mellitus (250)	118§	5,700	115, 120
			Drug-related deaths (292,304,3052–3059, 850–858,9500–9505,9620,9800–9805)	113§	550	103, 122
			Endocrine, nutritional, metabolic and immunity disorders (240–279)	111§	8,080	109, 114
			Motor vehicle traffic accidents (810–819)	110§	1,352	105, 115
			Cancer of pancreas (157)	109‡	790	102, 117
624	**871**	**Social assistance**	Non-A, non-B viral hepatitis (0704–0709)	190§	42	137, 257
			Human immunodeficiency virus infection (AIDS) (042–044)	186§	514	170, 202
			Neurotic and personality disorders (300–301)	171‡	27	113, 249
			Sarcoidosis (135)	163§	35	114, 227
			Polyarteritis nodosa and allied conditions (446)	153‡	30	103, 219
			Malignant melanoma of skin (172)	143§	108	117, 172
			Mental disorders associated with solvent exposures (296–297, 300–301, 3483)	136§	85	109, 169
			Lymphoid leukemia (204)	127‡	78	100, 159
			Cancer of bone, connective tissue, skin and breast (170–175)	122§	1,263	117, 172
			infectious and parasitic diseases (001–139)	120§	1,716	115, 125

Source: [NIOSH 2008b]

*Multiple cause proportionate mortality ratio (PMR) analysis was conducted using the 9th revision of the International Classification of Diseases (ICD-9) to code cause of death.

†The PMR is defined as the ratio of the age-adjusted proportion of deaths from a specific cause of death for a particular occupation or industry during a specified time period compared to the proportion of that cause among all industries or occupations during the same period, multiplied by 100. To test for statistical significance, two-sided 95% confidence intervals (95% CI) are calculated, based on the Poisson distribution for observed deaths, and using the normal approximation to the Poisson for large numbers. A statistically significantly elevated PMR must be interpreted as a flag that suggests elevated risk that should be further evaluated for confounding factors.

‡ = $p < 0.05$; § = $p < 0.01$

Table 21. Top three significantly elevated PMRs for largest healthcare occupations, 1984–1998

Occupation	COC code(s)	Total employed (in thousands)	Cause of death (ICD-9 code(s))[§]	PMR[†]	No. of deaths	95% CI LCL, UCL
Registered nurses	095	2,529	Air and space transport accidents (840–845)	211[¶]	28	140, 305
			Viral hepatitis B (0701, 0703)	192[¶]	58	146, 248
			(AIDS) Human immunodeficiency virus infection (042–044)	180[¶]	587	166, 195
Health aides, except nursing	447	1,906[‡]	Myoneural disorders (358)	245[¶]	8	106, 483
			Hodgkin's disease (201)	216[¶]	21	134, 330
			(AIDS) Human immunodeficiency virus infection (042–044)	154[¶]	139	130, 182
Nursing aides, orderlies, and attendants	446	1,906[‡]	(AIDS) Human immunodeficiency virus infection (042–044)	172[¶]	1416	166, 178
			Non-A, non-B viral hepatitis (0704–0709)	171[¶]	120	142, 205
			Viral hepatitis B (0701, 0703)	152[¶]	60	116, 196
Child care workers	406, 468	1,401	Systemic sclerosis (7101)	154*	27	102, 224
			Lymphatic cancer and multiple myeloma (202–203)	123[¶]	223	108, 140
			Cancer of ovary and other uterine adnexa (183)	120*	207	104, 138
Physicians	084	863	Air and space transport accidents (840–845)	942[¶]	65	727, 1201
			Viral hepatitis B (0701, 0703)	304[¶]	28	202, 439
			Drug-related deaths (292, 304, 3052–3059, 850–858, 9500–9505, 9620, 9800–9805)	300[¶]	241	263, 340
Personal service occupations, n.e.c. (includes personal and home care aides)	469	703	(AIDS) Human immunodeficiency virus infection (042–044)	199[¶]	129	166, 236
			Chronic myeloid leukemia (2051)	171[§]	20	105, 264
			Cancer of urinary organs (188, 1893–1899)	144[¶]	73	113, 181
Licensed practical nurses (LPNs)	207	556 (includes licensed vocational nurses)	Sarcoidosis (135)	161[§]	34	112, 226
			Drug-related deaths (292, 304, 3052–3059, 850–858, 9500–9505, 9620, 9800–9805)	146[¶]	226	127, 166
			(AIDS) Human immunodeficiency virus infection (042–044)	146[¶]	174	126, 170

See notes at end of table.

(Continued)

Table 21 (Continued). Top three significantly elevated PMRs for largest healthcare occupations, 1984–1998

Occupation	COC code(s)	Total employed (in thousands)	Cause of death (ICD-9 code(s))*	PMR†	No. of deaths	95% CI LCL, UCL
Health diagnosing practitioners	089	425	Anterior horn cell disease including motor neurone disease (335)	333¶	13	177, 569
			Asthma (493)	218§	13	116, 373
			Cancer of brain and nervous system (191–192)	201¶	22	126, 305
Clinical laboratory technologists and technicians	203	321	Viral hepatitis B (0701, 0703)	348¶	18	206, 550
			Toxic encephalopathy (3483)	192¶	24	123, 285
			Sarcoidosis (135)	191§	15	107, 315
Dental assistants	445	274	Hodgkin's disease (201)	264¶	11	132, 472
			Human immunodeficiency virus infection (AIDS) (042–044)	163§	28	109, 236
			Alzheimer's disease (290, 3310, 3311)	155¶	125	129, 184
Pharmacists	096	245	Drug-related deaths (292, 304, 3052–3059, 850–858, 9500–9505, 9620, 9800–9805)	242¶	90	194, 297
			Cancer of ovary and other uterine adnexa (183)	179¶	30	121, 255
			Cancer of brain and nervous system (191–192)	165¶	79	130, 205
Physical therapists	103	198	(AIDS) Human immunodeficiency virus infection (042–044)	200¶	35	140, 279
			Cancer of bone, connective tissue, skin and breast (170–175)	179¶	26	117, 262
			Non-Hodgkin's lymphomas (200, 2020–2022, 2028, 2029)	151¶	100	123,184
Dentists	085	196	Air and space transport accidents (840–845)	643¶	15	360,1060
			Disorders of the peripheral nervous system (350–357)	218¶	15	122, 359
			Chronic myeloid leukemia (2051)	213¶	17	124, 342
Radiologic technicians	206	182	Tuberculosis (010–018, 137)	307§	12	159, 537
			(AIDS) Human immunodeficiency virus infection (042–044)	216¶	73	170, 272
			Accidental poisonings (850–869, 9292)	168§	25	109, 248

See notes at end of table.

(Continued)

Table 21 (Continued). Top three significantly elevated PMRs for largest healthcare occupations, 1984–1998

Occupation	COC code(s)	Total employed (in thousands)	Cause of death (ICD-9 code(s))*	PMR†	No. of deaths	95% CI LCL, UCL
Emergency medical technicians (EMTs), paramedics and other technologists	208	156 (EMTs alone)	(AIDS) Human mmunodeficiency virus infection (042–044)	168¶	199	146, 194
			Infectious and parasitic diseases (001–139)	124¶	514	113, 136
			Alzheimer's disease (290, 3310, 3311)	124§	99	101, 151
Dental hygienists	204	144	Accidental falls (880–888, 9293)	174§	19	105, 272
			Cancer of ovary and other uterine adnexa (183)	167§	26	109, 244
			Cancer neoplasm of breast (174, 175)	156¶	92	126, 191
Speech therapists (speech language pathologists)	104	114	Mental disorders associated with solvent exposures (296-297, 300-301, 3483)	360§	6	132, 783
			Multiple sclerosis and other demyelinating diseases of central nervous system (340-341)	279§	6	102, 607
			Cancer of brain and nervous system (191-192)	209§	11	104, 373
Health record technicians	205	98	(AIDS) Human immunodeficiency virus infection (042-044)	213¶	27	140, 310
			Lymphatic cancer and multiple myeloma (202-203)	164§	31	112, 233
			Mental disorders related to substance abuse (291-292, 303-305)	148§	33	102, 208

Source: [NIOSH 2008c]

*Multiple cause proportionate mortality ration (PMR) analysis was conducted using the 9th revision of the International Classification of Diseases (ICD-9) to code cause of death.

†The PMR is defined as the ratio of the age-adjusted proportion of deaths from a specific cause of death for a particular occupation or industry during a specified time period compared to the proportion of that cause among all industries or occupations during the same period, multiplied by 100. To test for statistical significance, two-sided 95% confidence intervals (95% CI) are calculated, based on the Poisson distribution for observed deaths, and using the normal approximation to the Poisson for large numbers. A statistically significantly elevated PMR must be interpreted as a flag that suggests elevated risk that should be further evaluated for confounding factors.

‡The two occupations: Health Aides (except nursing) and Nursing Aides, Orderlies and Attendants employ 1,906 workers combined. Separate employment figures were unavailable.

§= $p < 0.05$

¶= $p < 0.01$

occupations. Other causes that were observed in more than one occupation included lymphatic cancer and multiple myeloma, drug-related deaths, air and space transport accidents, sarcoidosis, and mental disorders.

Infectious Disease Data

Sharps Injuries. Two surveillance programs have been developed to measure sharps injuries among healthcare workers: the Exposure Prevention Information Network (EPINet) at the University of Virginia (www.healthsystem.virginia.edu/internet/ epinet/about_epinet.cfm) and the CDC's National Surveillance System for Healthcare Workers (NaSH) (www.cdc.gov/ncidod/dhqp/nash.html). Characteristics of these two systems and data derived from them are shown in Table 22. Data from EPINet and NASH, adjusted for underreporting, have been used to estimate that 384,325 percutaneous injuries are sustained annually by hospital-based healthcare personnel [Panlilio et al. 2004]. Since almost half of U.S. healthcare workers work outside of hospitals, as many as 600,000 to 800,000 sharps injuries (Table 23) may occur annually among all healthcare workers, but little data is available about the occurrence of sharps injuries in out-patient settings [NIOSH 2000]. A few states, including Massachusetts and California, have also developed their own sharps injury surveillance systems. Based on data from these surveillance systems, it is known that most sharps injuries are associated with hypodermic syringes or other hollow-bore needles; most reported sharps injuries occur in nursing, medical, or laboratory staff, but housekeepers and other healthcare workers are also at risk (Table 22) [Perry et al. 2005; CDC 2000; Laramie et al. 2007; Cone 2008].

Although sharps injuries among healthcare workers are a common occurrence, fortunately they rarely lead to infection with bloodborne pathogens (Table 23) [NIOSH 2000; Luckhaupt 2007; DoAN et al. 2003]. Using mathematical modeling, the World Health Organization estimated the incidence of infections attributable to percutaneous injuries and concluded that 39% of HCV, 37% of HBV, and 4.4% of HIV infections acquired among healthcare workers worldwide in 2000 were attributable to occupational exposure via sharps injuries. The occupational attributable fractions for the U.S. were estimated to be substantially lower: 8%, 1%, and 0.5% for HCV, HBV, and HIV respectively. The probability of acquiring an infection depends on the prevalence of infection among the patient population, the probability of healthcare worker exposure, the probability of infection occurring after exposure, and the proportion of healthcare workers that are susceptible to infection [Pruss-Usten et al. 2005]. Sepkowitz and Eisenberg estimated annual death rates for U.S. healthcare workers from occupational events to be 17–57 per 1 million workers. They attributed more than half of these deaths (between 80 and 260 total deaths in 2002) to infection, 75–250 deaths from HBV, and 5–10 deaths

Table 22. Sharps injury (SI) surveillance data from four sources

Characteristic	EPINet data sharing network*	NaSH†	Massachusetts‡	California§
Number of sites	48 hospitals	26 hospitals	99 hospitals	316 (of >3,000 licensed acute care hospitals, home healthcare agencies, and skilled nursing facilities)
Most recent published data	2003	Summary report for June 1995–July 1999	2004	1998-1999
# of SIs/year reported	1,728	1,380 (avg.)	3,279	976 (avg.)
Rate of SIs in most recent year available	23.87 SIs/100 occupied beds		18.3/100 licensed hospital beds	—
Occupations associated with injuries	37.9% nurses 22.1% physicians 9.0% surgery attendant 5.4% phlebotomist/ venipuncture/IV team 2.4% clinical lab worker	44% nurses 30% physicians 13% technicians	39% nurses 33% physicians 20% technicians (includes surgical, phlebotomists, clinical lab)	49% nurses 9% physicians 10% technologists 9% aides, orderlies, and nursing assistants 8% phlebotomists
Devices associated with injuries	32% disposable syringe 21% suture needle	34% syringe 16% suture needle 13% butterfly needle	31% hypodermic needle 22% suture needle (56% hollow bore needle: hypodermic, butterfly, vacuum tube, other)	32% disposable needle/syringe 8% suture needle 7% butterfly needle
% injuries with safety devices	32%	4.3% (196/4569)	33%	—

Sources: *[Perry et al 2005] and [Panlilio et al 2004]; †[CDC 2000]; ‡Laramie et al 2007]; §[Cone 2008]

Table 23. Frequency estimates for sharps injuries and related occupationally acquired health outcomes of healthcare workers, 1998

Health outcome	Estimated number
Sharps injuries	600,000–800,000
Occupationally acquired hepatitis B infection	461
Occupationally acquired acute hepatitis B	132
Occupationally acquired acute hepatitis C	70
Occupationally acquired HIV	1

Sources: [NIOSH 2000]; [Luckhaupt 2007]; [DoAN et al 2003]

from HIV, HCV, and tuberculosis combined. Their estimates were based on reported rates of needlestick injuries, infection prevalence among patients, reported infections among healthcare workers, and the risk of dying from infections once acquired [Sepkowitz and Eisenberg 2005].

Human Immunodeficiency Virus (HIV). The average risk of HIV transmission after a percutaneous exposure from a known positive source is estimated to be 0.3%. Risk factors for transmission include exposure to a large quantity of blood from the source person (e.g., device visibly contaminated with patient's blood, procedure involving a needle being placed directly into a vein or artery, or deep injury), exposure to blood from a source person with terminal illness, hollow-bore needles, and immunologic factors in the exposed worker [CDC 2001].

Data on HIV infection and AIDS among healthcare workers have been collected by the CDC through the HIV/AIDS Reporting System and the National Surveillance for Occupationally Acquired HIV Infection System [CDC 2006a]. Healthcare personnel with HIV/AIDS who are reported without any known risk for HIV infection are investigated by state and local health departments using the following case definitions. Documented cases of occupationally acquired HIV/AIDS are those in which HIV seroconversion is temporally related to an exposure to an HIV-positive source and in which the exposed worker has no nonoccupational risk factors for acquisition of HIV (e.g., male homosexual-bisexual contact or IV drug use). Possible cases of occupationally acquired HIV/AIDS are those in which a worker is found to be HIV positive, has no nonoccupational risk factors for HIV/AIDS, and has opportunities for occupational exposure to blood, body fluids, or HIV-positive laboratory material. More than 90% of healthcare personnel infected

Table 24. Occupations of healthcare workers with documented and possible occupationally acquired HIV infection, 1981–2006

Occupation	Documented	Possible
Nurse	24	35
Laboratory technician, clinical	16	17
Physician, nonsurgical	6	12
Laboratory technician, nonclinical	3	-
Housekeeper/maintenance workers	2	13
Technician, surgical	2	2
Embalmer/morgue technician	1	2
Health aide/attendant	1	15
Respiratory therapist	1	2
Technician, dialysis	1	3
Dental worker, including dentist	—	6
Emergency medical technician, paramedic	—	12
Physician, surgical	—	6
Other technician/therapist	—	9
Other healthcare occupation	—	6
Total	**57**	**140**

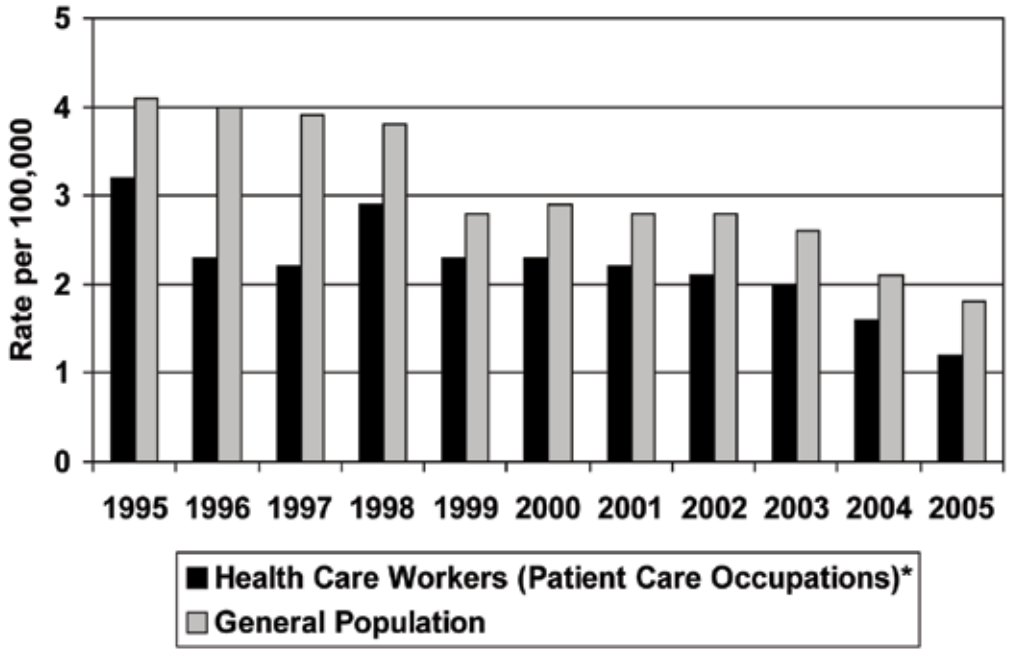
Source: [DoAN et al. 2003]
Dash (-) indicates no documented cases

with HIV have reported nonoccupational risk factors for acquiring their infection. Between 1981 and 2006, the CDC received reports of 57 documented cases and 140 possible cases of occupationally acquired HIV in U.S. healthcare workers (Table 24). Thirty-one (54%) of the implicated exposures occurred prior to 1991. Eight of the documented HIV cases occurred despite antiviral post-exposure prophylaxis (PEP). No documented occupationally acquired cases of HIV infection have been reported since 1999, and the most recent possible case of occupationally acquired HIV was reported in 2000.

Hepatitis B Virus (HBV). CDC estimated an incidence of 17,000 HBV infections per year among healthcare workers in 1983, which declined to approximately 400 in 1995 after widespread immunization of healthcare workers, implementation of universal precautions, and adoption of the OSHA bloodborne pathogens standard. In 1983, the estimated incidence of HBV infections among healthcare

workers was three times higher than the incidence in the general U.S. population (386 per 100,000 vs. 122 per 100,000). By 1995, however, the estimated incidence of HBV infections among healthcare workers was more than five times lower than the incidence in the general U.S. population (9.1 per 100,000 vs. 50 per 100,000) [Mahoney et al. 1997]. The CDC's Division of Viral Hepatitis estimates that 139 cases of acute HBV were occupationally acquired in 1995 (3.2 per 100,000 healthcare workers in patient care occupations), which declined to 87 in 2004 (1.6 per 100,000 workers) (Figure 16) [Luckhaupt 2007; BLS 2006b].

Hepatitis C Virus (HCV). From 1999 through 2004 the percentage of patients with acute hepatitis C who reported being healthcare workers averaged about 2% (1%–4%). This increased to 7.2% in 2005. It is unknown what proportion of these cases were occupationally acquired [CDC 2007]. It has been estimated that percutaneous exposure leads to 50–150 transmissions of HCV among healthcare workers annually, assuming that hospitalized patients have the same HCV seroprevalence as the rest of the U.S. population [Sepkowitz and Eisenberg 2005]. Seroprevalence studies of HCV in healthcare workers suggest minimally increased risk compared with the general population [Henderson 2003].



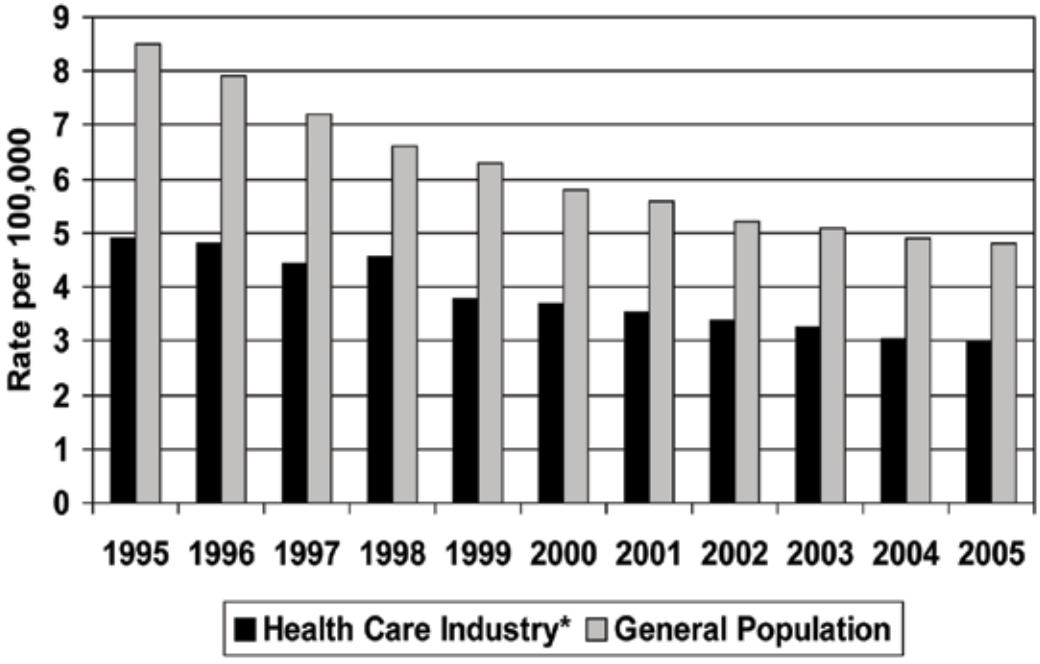
*Patient care occupations include physicians, dentists, nurses, physicians' assistants, and health technologists and technicians

Figure 16. Incidence of acute hepatitis B among healthcare workers, 1995–2005 (Sources: [Luckhaupt 2007]; [CDC 2007]; [BLS 2006b])

Tuberculosis (TB). The TB incidence in healthcare workers declined from 4.9 per 100,000 workers in the healthcare industry in 1994 to 3.0 in 2005 (Figure 17) [BLS 2006b; CDC 2006b,c]. In 2005, 3.1% (420) of nationally reported TB cases for whom occupational information was available occurred among healthcare workers [CDC 2006c].

The prevalence of TB among healthcare workers in 2006 (3.2 per 100,000 population) was higher than the prevalence of TB among healthcare workers in 2005 (3.1 per 100,000 population), and the prevalence has been slightly increasing since 2001. The risk of occupational acquisition of tuberculosis among healthcare personnel has increased due to the emergence of multidrug-resistant (MDR) and extensively drug resistant (XDR) TB and the need to hospitalize patients not responding to traditional outpatient antibiotic regimens. Even though the incidence of TB is decreasing in the U.S. population, healthcare personnel remain at risk without careful adherence to engineering and administrative controls [Rosenstock et al. 2006; Maloney et al. 1995].

Other. A recent review found published case reports of occupationally acquired bloodborne infections for a total of 60 pathogens or species: 26 viruses, 18 bacteria/rickettsia, 13 parasites, and 3 yeasts [Tarantola et al. 2006].



*Healthcare industry includes hospitals and nonhospital health services

Figure 17. Incidence of tuberculosis among healthcare workers, 1995–2005 (Sources: [CDC 2006a]; [CDC 2006b]; [BLS 2006b])

Recommendations

A more comprehensive system for tracking nonfatal work-related injuries and illnesses that is not solely dependent on employer-based data sources is needed to provide more accurate estimates of the magnitude of nonfatal work-related injuries and illnesses. Other sources of such data may include workers' compensation data, OSHA's Integrated Information and Management System, and various physician reporting systems. This recommendation represents a repeated call for use of multiple data sources [Rosenman et al. 2006; Azaroff et al. 2002; NIOSH 2001].

A national approach is needed which focuses on the collection of data on prospective or leading indicators for improved surveillance of work-related hazards, injuries, and disease.

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Section II

Issues Associated with Many Health and Safety Problems

Chapter 4 ▪ Nursing Shortage, Retention, and Burnout

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Melissa Leone, RN, BSN, Apria Healthcare

Issue

As the largest healthcare occupation, registered nurses (RNs) held about 2.4 million jobs in 2004 [BLS 2006]. Job opportunities for nurses in all specialties are expected to grow much faster than average for all occupations through 2014, creating the second largest number of new jobs among all occupations [BLS 2006]. Thousands of job openings will also result from the need to replace experienced nurses who leave nursing, especially as the median age of the registered nurse population continues to rise. Even still, employers in some parts of the country and in certain employment settings are reporting difficulty in attracting and retaining adequate numbers of nurses, primarily because of an aging workforce, lack of younger workers to fill positions, limited capacity to train new recruits, and high rates of turnover attributed to high rates of job dissatisfaction [USDHHS 2007; GAO 2001; Buerhaus 2002]. A recent survey by the American Hospital Association (2006) reported vacancy rates of 8.5%, 7.6%, and 7.3% among registered nurses, nurses aides, and licensed practical nurses, respectively. Furthermore, hospitals are reporting considerable difficulty in recruitment of all categories of healthcare workers with registered nurses at the top of the list (Figure 18) [AHA 2006]. These shortages have important implications for worker safety, patient safety, and the healthcare industry as a whole.

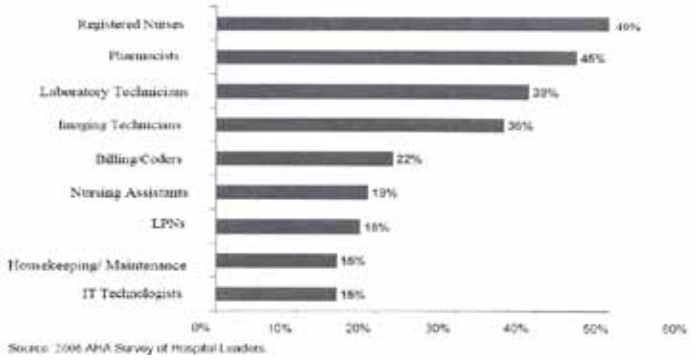

Figure 18. Percent of hospitals reporting recruitment more difficult in 2005 vs. 2004 (Source: [AHA 2006]).

Risks

Nurses provide numerous healthcare services in a variety of work environments that often are potentially hazardous. The nature of the work requires sophisticated technical skill, vigilance, and judgment often working long hours under intense conditions and considerable pressure. Most nurses work as staff nurses; however, some choose to become advanced practice nurses, nurse anesthetists, nurse midwives, nurse practitioners, case managers, forensics nurses, infection control nurses, nurse administrators, nurse educators, and clinical nurse specialists. While most nurses work in healthcare facilities such as hospitals or nursing homes, nonhospital settings such as home healthcare, public health, schools, community centers, and workplaces provide other work venues. While some job tasks (e.g., wound care, lifting) may be common across settings, each work environment also involved tasks that present specific risks.

Nurses are exposed to numerous hazards including biological, chemical, enviromechanical, physical, and psychosocial hazards. Exposure to biological agents and infectious diseases occur through inhalation, ingestion, or direct or indirect contact. A significant exposure route for bloodborne pathogens is via needlestick injuries with an estimated 385,000 percutaneous injuries annually [Panlilio et al. 2004]. Nurses may be exposed to more than 20 pathogens, which the most commonly transmitted are HBV, HCV, and HIV [Bell 1997; Collins 1987; Pike 1976; Shapiro 1995; Wagner 2004]. Also of significant concern is exposure to emerging infectious disease agents such as multidrug-resistant pathogens (e.g., staphylococcus, enterococcus, and tubercle bacillus) and from a potential influenza A (H5N1) pandemic. Chemical exposure from medications such as antineoplastic agents and other substances, including disinfectants, sterilants, latex, and anesthetics, pose significant threats [Rogers 1997; NIOSH Alert 2003; IARC 2004]. Enviromechanical factors including heavy lifting and awkward postures can result in falls, lacerations, and disabling musculoskeletal injuries [BLS 2003]. Studies have indicated that nurses working for at least one year reported neck problems (45.8%), shoulder problems (35.1%), and back problems (47%) [Trinkoff et al. 2002], and that nearly 80% of nurses experience low back pain during the course of their working life [Hignett 1996]. Radiation exposure has been linked to cancer and reproductive toxicity, and eye and skin damage can result from laser exposure. Psychosocial factors such as organizational climate including interpersonal conflicts, caring for patients and their worried or grieving families, shift work, personal issues, and work-related violence can result in enormous amounts of stress leading to burnout, job turnover, and ultimately leaving the profession.

Research

Recruitment, retention, and burnout are significant issues in nursing. An American Nurses Association (ANA) Health and Safety Survey (2001) revealed that 88% of nurses reported that health and safety concerns influence their decision to remain in nursing and the kind of nursing work they choose to perform [ANA 2001]. More than 70% said the acute and chronic effects of stress and overwork were among their top three health concerns, with more than two-thirds reporting they work some type of mandatory overtime every month. In addition, nurses cited a disabling back injury (60%), followed by fear of contracting HIV or hepatitis from a needlestick injury (45%), as also being among their top three health and safety concerns. The survey further revealed that fewer than 20% of respondents felt safe in their current work environment. Seventeen percent had been physically assaulted in the past year, and more than half were threatened or experienced verbal abuse (www.nursingworld.org/surveys/hssurvey.htm).

Buerhaus et al. [2005] found that more than 75% of RNs believe the nursing shortage presents a major problem for the quality of their work life, the quality of patient care, and the amount of time nurses can spend with patients. Looking forward, almost all nurses surveyed see the shortage in the future as a catalyst for increasing stress on nurses (98%), lowering patient care quality (93%), and causing nurses to leave the profession (93%). In a report by the Bernard Hodes Group [2006], 55% of nurses surveyed reported their intention to retire between 2011 and 2020. A Canadian study further documented that a "high proportion of nursing graduates are reporting severe burnout less than 2 years into their jobs—primarily because of crushing workloads" [Laschinger et al 2006]. The author surveyed 225 junior hospital nurses working across Ontario, and they found that 66% were experiencing "symptoms of burnout, including emotional exhaustion and depression," up from 58% from earlier studies.

Aiken et al. [2002] reported on a large research study of 10,000 nurses and 230,000 patients from 168 hospitals in Pennsylvania from 1998–1999. This study examined if correlations exist between nurse/patient ratios and patient mortality, nurse burnout, and job dissatisfaction. Researchers found that for each additional patient assigned to a nurse

- 30-day patient mortality increased by 7%.
- Failure-to-rescue rate increased by 7%.
- Job dissatisfaction among nurses increased by 15%.
- Burnout among nurses increased by 23%.

When nurses had eight patients instead of four, their patients had a 31% higher chance of dying within 30 days of admission. In addition, 43% of the nurses

surveyed were burned out and emotionally exhausted, and those who were burned out were four times as likely to report that they were leaving their jobs in the next year.

The future demand for nurses is expected to increase dramatically as the baby boomers reach their 60s and beyond. With fewer new nurses entering the profession, the average age of the registered nurse is climbing. According to the 2004 National Sample Survey of Registered Nurses released in February 2007 by the Federal Division of Nursing, the average age of the RN population in March 2004 was 46.8 years of age, up from 45.2 in 2000. The RN population under the age of 30 dropped from 9.0% of the nursing population in 2000 to 8.0% in 2004. In April 2006, officials with the Health Resources and Services Administration (HRSA) released projections that the Nation's nursing shortage would grow to more than one million nurses by the year 2020 [HRSA 2006]. The rapidly aging nurse workforce may be at increased risk of work-related injuries due to their increased age-related susceptibility.

While the intensity of nursing care is likely to increase requiring more nurses per patient, the number of inpatients (those who remain in the hospital for more than 24 hours) is not likely to grow by much. However, the risk of exposure to injury or infectious agents will undoubtedly increase for nurses in the nonhospital settings because patients are being discharged earlier and more procedures are performed on an outpatient basis. Rapid growth is expected in hospital outpatient facilities, such as those providing same-day surgery, rehabilitation, and chemotherapy.

Employment in nursing care facilities and home healthcare is expected to grow faster than average because of increases in the number of elderly patients and those with functional disabilities, many of whom require long-term care.

It is estimated that the shortage of RNs in the U.S. will increase to 340,000 by the year 2020. Though this is significantly less than earlier projections for a shortfall of 800,000 RNs which was made back in 2000, researchers note that the nursing shortage is still expected to increase by three times the current rate over the next 13 years [Auerbach 2007]. Given the demands of today's healthcare system, the greatest need in the nursing workforce is for nurses prepared at the baccalaureate and higher degree levels. Baccalaureate programs experienced 6 years of declining enrollments from 1995–2000, and the subsequent recovery noted from 2001–2003 was followed by another smaller decline (Figure 19).

Regardless of these trends, access to professional nursing educational programs continues to be a major issue. As shown below, many qualified applicants are being turned away because of a shortage of nursing faculty, and the need for nursing faculty will only increase as a large number of instructors near retirement (Figure 20).

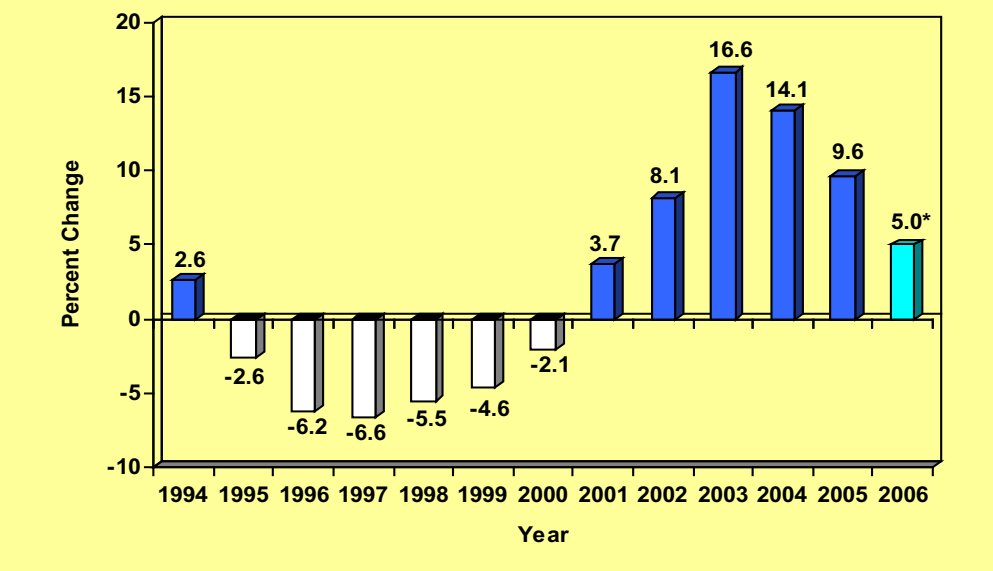

Figure 19. Enrollment trends in baccalaureate nursing programs, 1994–2006 (Source: [AACN 2007])

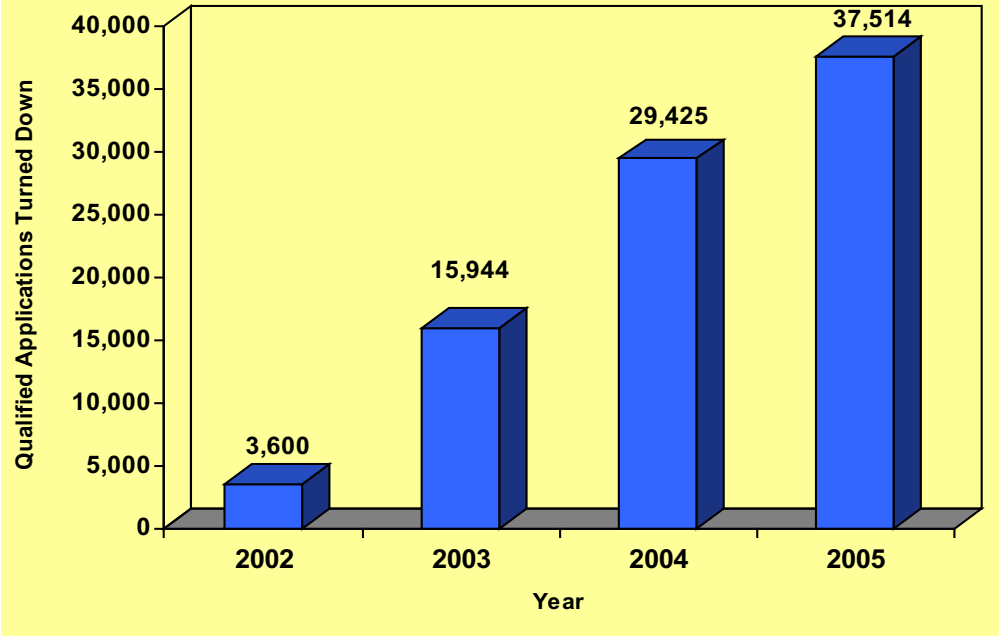

Figure 20. Trends in the number of nursing school applications rejected, 2002–2005 (Source: [AACN 2007])

According to the American Association of Colleges of Nursing report on the 2006–2007 Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing, nursing schools in the U.S. turned away 42,866 qualified applicants to baccalaureate and graduate nursing programs in 2006 due to an insufficient number of faculty, clinical sites, classroom space, clinical preceptors, and budget constraints [AACN 2007]. Almost three-quarters (71.0%) of the nursing schools responding to the 2006 survey pointed to faculty shortages as a reason for not accepting all qualified applicants into nursing programs (www.aacn.nche.edu).

Further, Sochalski [2002] found higher numbers of new graduates of the Nation's nursing schools are not going into nursing at all. Among the most recent crop of graduates, more than 4 out of every 100 female nurses were not working in the nursing profession after graduating, and that number is nearly twice as high for new male nurses.

Opportunities

While the need to recruit, train, and continually educate nurses is acknowledged, there is an important role for occupational health and safety to play in terms of retention. The work that nurses do can be risky and hazardous. Organizations, regardless of their setting, need to take steps to continuously improve the work conditions and design systems to eliminate and/or mitigate these risks. Addressing the concerns of nurses regarding quality of work-life issues and making the improvements necessary for a safe and healthy workplace should be a national priority, so that recruiting nurses will be less challenging for the nursing profession. This will undoubtedly not only help retain nurses but minimize the risk to this aging workgroup. It is essential that the association between quality of work-life factors and turnover be thoroughly explored in order to develop a comprehensive strategy for addressing these concerns. Strategies needed to address quality of work-life have not been clearly articulated other than in the area of nurse/patient ratios and number of hours worked. Clearly much more research is needed on changing the organizational culture and climate so that critical issues, such as nurses' well-being and job dissatisfaction, are addressed.

Access to baccalaureate and graduate-level nursing programs should be evaluated to determine the root cause of an insufficient number of faculty, clinical sites, classroom space, clinical preceptors, and financial resources. The ability to accommodate even half of the prospective students turned away each year would significantly reduce the stress of insufficient staffing on those nurses already in the workplace. Incentives for public universities to expand their nursing programs could help to expand access for those prospective nursing students and reduce the patient-safety implications of an increasingly short-staffed healthcare system.

Recommendations

It is clear that as the nursing workforce ages there may be fewer nurses engaged in the profession. In addition, the type of work that nurses do is inherently risky and may lesson the enthusiasm of potential recruits into the profession. The issue of the nursing shortage and its ultimate effects on nurses' fatigue, injuries, and errors need further exploration. It is important to examine how the work that nurses do impacts both the quality of care patients receive, and work organization issues that create unsafe and unhealthy work environments. In addition, the role that nursing schools play in preparing nursing students to deal with occupational health and safety issues, including hazards associated with nursing and the workplace, should be examined especially with respect to the relationship between worker safety and patient safety. Workplace safety and health should be a critical learning objective, and nursing schools should devote adequate time in the curriculum to address these issues. Students should acquire not only knowledge regarding workplace hazards, but how to protect themselves against exposure to these hazards. Another important area for additional research is how best to support workplace safety practices in nurses already in the workforce, and in particular the aging nurse.

Shifts in nursing curriculum are necessary in order to encompass the issues that exist in the real world of nursing practice. The increase of acute care in the home setting, home infusion opportunities, and other alternate-site nursing roles are generally not adequately explored with nursing students. Additional research on why so many graduating students do not ever practice in the nursing profession may provide insight into the gaps that exist in preparing the student for a realistic nursing career.

Addressing the problems faced by nurses may also help in addressing the parallel challenges faced by other occupations in the HCSA sector. For example, a workforce shortage is also predicted for social workers. A recent study found that 12% of licensed social workers had plans to leave the workforce within the following two years. Seven percent of licensed social workers planned to leave due to retirement; another five percent planned to continue working, but to leave the profession. The profession identified three challenges to maintaining its workforce; replacing retiring social workers; recruiting new social workers; and retaining the current work force [Whitaker, Weismiller & Clark 2006].

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Chapter 5 ▪ Work Organization and Work-Related Stress Disorders in the HCSA Sector

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Work Organization and Health

Work organization refers to the design of the job and the way it is performed and managed. The National Occupational Research Agenda (NORA) identifies six major components of work organization: work schedule, job design, interpersonal relationships with supervisors and coworkers, career concerns, management style, and organizational characteristics [Huang et al. 2002; Hurrell and Kelloway 2007; Sauter et al. 2002]. Some experts also include work-home interface. Sauter et al. [2002] also considers the external factors that have a strong influence on work organization including economic, legal, political, technological, and demographic forces at the national/international level.

Poor match between organization of work and the capabilities, resources, or needs of workers can lead to a stress response; reduced time available for sleep, family, and nonwork activities; and longer exposures to occupational hazards. These immediate effects can lead to mood disturbances; difficulty thinking; disturbed sleep; fatigue; pain; neurological, cognitive, and physiological dysfunction; and negative health behaviors such as smoking and substance abuse. These can lead to a wide variety of injuries and illnesses for the worker. In addition, worker stress and fatigue can lead to negative impacts to the employer and community such as medical errors, shortages of healthcare workers, and automobile crashes while commuting to and from work (Table 25).

Table 25 lists an overview of the hazards associated with poor organization of work and adverse outcomes reported in the literature. Career concerns include low status in the organization, inadequate pay, job insecurity, lack of promotion or growth prospects, unclear or unfair performance evaluation systems, and being over-skilled or under-skilled for the job. Organizational climate and culture and violence in the workplace are discussed in more detail in other sections of this document. Work hours, worker control over their job, support, aspects of job design and content particularly relevant to HCSA, staffing, and interpersonal relationships will be discussed in more detail below.

Table 25. Overview of the hazards related to the organization of work

Hazard	Reported adverse outcomes applicable across more than one hazard
Demanding work schedules Shift work Long work hours per week Extended work shifts (e.g., 12-hr shifts) Unpredictable working hours (i.e., mandatory overtime, on-call) Strict, inflexible work schedules Inadequate work rest breaks Job content Emotional, cognitive, physical demands Aversive or unpleasant tasks Lack of variety, monotonous understimulating tasks Job design Task complexity Required skill/effort Lack of participation in decision making and control over work Heavy workload, too fast work pace (staffing) Role conflict (conflicting job demands) Role ambiguity (unclear scope/ responsibilities) Poor interpersonal relationships with Coworkers Supervisors Career concerns Poor management style Participatory approaches Hierarchical approaches Teamwork Organizational characteristics Climate Culture Home-work interface Conflicting demands between work and home Lack of support at work for domestic demands Lack of support at home for work demands	Immediate effects: stress, reduced time available for sleep, family, and nonwork activities, longer exposure to workplace hazards ↓ Disturbed sleep; fatigue; sleepiness; negative mood; discomfort; pain; neurological, cognitive, physiological dysfunction; work/family conflict. ↓ Poor health behaviors: smoking, alcohol/drug abuse, lack of exercise, poor diet, obesity Job dissatisfaction Accidents, injuries Cardiovascular, gastrointestinal, and psychological disorders (including depression and burnout); reduced fertility; preterm birth; cancer; musculoskeletal disorders; headache Marital and family problems, divorce Negative effects for employer: reduced quality of services, increased absenteeism, healthcare costs, workers' compensation costs, and turnover Early retirement, exit healthcare for other types of work or disability Negative outcomes to community: medication errors and other errors in delivery of healthcare due to worker fatigue, automobile crashes with other drivers, increased costs to community to support disabled, shortage of healthcare workers

Shift Work and Long Work Hours

Healthcare workers are often exposed to shift work and long work hours because their services are needed around the clock and because shortages of workers put pressure on those available to work longer hours. A large number of studies report an association between shift and health and safety risks, and a growing number of studies is associating long work hours with similar risks. Researchers theorize that shift work exerts negative effects by disturbing circadian rhythms, sleep, and family and social life Barton et al. [1995]. These disturbances may lead to reductions in the length and quality of sleep and may increase fatigue; sleepiness; worker errors; as well as gastrointestinal, psychological, and cardiovascular symptoms and disorders; breast cancer; and adverse reproductive outcomes [Frazier and Grainger 2003; Knutsson 2003; Megdal et al. 2005; Rohr et al. 2003]. In addition, working at unusual times may make it difficult to interact with family and maintain other social contacts [Presser 2003]. Similarly, long work hours may reduce the time available for sleep, leading to disturbed sleep and incomplete recovery from work. This may adversely affect nervous, cardiovascular, metabolic, and immune functioning as well as result in accidents and injuries [NIOSH 2004; Folkard and Lombardi 2006; van der Hulst 2003]. 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 and may reduce time available for exercise or nutritious meals. Added job stress can increase smoking and caffeine use.

Intervention to ease the difficulties of shift work and long work hours include strategies for both workers and employers. Strategies include setting up a good sleep environment, altering circadian rhythms with bright light or blue light, rest breaks and naps during work, optimally timing physical activity or other work demands, improving physical conditioning, not using caffeine at bedtime, planning dietary regimens, stress reduction, support groups, and family counseling [Rosa et al. 1990; Monk 2000; Knauth and Hornberger 2003; Revell and Eastman 2005; Caldwell and Caldwell 2005; Arendt and Skene 2005; Tepas 1990; Lennernäs 2004]. Using workplace strategies to improve sleep hygiene is consistent with clinical guidance. For example, Caldwell and Caldwell suggest behavioral and administrative strategies be used 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. Workplace policies and systems could be developed and tested to reduce accumulation of fatigue such as protecting rest days, limiting overtime, and designing better shift schedules. Also, services such as child care, domestic services, and transportation to and from home could be tested for their effectiveness in reducing the stress of meeting nonwork responsibilities during unavoidable, demanding times. Taking naps during work has been associated with improvements in alertness

[Takahashi et al. 1999, 2004] and is an accepted practice in some Asian countries, but cultural barriers have slowed adaptation of this intervention in the U.S. More research is needed to refine these strategies so that they can be easily adapted by workers in a wide range of demanding work schedule situations; however, current research findings will give some measure of improvement for many workers.

Emotional Demands

The emotional demands of healthcare and social assistance work include dealing with uncontrolled and unpredictable events, interpersonal stressors, maintaining acceptable demeanor (emotional labor), situations that induce moral and spiritual distress, and, for some, stress reactions to traumatic events (vicarious trauma) [McGuiness 2006; Zammuner et al. 2002; Glasberg et al. 2006; Sabin-Farrell and Turpin 2003; Creamer and Liddle 2005]. Uncontrolled or unpredictable events include natural and man-made disasters, infectious disease outbreaks, workplace accidents, and aggression or violence. Healthcare workers responding to disasters are exposed to human suffering, often on a grand scale [Carballo et al. 2006]. In the immediate response period, heathcare workers may find themselves unable to relieve the victim's suffering. Because these events are unpredictable, there is no ability to mentally prepare for the exposure. In some situations, such as outbreaks of infectious disease, they may be stigmatized: traumatized by fear for their own safety or for the safety of their family [McAlonen et al. 2007; Bai et al. 2004]. Even unpredictable events in a controlled environment (e.g., needlestick injuries, patient violence, rapid and unexpected deterioration in a patient's condition) can cause emotional reactions that are long lasting [Sohn et al. 2006].

The day-to-day work of HCSA workers is conducted within the context of interpersonal relationships. These relationships are the substrate upon which the treatment is built and require the investment of emotional energy. These relationships require the HCSA to witness the suffering of others in an empathic way, deal with the anger of patients and families in situations of loss, deliver bad news, and grieve when treatment fails [Saunders 2004; Philip et al. 2007; Sherman et al. 2006; Redinbaugh et al. 2001]. In addition, there is spiritual distress when unable to relieve the suffering of others; when patients or their surrogates make decisions that are counter to their best options; when providing futile treatment; and when patients must make decisions in morally ambiguous situations such as end-of-life, reproductive, and genetic issues [Farsides et al. 2004; Trotter 2002; Lewis 2005; Austin et al. 2005; Schwenzer and Wang 2006]. Emotional labor is necessary in order to display organization-required, appropriate emotions that are congruent with the job requirements in face-to-face interactions with patients [Mann 2005]. The more frequent and intense the interpersonal interactions are with others (staff,

visitors, and patients) the more likely the HCSA worker will experience symptoms of burnout, including depersonalization and emotional exhaustion [Zammuner and Galli 2005]. Vicarious trauma, a consequence of listening to the fears, pain, and suffering experienced by patients, is common in several HCSA jobs (e.g., child welfare, mental health, and ER and intensive care) and associated with adverse outcomes [Bennett et al. 2005]. Not all vicarious trauma progresses to post-traumatic stress disorder, burnout, or minor psychiatric morbidity, but accumulated exposure increases the risk [Sabin-Ferrell and Turpin 2003; Weinberg and Creed 2000].

Research in this area could be advanced by identifying subpopulations of healthcare and social assistance providers with increased risk for psychiatric morbidity in typical caregiving situations. In addition, intervention research is needed that studies the effect of modifying the work environment to buffer the effect of emotional demands on workers.

Cognitive Demands

Clinical medicine, in an attempt to reduce variation in practice, relies heavily on research evidence to support clinical decision making. Keeping current in the sea of medical literature is demanding and requires HCSA workers to develop complex cognitive maps to synthesize disparate information into a coherent whole in the service of treating specific patients. In addition, the pace of inpatient care has increased, with round-the-clock diagnostic testing, shorter inpatient stays, resulting in more rapid turnover. Thus, hospital workers are faced with cognitive overload in keeping mentally current on medical needs of larger numbers of patients. In addition, healthcare work is performed in teams, so individual HCSA workers must also communicate with other team members and may not have all of the puzzle pieces at any one time. There is increased use of technology to monitor patients' conditions and deliver treatments, requiring additional cognitive mastery. Hospital information systems have improved to reduce the cognitive demands on healthcare workers; however, there is still a great deal to be done to reduce mental fatigue. Information systems are less available in ambulatory and home healthcare settings; thus workers have insufficient tools to reduce cognitive demands. Both acute and chronic partial sleep deprivation significantly reduce cognitive functioning in healthcare workers; thus work schedules are also implicated in this mental fatigue [Durmer and Dinges 2005]. For some jobs in healthcare, boredom is a problem, with either understimulation or cognitively repetitive tasks. Boredom is also a source of cognitive job stress.

The Institute of Medicine has called for increased use of information technology to improve the safe delivery of care to patients; this would also relieve some

of the cognitive burden on HCSA workers [IOM 2001]. There has been theory development and research in other disciplines such as marketing and organizational science [Eppler and Mengis 2004]. However, for HCSA workers, research is largely conducted by case report. In order to advance the science in this area there will need to be an interdisciplinary effort combining the work of organizational science, information specialists, and healthcare providers, with an emphasis on developing good measures of cognitive overload, discovering effective countermeasures to cognitive overload, and identifying barriers and facilitators in adopting technology.

Role Conflict

In any healthcare transaction, HCSA workers function and delegate based upon their understanding of roles. Three sources of role stress are common: role ambiguity (unclear responsibilities), role conflict (competing responsibilities), and role overload (too many responsibilities) [Clarke 2001; Johnson et al. 1998; White et al. 2006; Piko 2006; Chang and Hancock 2003; Santos et al. 2003; Elfert and Mirenda 2006]. There has been a general shift of responsibilities in healthcare services, with nurses taking on advanced-practice roles that were the former province of physicians and physicians' assistants. Unlicensed assistive personnel (UAPs) are now performing technical tasks which were once the role of specialized technicians (e.g., EKGs, venipuncture). Chaplains are now assuming the consoling role once held by nurses. These changes are very confusing for patients and a source of stress for providers. As healthcare uses more quality-monitoring tools to assess the quality of care that is delivered, mandates are added without any clear understanding of whose role it is to perform these care elements (e.g., assess whether patients received pneumococcal vaccination), leading to ambiguous accountability. There is state-to-state variation in the scope of practice for healthcare providers, which also leads to confusion about what procedures each provider can do in their setting. In addition, so many providers see each individual patient that there are also disparate assessments and treatment opinions, without a clear roadmap for clarifying these disputes. As healthcare increases in complexity, new responsibilities are often added but without deleting old ones, and the result commonly is overload. Thus, role stress is a common experience among HCSA workers.

Another important aspect of role demands takes the form of justice concerns. Semmer et al. [in press] has proposed a model of "Stress as an Offense to Self" that describes the role of illegitimate tasks in reducing the self-esteem of workers and causing stress. These are work tasks that should be done by someone else, or perhaps not done at all. Other fairness-related organizational situations are a source of stress. Injustice occurs when procedures are developed without input of those affected, based on inadequate information, and with insufficient opportunity for

feedback or appeal [Elovainio et al. 2002, 2006]. Karasek [1979] theorizes that jobs with high demands and low-decision latitude result in job strain and stress. An extensive amount of literature links jobs with these characteristics to increased risk for cardiovascular disease and psychological disorders [Karasek and Theorell 1990; Sauter et al. 1998; Schnall and Landsbergis 1994]. Interventions include increasing worker control over the way they do their job and worker input about work practices [Sauter and Hurrell 1990].

Interpersonal Relationships

Increased stress is associated with poor interpersonal relationships with supervisors and coworkers, such as inadequate, inconsiderate, or unsupportive supervision and lack of team spirit, assistance, or cooperation from coworkers. When supervisors show personal biases, are untruthful, and fail to show individual concern for workers, relational injustice is present. These situations are associated with increased minor psychiatric morbidity. A review of musculoskeletal disorders reports strong evidence that poor support from supervisors and coworkers is associated with back pain [Panel of Musculoskeletal Disorders and the Workplace 2001]. Interventions to improve communication patterns of supervisors and workers are needed to reduce these stressors.

Staffing Levels

Nursing staffing levels have been examined mostly for patient outcomes, but research has started to examine the effect on workers' health and safety. Stone et al. [2007] reported that nursing units with higher staffing levels showed lower rates of patient infections, pneumonia, mortality, and decubitus ulcers. Trinkoff et al. [2005] reported that low nursing staffing levels were associated with high injury rates, needlesticks, and illnesses in nurses. Methods to measure staffing are an area for further study.

Interventions Across Organization of Work Factors

The most effective interventions, such as designing better work schedules, improve the organization of work. Secondary interventions are stress management strategies including cognitive-behavior interventions, time management, assertiveness training, physical exercise, and relaxation techniques [van der Klink et al. 2001; Mimura and Griffiths 2003]. Tertiary interventions include medical care and psychological counseling to treat the adverse physical, psychological, and behavioral consequences of these hazards.

Research Priorities

The organization of work in the HCSA sector has many areas that need more study: surveillance to identify hazards related to work organizational hazards, identification of the numbers of exposed workers and the types of negative outcomes experienced, development of better work organization of work strategies, interventions to reduce risks, and testing of interventions. Research priorities are adapted from priorities suggested by the NORA Long Work Hour Team [Caruso et al. 2006] and the NORA Organization of Work Team [Sauter et al. 2002].

- Research needs to systematically collect data to examine major trends and changes in organization of work: e.g., staffing patterns, organizational restructuring, composition of the workforce (i.e., age, sex, race, and minority status), work hours, and technological advances.
- Research needs to provide a clear and complete description of work organization factors, the workers, and the work environment to better compare findings across studies, build evidence, and move the science forward.
- Priority should be given to demanding work organization factors, such as mandatory overtime, shift work, or combinations of demanding work schedule features, emotionally demanding work, and the steady increase in workload. A critical need is to identify and test strategies to handle immediate needs when there is inadequate staff available.
- Research should measure and control for factors that may influence the relationship between work organization factors and outcomes.
- Research should explore a wider range of possible worker and patient outcomes, such as a variety of symptoms and functional deficits in workers, chronic diseases and acute injuries and illnesses in workers, risks for the employer (e.g., reduced productivity and quality of work, increased absenteeism, higher healthcare and workers' compensation costs, and less successful recruitment and retention of staff), and long-term impacts on the family and community.
- Research should examine workers in vulnerable groups, such as workers who are pregnant, older, chronically ill, exposed to more demanding occupational hazards, and socioeconomically disadvantaged.
- Research should develop intervention strategies and test existing interventions to reduce risks, such as teaching tools and strategies to disseminate scientific information, workplace or corporate interventions, and studies on the impact of broader public policy measures (e.g., impact of the state laws limiting mandatory overtime for nurses).

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Chapter 6 ▪ Health and Safety Culture

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Issue

Organizational variables are known to have important effects on the health and safety of the workforce. Aspects of the work organization, such as management models, decision-making, staffing levels and resource allocation, etc., have well documented impacts on worker health and safety across all sectors [Brown and Holmes 1986; Brown and Leigh 1996; Clarke et al. 2002; Dedobbeleer and Beland 1991; Gershon et al. 2000; ICN 2006; Hofmann and Stetzer 1996; Michela et al. 1995; Stone et al. 2007; Zohar 1980].

These work organization aspects are often conceptualized within the overarching construct referred to as "quality of worklife," broadly defined as the "sum of perceptions employees have about their work experience" [Cummings and Worley 1997; Yousuf 1996]. As shown in Figure 21, organizational characteristics, along with job characteristics and working conditions, all help shape the quality of worklife.

In the health care sector, quality of worklife in general, and the role of organizational variables in particular, are increasingly of interest, not only because of the impact on workers, but also because of the role they may play with respect to a wide range of quality indicators, including patient safety, as depicted in Figure 22. For example, the Federal Quality Interagency Coordination Task Force examined the effect of healthcare working conditions on patient safety and concluded that interventions designed to improve the healthcare workplace would also likely improve the overall quality of care for the patients [Conklin et al. 1990]. The working conditions identified by the task force included the physical work environment, work hours and staffing levels,

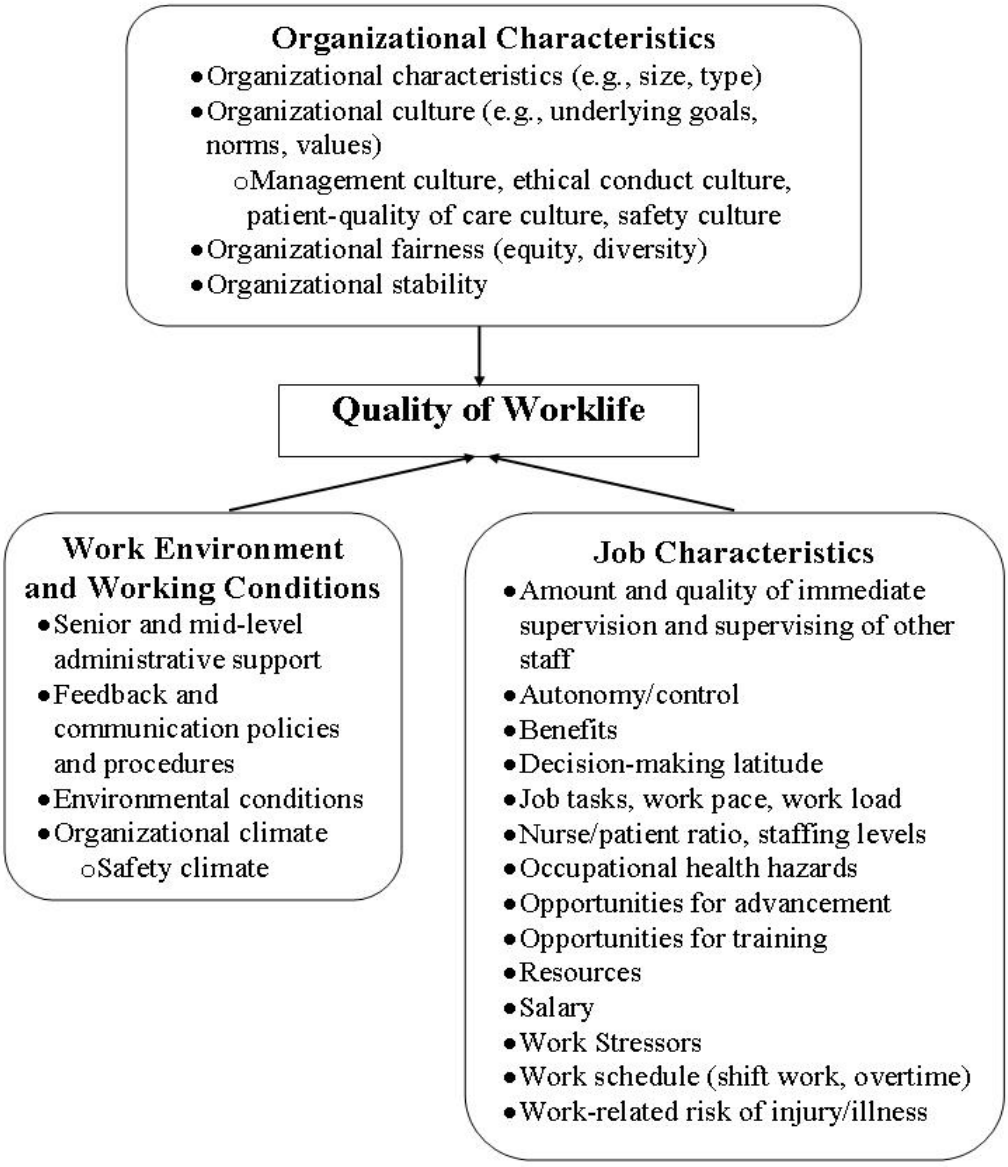

Figure 21. Quality of hospital worklife domains.

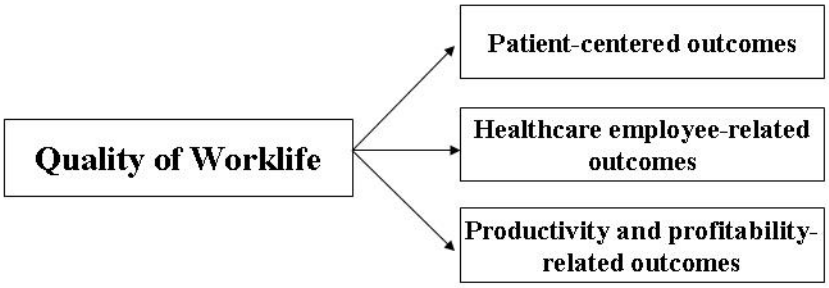

Figure 22. Quality of worklife outcomes in healthcare.

and organizational culture and climate [Conklin et al. 1990]. This section addresses one specific organizational variable, namely safety culture and climate.

Safety Climate

Definitions

Although the terms "safety culture" and "safety climate" are sometimes used interchangeably, they are increasingly recognized as two distinct concepts. Safety culture has been defined as the underlying principles, norms, values, and beliefs of an organization with respect to safety [Roberts 1990; Schein 1985]. Safety climate, in contrast, is conceptualized as employees' shared perceptions regarding safety within their work organization [Zohar et al. 2007]. Safety climate therefore is a reflection, or surface manifestation, of the safety culture within an organization. Both concepts derive from the human relations movement which began in the 1930s, but their application in United States work settings, especially in healthcare, is relatively recent. Other frequently used terms pertinent to the discussion of safety culture include "safety management" (a system of controlling against risk or harm), "safety mission" (the priority given to safety as part of the organization's overall mission), "safety involvement" (the combined efforts of both management and labor to provide a safe work environment), and "integrated safety culture" (whereby safety mission is integrated into work practices) [USDOE 2003]. The latter is what the Centers for Disease Control and Prevention (CDC) defines as a "culture of safety," i.e., the shared commitment [CDC 2004].

The reason that safety climate is considered an important factor with respect to worker health and safety is that it has been shown to correlate with compliance with safe work practices as well as with health and safety outcomes, such as injuries or exposures [Clarke 2006; Gershon et al. 2000; Oliver et al. 2002; Seo et al. 2004; Zohar 2000; DeJoy et al. 1996].

Safety climate also serves as a frame of reference for employee behavior and attitudes and for employee participation in safety-related activities [Clarke 2006; Neal et al. 2000; Griffin and Neal 2000]. A recent meta-analysis of 35 studies explored the relationship between safety climate and safety performance across a wide range of organizations and used a variety of measures and methodologies; this study found a small positive correlation between safety climate and safety performance (assessed as occupational accidents and injuries), although the standard deviation was very large [Clarke 2006]. The relationship between safety climate and safety performance is complex and most likely affected by a number of moderating variables.

Measurement

Safety culture can be assessed in a number of ways. For example, quality indicator data—e.g., accident rates, lost workdays, absenteeism, compensation claims, adverse patient events, safety infraction data (from internal and external surveys)—can serve as outcome measures of safety culture. There are numerous limitations (e.g., under-reporting by staff, data collection difficulties) as well as strengths to this approach. Increasingly, healthcare organizations supplement these data with safety climate data, usually through the use of safety climate surveys, which are administered to employees within the organization or work unit of interest. A number of safety climate scales have been developed, with some designed specifically for healthcare (particularly hospital) settings [Gershon et al. 1995; Gershon et al. 2000; Neal and Griffin 1997; Neal et al. 2000; Singer et al. 2003; Zohar 2003; Zohar et al. 2007].

There are, however, a number of limitations associated with the various safety climate measures. Most notably, researchers have found a lack of specificity and validity in many of the measures, and this is generally believed to be related to the lack of consensus regarding the dimensions of safety climate, i.e., the key elements that comprise safety climate [Dedobbeleer and Beland 1998; Gadd 2002]. There is also a problem regarding measurement with respect to the level that is measured, as there can be multiple microenvironments within a given hospital, i.e., one unit may rank their hospital's safety climate as very strong, while another may rank it as weak. Variability regarding analysis of safety climate data has also been noted; some researchers focus on the hospital as the unit of analysis, others aggregate to the unit level, still others analyze at the worker level. When data are clustered (i.e., observations are not independent) then the nursing unit or hospital should be the appropriate level of analysis [Stone et al. 2007].

Safety climate surveys are designed to measure the strength of the culture; a strong (or positive) culture of safety exists when employees' perceptions are aligned with the organizational safety values. Conversely, when there is little alignment, the culture is

referred to as weak (or negative). A stable climate exists when there is relatively high agreement among members of a workgroup or organization. Within-level homogeneity evidences the existence of shared perceptions among employees. Taking the mean for a workgroup and comparing this to other workgroups or organizations is probably not the best use of climate measures. Rather, these measures are probably most helpful in assessing the effectiveness of various safety interventions (e.g., using pre/postdesign surveys) and for periodically determining if the organizational safety goals and values map to employees' perceptions.

While there is variability among the various published scales, they generally include the following dimensions: management commitment, communication, priority of safety, management support for safe work practices, work environment supportive of safety (necessary supplies, staff), job hindrances, and feedback. In addition to these dimensions, other scales include items addressing cleanliness and orderliness of the worksite, coworker support for safety [DeJoy et al. 1995], and worker adherence to safe work practices [Neal et al. 2000].

Barriers to Improving Healthcare Safety Culture/Climate

An inherent tension exists between the culture of safety (i.e., valuing safety) and the culture of productivity (i.e., valuing speed and cost-containment), which can only be resolved in favor of safety by a shared commitment of both management and labor. The relative importance of safety climate is revealed when we look at its importance, not in isolation, but in comparison to other important organizational outcomes such as productivity, profitability, patient quality of care, etc. Zohar [2003], among others, have discussed these conceptual issues in some detail. Nearly 30 years ago, Sulzer-Azaraff [1978] pointed out that, at least in some work settings, job-task shortcuts that may result in poor safety compliance (e.g., lack of use of personal protective equipment) are naturally reinforced since they result, for the most part, in performing the job quickly. Administrators may inadvertently provide positive reinforcement for these potentially risky behaviors because efficiency and productivity are rewarded. This has implications for the healthcare work setting since work productivity is a high priority. In the 1980s, managed care initiatives resulted in unprecedented industry-wide organizational changes that led to reduced hospital stays, capitated payment plans, and managed care plans [Starr 1983]. Although impressive savings resulted, so did adverse impacts on healthcare providers [Aiken and Fagin 1997; Armstrong-Stassen et al. 1996]. Clarke argues that a strong safety climate can serve to counter this by putting a priority on safety and by rewarding employees' compliance with safety rules [Clarke 2006].

Other aspects of the healthcare setting may also conflict with safety climate and safe work practices. For instance, several authors have pointed out that for many

healthcare personnel (HCPs), patient-care issues (i.e., patient health, well-being, and safety) take precedence over personal safety [DeJoy et al. 1995]. There is also a concern that, at least in some settings, a culture and climate of risk acceptance may be the norm; some workers may come to expect that the risk of exposure or injury is simply part of the job. Other aspects of healthcare, including job hindrances and certain job tasks, may also inadvertently increase the likelihood of unsafe behaviors. For example, certain healthcare settings (e.g., emergency departments) may present a number of situational demands that can affect workplace compliance. The fact that healthcare delivery often involves groups of specialized and interdependent workers interacting with each other, the patient, and various types of equipment and devices [DeJoy et al. 1996] complicates individual-level safety behaviors, since they are not independent of all these other influences. Again, a shared commitment to safety may help to override this attitude.

Another potential barrier to achieving a strong safety climate may be related to the fact that 50% of healthcare workers work in nonhospital settings, where resources, coworker and management support, and safety expertise may be limited [Gershon et al. 2002]. These settings include private doctor and dental practices, out-patient clinics, and other nonhospital facilities, such as prison healthcare facilities, group homes for persons with disabilities, long-term care facilities, and home healthcare. Of special note is the fact that a sizeable percentage (16%) of HCPs work in establishments with five or less employees [BLS 2000]. These smaller nonhospital settings may potentially have important gaps in risk management infrastructure, thereby presenting a challenge in terms of developing a strong safety climate [Gershon et al. 2002]. Safety resources may be unavailable or substandard in these settings, even though the potential health hazards and risk of exposure to these hazards may be the same if not greater than the risk in the hospital setting.

Research

Interventions Designed to Improve Safety Climate

We now have the ability to measure safety climate, and we have a number of theoretical models that provide the framework for understanding the impact of safety culture and climate. We have also identified the characteristics and other qualities of a strong safety culture. However, we still do not yet have a definitive understanding of the steps that are necessary for effectively changing the culture of an organization. From the model presented in Figure 22, it is evident that climate change originates through culture change. Although culture is not immutable, it is relatively stable and slow to shift. Therefore, just as the formation of an organization's culture occurs over an extended period of time, changing or improving the culture is also likely to require a considerable amount of time and organizational commitment. This is a topic of continuing interest at a number of levels.

Lessons Identified from Other Sectors

In certain high-hazard work organizations, efforts to reduce risk has led to exemplary safety records. Referred to as high reliability organizations (HROs) (e.g., aviation, nuclear power production, chemical manufacturing), where error can result in extreme outcomes including fatalities, efforts to reduce risk has led to exemplary safety records. By putting measures in place to limit organizational failures, technical failures, and human errors, these companies have been able to successfully manage risk. The same approaches to managing risk in these high-hazard settings have been recommended for healthcare [Pizzi et al. 2001]. For a healthcare setting to achieve HROs' high safety standards, several key elements of an integrated safety culture must be fostered by senior management, including (1) occupational safety and health (OSH) policy; (2) acknowledgements of the risks; (3) nonpunitive response to reporting of incidents, near misses, or unsafe behaviors; (4) joint effort and partnership of labor and management for addressing safety issues; (5) management's financial resource commitment to support the safety program; (6) monitoring and analyzing safety-related data and correcting OSH problems [Pizzi et al. 2001; ANSI Z10-2005. 2005].

In the health care sector, with over 14 million workers employed in a very wide range of settings, occupations, facility size and structure, and job tasks performed, developing a strong safety culture can be a formidable undertaking. This is especially true considering that many facilities lack joint labor/management safety committees. The challenges the health care sector faces in developing a strong safety climate include a lack of trained professional safety personnel, who are increasingly in short supply and prohibitively expensive for most of the smaller practice settings (e.g., doctor and dental offices, long-term care facilities); a lack of sufficient financial resources available for the purchase of cutting edge safety equipment and supplies; and a lack of commitment on the part of both management and labor.

Research Gaps

Future research is needed in a number of areas with regards to safety culture/climate. Longitudinal studies, with repeated measures of both safety climate and injuries/exposures, would be helpful in providing reliable estimates of these relationships. These types of studies would also allow for robust testing of various models, thereby illuminating the nature of the complex role safety culture/climate plays in worksite safety and health. Longitudinal studies would also help clarify the role of safety culture/climate with respect to employee retention and recruitment as well as patient quality-of-care outcomes. Research is needed to clarify the nature of the association between safety culture and climate and worker safety culture and

climate, and the role of leadership on both of these construct domains. Leadership styles and management practices that strengthen both patient and worker safety would have important impacts on multiple levels.

A particularly important topic which has been largely unaddressed in the healthcare sector relates to specific safety climate interventions and their effectiveness. Although these studies can be costly and complicated to conduct in healthcare settings, they can serve to identify useful strategies as well as best practices regarding their implementation. More work is also needed on the distinctive subclimates of safety, such as bloodborne pathogens safety climate, respiratory protection safety climate, and the newly developed emergency preparedness safety climate, not only in terms of measurement, but in program development and implementation including employee training and education [Gershon 2007]. The strategies for implementing interventions targeting these subclimates are also needed. Interventions almost certainly should target administration since safety climate is derived from safety culture, yet the mechanism and impetus to do this remains uncertain. Although an excellent guide to a "culture of safety" was published by the Centers for Disease Control and Prevention [CDC 2004], to our knowledge, the implementation and effectiveness of this has never been assessed. The barriers to implementation of the precepts of the guide have also never been addressed.

Finally, studies are needed on the cost-effectiveness of programs that enhance and support a healthy safety culture, as evidence of this type might be beneficial in shifting organizational commitment to a culture of safety. It may be that some combination of research and policy is needed to address the complex problem of organizational commitment to developing a strong safety culture. The challenges faced by administrators of both hospital and nonhospital work settings are formidable and require innovative approaches to the real-world limitations imposed by financial constraints.

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Chapter 7 ▪ Healthcare Emergencies

Issue

In emergencies, whether from natural or manmade (unintentional or intentional) sources, the performance of the Healthcare and Social Assistance (HCSA) sector is part of the critical infrastructure needed to decrease public morbidity and mortality. Incidents can involve a wide range of hazards, including infectious disease outbreaks, chemical weapons agents, toxic industrial chemicals, radiological agents, and natural disasters such as hurricanes, earthquakes, etc. HCSA workers must be protected in order to preserve their own health and to maximize the system's capability to withstand the strains inherent in the emergency. If the duration of the emergency is extensive, as in a pandemic, emergency functions will need to be sustainable. Little is known about the impact on emergency functions during different types of disasters; i.e., the response of HCSA workers to report to work, what the surge capacity will truly be, and the sustainability of such a surge.

Risks

Because of the vast array of types of emergencies, it is impossible to predict all the potential scenarios. Current national plans are based on collecting information from intelligence sources as well as environmental and epidemiologic surveillance systems throughout the world. Inherent to each emergency will be the physical and psychological risks that workers in this sector may experience during efforts to care for victims and patients. Initially there may be lack of information regarding the nature and characteristics of the hazardous agent, leaving HCSA workers more vulnerable. Timely identification and characterization of the hazard and provision of appropriate countermeasures may be dependent on the size, location, and resources of the communities affected as well as on the nature of the event. Early identification of the risk allows for communication, proper implementation of plans, and timeliness in invoking physical barriers of disease containment, as appropriate.

If the hazard is an infectious agent, accurate and rapid diagnostic testing and epidemiologic surveillance systems are critical in providing early warning of a community-level concern, possibly mitigating the impact on the system. Even once the etiologic agent is known, there may not be an effective vaccine or the vaccine may not be readily available. In the case of pandemic or avian influenza, the appropriate strains may not have been previously identified, and there may be a lag time before the vaccine is available.

Dependent upon the scenario, proper decontamination of victims optimally occurs prior to arrival at healthcare facilities, exposing receivers only to secondary exposures but the hazard "depends largely on the toxicity of the substance on the victims' hair, skin, and clothing; the concentration of the substance; and the duration of contact [first receivers have] with the victim" [Horton et al. 2003]. However, onsite decontamination may not be completely effective, or some victims may bypass this process altogether; therefore, elements of planning for decontamination, including recommendations on personal protective equipment (PPE), should be addressed in emergency management plans. The infrastructure of some emergency rooms and urgent care clinics may not be conducive for an efficient decontamination process and should be assessed prior to an event.

Research

A survey of healthcare workers from 47 healthcare facilities in New York City and the surrounding metropolitan area was conducted to determine ability (defined as capability to report to work) and willingness (defined as personal decision to report to work) during various events [Quereshi et al. 2005]. They identified that barriers to ability included transportation issues, child care, eldercare, and pet obligations. Barriers to willingness included fear and concern for family and self and personal health problems. In both instances, barriers differed depending on the type of incident, and abilities and willingness were lowest in situations where workers were more likely to perceive the highest degree of risk to themselves or their family (smallpox, chemical, radiation, and SARS). A study of Israeli healthcare workers reported that 42% of respondents were willing to report to work after an unconventional missile attack; this percentage increased to 86% if personal safety measures were in place [Shapira et al. 1991].

Although there is a large body of research on PPE, many sources avoid making specific PPE recommendations, instead choosing to discuss advantages and disadvantages of options, often recommending a multi-tiered approach. The Occupational Safety and Health Administration (OSHA) in its Best Practices for Hospital-Based Receivers [OSHA 2005] provides guidance to hospitals on PPE selection to protect first receivers caring for victims contaminated with unknown substances, once facilities meet certain prerequisite conditions. All healthcare facilities should familiarize themselves with this document and conduct a hazard vulnerability analysis for their facility, taking into consideration any community-specific

hazards that may exist. The OSHA best practices document also provides facilities with guidance on training and matches training levels to roles and work areas. It is important to note that this document does not address infectious outbreaks for which decontamination does not occur.

Opportunities

Complete reliance on PPE is problematic since many workers will not have been properly trained or fit-tested and breaches in protection occur, often unrecognized, even under the best of circumstances. Identifying other controls to help minimize exposures and hazards will be needed in a timely manner. Depending on the nature, duration, and extent of the emergency, PPE, vaccine, and pharmaceutical supplies may become scarce. Additional research is needed to identify ways to prolong usability, or reuse, of PPE.

The HCSA sector is chronically understaffed, and the availability of staff could be further decreased during healthcare emergencies by the need to care for ill or injured family members affected by the incident or outbreak. Workers should prepare emergency plans for their families to establish alternative mechanisms of caring for families. In the case of natural disasters, living quarters may be uninhabitable and alternative housing arrangements may be necessary. This same principle applies to facilities and thought should be given in advance to identifying alternative locations for temporary facilities.

Workplaces should be creative in developing solutions to potential barriers to the ability and willingness of their employees to come to work during healthcare emergencies. Some examples may include the following:

- Setting up transportation systems to bring workers to the worksite.
- Forming pools of resources to respond to needs for child, elder, and pet care.
- Forming emergency employee assistance programs.
- Developing effective methods to alleviate worker fears through education and instruction in PPE use [Quereshi et al. 2005].

In the case of infectious disease outbreaks, vaccines and/or prophylactic medications may be available for HCSA workers. Stockpiles of medical countermeasures, as well as PPE, are being established at federal, state, and local levels, but the contents of these stockpiles are based on best-guess scenarios. In addition, in some instances social distancing and other infection control measures may be an appropriate strategy for some workplaces. This may include the use of rotating work schedules, increasing spacing between workers, and maximizing use of teleconferences and audio conferences, as feasible.

HCSA workers are usually very dedicated, often jumping in to provide care before thinking of their own welfare. Overcoming these heroic intentions takes education and exercise of emergency management plans.

Recommendations

Members of the HCSA sector must develop emergency management plans that are adaptable to various scenarios. The Joint Commission requires an all-hazards approach to ensure plan flexibility and requires hospitals to coordinate activities with other emergency response agencies and hospitals in the community [JCAHO 2002, 2004]. Emergency management plans should be reviewed frequently as new hazards are identified and new guidance becomes available. Plans must be exercised to familiarize workers with details. If staff are relatively comfortable that their facility is adequately and appropriately prepared to provide them protection, they will likely be more willing to report to work during an emergency.

Establishing emergency management plans and exercising those plans are necessary for all areas of the HCSA. Plans should be tailored to the type of organization and characteristics of the workforce but integrated into the community plan. It is paramount to protect the workers in this sector so that they will be available to help reduce morbidity and mortality and assist in recovery of the community.

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Chapter 8 ▪ Healthy Healthcare Design

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Introduction

The most effective way to prevent occupational injuries, illnesses, and fatalities is to "design out" or minimize hazards and risks early in the design process. NIOSH is leading a national initiative called Prevention through Design (PtD) to promote this idea and highlight its importance in all business decisions (NIOSH PtD 2008). The concept of PtD can be defined as follows:

Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and ultimate disposal or re-use of work premises, tools, equipment, machinery, and substances.

A growing number of business leaders are recognizing PtD as a cost-effective means to enhance occupational safety and health. The ultimate goal of the PtD initiative is to prevent or reduce occupational injuries, illnesses, and fatalities through the inclusion of prevention considerations into all designs that impact workers [NIOSH 2008].

One of the main models guiding occupational safety and health (OSH) improvements is called the "hierarchy of controls" [Plog et al. 1996]. This model prioritizes actions for workplace interventions, beginning with elimination of the hazard at its source (e.g., replacing a hazard with a safer design), followed by the application of engineering controls (e.g., ventilation systems or machine safety devices), then application of administrative controls (e.g., rotating workers to reduce the duration of exposure), and lastly, by placing personal protective equipment on individual workers (e.g., respirators, gloves, goggles, etc). The basic principle holds that the closer an intervention is applied to the source of a hazard, the more effective it will be in protecting human health and safety. Thus, elimination of the hazard at its source is the top choice in the occupational hygiene hierarchy of controls. Designing out a hazard before it enters a workplace is the best way to eliminate the health and safety concerns as well as the direct and indirect costs associated with handling a hazard [EPA 1996]. This is the aim of prevention through design.

When considering the role of design in the healthcare industry, it is essential to recognize the nature and organization of the work. Work stations, procedures, and tasks are highly variable and there is always a sense of urgency in regard to patient outcomes. In addition, the settings for healthcare delivery are very diverse including hospitals, nursing homes, outpatient clinics, and the home. Each presents different design challenges for both patient safety and healthcare worker safety.

The health and safety of healthcare workers, patients, and the environment are inextricably linked. A well-designed healthcare environment will account for all simultaneously, rather than trading off one against the other. There are numerous initiatives focused on patient safety (e.g., The Joint Commission, Environment of Care) and, more recently, on preventing environmental pollution from the healthcare industry (e.g., U.S. Environmental Protection Agency, Hospitals for a Healthy Environment). Thus far, these initiatives have not fully incorporated the OSH of healthcare workers. However, occupational, environmental, and patient safety hazards arise from the same source—healthcare production processes, products, materials, and built environments—and so the development of comprehensive solutions to these problems requires approaches that integrate them all. This integration is most effectively accomplished at the design stage, including each as design parameters [Quinn et al. 1998]. Without considering all of these in healthcare design, we risk simply shifting hazards from one constituency to another [Quinn et al. 2006].

Design for OSH can be applied at all organizational levels of work in the healthcare industry, including the (1) product-user interface; (2) processes, materials, equipment, and associated work practices; (3) engineering controls, (4) work organization and policies; and (5) built environments (i.e., building design, construction, and maintenance). These levels will be used to organize the following discussion and recommendations.

Research Gaps and Needs

Product-User Interface

Patient safety is the first concern of healthcare workers. This has led to the perception that patient safety and healthcare worker safety are in conflict. While many healthcare workers are expected to risk themselves to assure patient safety, in reality, both are critical for good patient care and thus must be considered simultaneously when designing medical devices. Medical device manufacturers often consider the "user" of medical products and devices to be the patient. However, in order for the patient to use the device, it must be administered, maintained, and/or disposed of by a healthcare worker. Thus both the healthcare worker and the patient are "users."

This direct linkage of device, healthcare worker, and patient often goes unrecognized in medical product design. For example, the Federal Drug Administration (FDA) requires demonstration of patient safety for new devices and drugs, but healthcare worker safety is not required for FDA approval. Manufacturers frequently develop devices with limited input regarding how they will be used in the workplace. As a result, healthcare workers are particularly adept at adapting devices for specific applications. For example, duct tape on devices is universal in the clinical setting. Much of the adaptation is a result of manufacturers not understanding the breadth of applications for a device. Having to constantly adapt a device puts great pressure and time demands on a very busy workforce and may compromise both patient and healthcare worker safety.

Appropriate user-based design would incorporate user input from the very beginning by involving potential users in a needs assessment. Even when clinicians become designers, they may fail to get the full range of healthcare worker input on the usability of a device. If input is sought during the manufacturing process the product or device is usually in the late stages of development. Input from a broad group of healthcare workers, as well as from trained users, should be sought before a device is developed. Criteria developed by these groups should be broadly used. In addition, healthcare workers from across the healthcare industry should be involved in this process; for example, a device may have impact on housekeeping and central supply as well as the clinicians who use the device. Interdisciplinary groups of healthcare workers should be trained in principles of design so that they see a role for their input into the design/re-design process and can talk to device designers. Conversely, device designers should have the opportunity of being apprenticed to a broad group of healthcare workers so that they understand the realities of the environment where the device will be used.

Processes, Materials, Equipment, and Associated Work Practices

A material or process cannot be designed successfully without understanding its function in the production process, the associated job requirements and work practices, and the final product or service to which it contributes [MA TURI 1998]. It is this interface that links OSH with the design of medical products, equipment, and facilities. A new design must provide the necessary production process function and enable the work to proceed efficiently, as well as eliminate the hazard. Quinn et al. [2006] have proposed a worksite-based method for targeting, designing, and implementing a new product, material, or process used in healthcare. Here, the term "process" is broadly defined to refer to the procedures involved in producing medical care. Many design concepts were originally developed in the manufacturing sector, which uses the term "production process." This term is used in our discussion of the healthcare industry in order to maintain a common language across sectors.

In a pilot study to apply and evaluate the worksite-based design methods in six hospitals, Quinn and colleagues [2006] identified several research, practice, education, and policy needs:

- Healthcare workers (administrators, clinicians, laboratory scientists, technicians and facilities support staff) did not see themselves as having a role in the design of the products, equipment, or related processes that they used. They saw themselves as having some role in the redesign of work practices but viewed these as separate from the materials and products they used; i.e. the products and materials were often accepted as given or modified by the workers on an individual basis. There was no systematic way for the healthcare workers to have input into the design process.
- Designers and manufacturers of medical devices and materials had limited, if any, communication with the healthcare workers.
- Information about alternative materials, products, and devices did not exist in a form that was readily accessible to healthcare workers.
- Few alternative designs for products, materials, and equipment were available, even when healthcare workers recognize the need to search for a better design.
- OSH professionals are well positioned to participate in healthcare design efforts but will need new training to redirect and maximize their abilities. To date, OSH professionals mostly have been relegated to "control" activities and thus have been viewed as peripheral to design and to the primary production processes/services.

Work Organization and Policies

The successful design and implementation of new products, materials, and work procedures involves a social process, as well as a technical one. Product and process design should incorporate the input of those who use it. A new design cannot be implemented successfully in the long term without the participation of the workers affected by the change because they understand the functions and work practices best and, ultimately, will or will not maintain it. The most successful implementation of newly designed materials and processes occurs when all parties involved are represented in the change [Quinn et al. 2006]. This is true whether the redesign is focused on a material or product (e.g., replacing formaldehyde in pathology) or on a worksite policy (e.g., implementing a hospital mercury elimination policy).

Work organization can affect the type of design solutions implemented. Quinn et al. [2006] found that hospital staff preferred direct substitutes for chemicals rather than selecting an entirely new design that required significant work reorganization. For example, a pathology lab team preferred replacing formaldehyde as a tissue fixative

with another chemical that could be "dropped into" the existing work process over microwave tissue fixation that might have been safer and more cost efficient in the long run but required significant work reorganization.

It is often easier for managers to engage in OSH improvements that focus on materials and process redesign, rather than hazard identification and control only. Managers often view exposure controls, such as laboratory fume hoods or personal protective equipment, as necessities but ones that constrain productivity by taking time and resources away from the main production process. In contrast, the search for alternative designs represents innovation and solutions and is thus seen as building the organization, even if the design process requires extra work.

The successful implementation of a new design requires commitment at all levels of the healthcare facility. Top management commitment is needed for employees to understand that innovative design is an organizational priority. They need to know how design efforts can improve the organization and their working conditions. Commitment of midlevel managers and frontline clinicians is needed to implement new designs; commitment is needed from facilities operation staff to maintain the design.

Built Environments: Building Design, Construction and Maintenance

Many hospitals in the U.S. were built shortly after the World War II and are now entering a period of significant renovation or new-building construction.

One of the most promising areas of developing research in healthcare design is the field of evidence-based architectural design, so-called because of its dependence on the findings from research linking the physical environment of hospitals to patients and staff outcomes [Hamilton 2003; AHRQ 2003; Guenther and Vittori 2007]. Recent highlights aspects of hospital architecture with the potential to "reduce staff stress and fatigue and increase effectiveness in delivering care, improve patient safety, reduce stress and improve outcomes, and improve overall healthcare quality" [Ulrich et al. 2004; IOM 2007]. Some examples include design for infection control, design to maximize natural light, design to reduce noise and distractions, design of private rooms with space for a family caregiver, and design of healing gardens to reduce stress and increase the emotional resiliency of patients, their families, and healthcare workers [Brown and Gallant 2006; Ulrich et al. 2004; AHRQ 2003].

Another area of increasing importance is "green" or environmentally sound building practices. This includes concern for building materials that emit formaldehyde and other hazardous substances, sustainable energy, indoor air quality, elimination of mercury, and reduction of building impacts on human health and the environment. The U.S. Green Building Council developed Leadership in Energy and Environmental

Design (LEED), a nationally accepted bench program recognizing efforts in the design, construction, and operation of green buildings including healthcare institutions.

Much of the research deals with the creation of healing environments for patients, with relatively fewer studies focusing on the potential of design to favorably impact the health and safety of healthcare workers. More work needs to be done to further understand the potential for design to reduce employee risk of exposure to infectious diseases such as SARS [Jiang et al. 2003], *Aspergillus fumigatus* [Smedbold et al. 2002], tuberculosis [Menzies et al. 2000], and even sick building syndrome. Other environmental exposures with a growing body of research suggesting potential risks to healthcare workers, as well as the potential for informed design to make improvements, include high intensity light sources [Fox and Henson 1996], noise [Topf and Dillon 1988], and poor ergonomic design of patient areas [Garg and Owen 1992]. There is also the need to better understand the role of patient falls and injuries in contributing to staff falls and injuries. An example would be when a patient falls while being helped to the bathroom and injures a staff person during the fall; another example would be when a patient is being transferred to a stretcher or bed and a staff person is injured during a lift associated with the transfer [Ulrich 2006]. The mandate to further explore the potential for healthcare design to create safer environments for healthcare workers is fueled by the aging of the nursing workforce, coupled with the nursing shortage. The average age of nurses is nearly 50 years and nursing jobs have high turnover and vacancy rates [American Association of Colleges of Nursing 2008].

What is particularly difficult to quantify is the "value" of good healthcare design to healthcare workers. Some work has been done on the business case for safer workplace for medical and nursing staff, but much work remains to be done [Rizzo et al. 1998]. While it is somewhat intuitive that safer design is more cost-effective for healthcare facility operators, it is still important to document the financial impact of adverse staff events such as falls, lost time at work due to illness, the medical costs of treating a workplace injury or illness, lost productivity, the cost of alternate staff such as temporary or contract workers, recruiting costs for replacement workers, and overtime for other staff.

As the momentum of evidence-based design reaches into healthcare architecture practices worldwide, it will be increasingly important to study the interface between management, clinical operations, and design. Conventional management paradigms may not be compatible with new facilities designed to accommodate new clinical models aimed at improving worker and patient safety. In addition, as evidence-based design gains momentum in the workplace, and as design guidelines begin to find their way into healthcare building codes and standards, it will become increasingly important for the design and construction professions, jointly with the healthcare

clinical and administrative teams, to see themselves as coresearchers. The imperative to validate and further clarify emerging evidence-based design research findings and the need to greatly expand basic research activities will drive these various healthcare professionals into alliances with new mandates and new opportunities for not only improving healthcare delivery at the facility where they are working but also for contributing new and meaningful design insights to the profession in general. Such a wave of activity will invite all of those working in the healthcare field to embrace research as an integral aspect of routine architectural practice and not something that is only done in academic settings by a select few faculty researchers.

Recommendations

Linking Designers, OSH professionals, and Frontline Users for Promoting Healthy Healthcare Design

Research and demonstration projects should be aimed at developing interdisciplinary efforts between designers and the healthcare workers (clinicians, support staff, and administrators). This should include the following:

- Identify existing models and methods where effective design-user collaboration has been implemented and develop these models for wider dissemination throughout the healthcare industry.
- Develop case studies and other research to identify and evaluate the role of design as an effective intervention for improved health and safety at all levels of healthcare work organization.
- Identify how frontline workers (i.e., those using the product/process/policy/building) can be a part of design teams.
- Integrate OSH professionals and their input into the design teams and processes aimed at all levels of healthcare.
- Conduct demonstration projects where OSH issues of healthcare workers are incorporated into existing design approaches aimed at patient safety.

Information Systems for Improved Design

A clearinghouse should be developed of research related to national and international healthcare PtD and good practices. This should include the following:

- **For Designers.** Develop research and implement and evaluate demonstration projects to determine how to make OSH information accessible to designers so that it can be used when critical design decisions are being made about materials, products, equipment, processes, work practices, and building construction in healthcare. An example is a database of OSH characteristics of

materials, processes, and applications. This might include the ergonomic aspects, toxicity information, and also the track record on injuries and illnesses related to specific materials, equipment, products, and their applications.

- **For healthcare clinicians, administrators, and OSH professionals.** Conduct research and implement and evaluate demonstration projects to determine how to make information on alternative, safer, and/or healthier products, materials, equipment, and building designs accessible to clinicians, administrators, and OSH professionals working in healthcare.

Training and Education

- **For OSH professionals.** Develop *Prevention through Design* (PtD) curricula and training materials to be used in (1) academic courses and programs and (2) professional continuing education training. The curricula should emphasize the complexities of the healthcare industry and work environment and the unique context in which patient safety predominates.
- **For healthcare workers (clinicians, support staff, and administrators).** Develop, implement, and evaluate training on design processes and related OSH issues and how frontline workers (nurses, doctors, clinicians, and those doing support work such as facilities management) can participate in the design process.
- **For designers and materials scientists.** Develop, implement, and evaluate training on design processes and related OSH issues so that designers and materials scientists can understand the complexities of OSH in healthcare and basic principles of OSH for end users. They need to learn the language and conceptual framework for incorporating OSH into design. Medical-product design students should work on OSH teams in hospitals. Device designers should have the opportunity to apprentice to a broad group of healthcare workers so that they understand the realities of the environments and working conditions where the device will be used.
- Link the above groups in training sessions so professionals learn to communicate with healthcare workers and adapt their designs in the field where their products are used.
- Develop a manual for designers and engineers that serves as a primer on OSH and how OSH issues can be incorporated into designs for new products, processes, buildings, etc.

Economics

- Conduct a comprehensive review of existing information and case studies on the economic advantages of PtD in healthcare. For example, a very powerful

business case study [Collins et al. 2004] addressing the economic benefits of patient lifts is discussed in Chapter10.

- Evaluate the potential economic advantage for healthy and safe design in future healthcare work. For example, recruiting and retention of high quality clinicians and administrators may be enhanced through healthy building design.
- Work with group purchasing organizations (GPOs) and other healthcare purchasing systems to develop and evaluate more flexible methods to get designs for new safer, healthier products into the markets quickly. GPOs should articulate OSH design parameters in their criteria for evaluating the products, devices, and services for which they contract.
- Evaluate methods for linking OSH with "environmentally preferable" purchasing programs in hospitals and other healthcare settings.

Policy

- Develop recommendations for standards and guidelines for healthy building and product design for healthcare. This is particularly important to address long-term needs. On average, hospital CEOs remain on a job for only a few years and so long-term benefits may not be addressed through business and management approaches only. A new building will impact workers, patients, and community members for many years. Standards and guidelines are often viewed as helpful by building designers.
- Explore jointly sponsored research, demonstration programs, and training among the agencies (e.g., AHRQ, EPA, and NIOSH) involved in the health and safety of workers, patients, and the environment.
- Establish a "Center" devoted to the health and safety issues of healthcare workers, analogous to the Center to Protect Workers' Rights for the Construction sector.

Research and Surveillance

- **Understanding the role of design in OSH.** Expand existing healthcare injury and illness surveillance systems and develop new systems to gather information about the products, materials, processes, and work practices that contributed to workplace injury or illness. Develop methods to feed this information back to designers so that OSH can be incorporated into redesign/design efforts. For example, sharps injury surveillance should gather information on the features of the devices related to the injuries, how the devices were used, and procedures for disposal.

- Partner with healthcare design firms to identify who makes design decisions that impact OSH. Identify the decisions that have major impacts in healthcare and evaluate the feasibility of integrating OSH parameters into these design decisions.

Design Evaluation and Continuous Improvement and Future Directions

- **Oversight and planning at the facility level.** Once a healthcare facility is constructed, implement an ongoing committee to address future technological changes in healthcare and to anticipate the impacts these changes may have on workers, patients, and healthy building design.

OSH Design and Globalization

- Explore international models for healthy healthcare design and evaluate their adaptability to the U.S. setting.
- Disseminate advances in designs that promote OSH throughout the U.S., including community, rural, and home healthcare settings. Dissemination should be to healthcare workers globally, not just to resource-rich nations or healthcare systems. Develop research that can make new designs usable and affordable in less resource-rich areas.

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Chapter 9 ▪ Healthcare and the Environment

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Introduction

The healthcare work environment is inextricably linked to worker and environmental health and safety. Healthcare procedures and materials can present health and safety hazards for workers while generating environmental pollution and consuming energy and other natural resources. At the same time, human health and the need for healthcare are impacted by environmental factors such as natural disasters and pollution, and these in turn can place a burden on the healthcare system and its workforce. Worker and environmental health and safety are often studied separately and so we have a limited understanding of their interrelation. Yet, occupational and environmental hazards, as well as patient safety hazards, arise from the same source—healthcare practices, products, materials, and the built environment—and so the development of comprehensive solutions to these problems requires an approach that integrates them [Quinn et al. 1998, 2006]. This section provides a brief description of the links between environment and healthcare and recommendations to evaluate these links further so that effective interventions can be developed.

The Environment-Healthcare Link

The United Nations Environment Programme provided a large-scale peer-reviewed assessment of the health of the earth's ecosystems [UNEP 2007]. The findings indicate that in the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period. Approximately 60% of environmental services related to air quality and the purification of water are being degraded or used unsustainably. In the same period, the world's human population has increased from 2.4 billion to 6.4 billion. Much of this growth has occurred in increasingly large cities where mega-slums proliferate. Mega-slums are incubators of new and re-emergent infectious diseases that quickly spread throughout the world via air travel. These highly populated, poor areas also intensify the disastrous impacts of the earth's natural forces, like floods and hurricanes.

Over the past 50 years, there has been an accelerated release of artificial chemicals into air, food, and water sources. Many of these persist in the environment

for years [UNEP 2007]. Environmental epidemiology and toxicology studies are increasingly providing evidence that chronic diseases such as cancer and heart disease are related to some of these pollutants [Smith et al. 1999; Siemiatycki et al. 2004; Weinhold 2004; Brody et al. 2007]. These chronic diseases place an enormous burden on the healthcare system, including healthcare workers.

In the U.S., the need for healthcare is growing as the population lives longer with more chronic diseases. When patients enter the healthcare system with an acute disease, such as a newly emergent infectious disease, they are likely to have underlying chronic disease. This means that more people enter the healthcare system with needs for multiple procedures, thus placing a greater demand on healthcare workers.

At the same time, there is a growing nursing shortage in the U.S. and other industrialized countries. The increasing needs of the population for healthcare and the shortage of healthcare workers are resulting in more intensive international recruitment of aides and nurses. A literature review by Janiszewski Goodin [2003] explored factors for the severe shortage of registered nurses in the U.S and concluded that facilitation of the immigration of foreign healthcare professionals is a critical solution. Internationally, the global healthcare professional shortage has fostered a fierce competition, sometimes with aggressive recruitment campaigns [Maybud and Wiskow 2006]. For the U.S., a 20% deficit in the registered nurse workforce is forecasted by 2020 unless the current trends change [Janiszewski Goodin 2003; Maybud and Wiskow 2006]. Immigrant home healthcare clinicians increased by 114% during 1990–2000, compared to a 31% growth of U.S.-born clinicians [Paral 2004]. A review of direct care workers in long-term care revealed that half of home health aides were nonwhite and 89% of them were female [Wright 2005]. These shortages of U.S. healthcare workers are occurring while environmental changes are placing an increasing burden on the healthcare system. The shortages are influencing the demographic composition of the U.S. healthcare workforce, and this will place specific language and cultural demands on occupational safety and health training and education in the healthcare industry.

The Healthcare-Environment Link

The healthcare industry, including hospitals, nursing facilities, clinics, and home care, has a significant impact on the environment through hazardous, solid, and medical waste; air and water emissions; and consumption of raw materials and energy. Hospitals alone generate more than 2 million tons of waste annually [HCWH 2007] and are respectively the third and the fourth largest source of pollution from dioxins and mercury in the U.S. [USEPA 1997, 2001]. U.S. medical facilities spend $5.3 billion annually on energy and rank second only to the food service industry

in intensity of energy use [USDOE 2006]. With regard to the work environment, many healthcare workers routinely experience biological, chemical, physical, musculoskeletal, work organization, and safety hazards [NIOSH 1998; 2002]. These occupational safety and health hazards are addressed in more detail earlier in this document.

Improvements for Worker, Patient, and Environmental Health and Safety

Some hospitals are initiating efforts to address worker, patient, and environmental health and safety using integrated approaches. Examples of these include the following:

- Introduction of new mopping systems that provide improved infection control and ergonomic design as well as using less water and cleaning chemicals. The hospitals are seeking alternative cleaning products without respiratory irritants and other human and environmental toxins [Quinn et al. 2006].
- Use of mercury-free sphygmomanometers. Mercury exposures generated in the work environment through equipment breakages and spills are hazardous to workers and patients [USEPA 200]. Cleanup costs can be very expensive for hospitals [SHP 2003]. In the ambient environment, mercury is toxic to aquatic life and persists for years. Fish in many U.S. lakes contain such high mercury concentrations that restrictions on consumption are recommended for population subgroups such as pregnant women and children.
- Use of polyvinyl chloride (PVC)-free, resilient flooring. The production of PVC is a significant source of chlorine pollution. When incinerated, PVC can release dioxins. Recent research on slips and falls indicates that there are alterative surfaces for flooring that are less slippery than vinyl when wet, that generate less noise, that ease foot and back strain for healthcare workers, and that do not require stripping and waxing chemicals.
- Establishment of farmers markets and other sources of locally grown, wholesome, organic foods at hospitals. These markets provide food for patients, their families, and the hospital workers.

Research Gaps and Needs

While there is considerable literature on the impacts of U.S. economic and demographic changes on the healthcare workforce, little information exists regarding the impacts of environmental changes and their impacts on the health and safety of healthcare workers. In addition, there is a lack of information on the economic

costs of occupational and environmental hazards in the healthcare industry. Many healthcare facilities purchase their products and materials through group purchasing organizations (GPOs) which often do not include environmental and occupational health and safety criteria in their purchasing specifications. GPOs serve hospitals and other healthcare organizations by negotiating a contract for a group of healthcare organizations with suppliers of medical products and devices. This is beneficial because it increases the buying power of a single healthcare organization but often commits it to a multiyear contract, making it difficult to switch to a safer, more environmentally sound product as it becomes available.

Numerous initiatives have been established recently by government, industry, labor, and community groups (e.g., U.S. Environmental Protection Agency (EPA), The Joint Commission, and government-industry-labor-community group collaboration Hospitals for a Healthy Environment) to foster pollution prevention in hospitals and other healthcare facilities. Thus far, many of these initiatives focus on replacing hazardous materials to reduce pollution without considering the work environment. Without considering occupational and environmental health and safety in concert, we will develop impoverished solutions and may simply shift the risks from one to the other.

Recommendations

Research

- Develop case studies and other research to identify how occupational and environmental safety and health are linked and to identify effective, integrated interventions at all levels of healthcare work organization.
- Foster research on the development of integrated frameworks and methods to assess occupational and environmental safety and health problems and on effective, integrated intervention methods. These methods should focus on "designing out" the hazards at their source (see Chapter 8, Healthy Healthcare Design Section).

Training and Education

For occupational safety and health professionals

- Develop integrated occupational and environmental safety and health curricula and training materials to be used in (1) academic courses and programs and (2) professional continuing education training. These materials should focus on teaching integrated methods to "design out" both occupational and environmental hazards at their source (see Chapter 8, Healthy Healthcare Design Section).

For healthcare clinicians, administrators, and occupational safety and health (OSH) professionals

- Develop education and training materials showing the links between occupational and environmental health and safety and what healthcare workers can do about them.
- Conduct research and implement and evaluate demonstration projects to determine how to make information on alternative, safer, healthier, more environmentally sound products, materials, equipment, and building designs accessible to clinicians, administrators, and OSH professionals working in healthcare. The specifications of new, improved designs should be made available to all healthcare facilities and their employees.

For medical product and device designers and materials scientists

- Develop, implement, and evaluate training about design for OSH and the environment.
- Develop a manual for designers and engineers that serves as a primer on OSH and the environment and shows how OSH issues can be incorporated into new healthcare designs for products, processes, buildings, etc.

Economic

- Evaluate the potential economic advantages and costs related to occupational and environmental health and safety in the healthcare industry.
- Evaluate methods for linking OSH with "environmentally preferable" purchasing programs in hospitals and other healthcare settings.
- Work with GPOs and other healthcare purchasing systems to develop and evaluate more flexible methods to get designs for new safer, healthier and more environmentally sound products into the markets quickly. GPOs should articulate occupational and environmental design parameters in their criteria for evaluating the products, devices, and services for which they contract.

U.S.-Global Environmental and Occupational Safety and Health

There is growing evidence that global changes in ecosystems and in economic and workforce systems will have an impact on the occupational safety and health of U.S. healthcare workers. Research is needed to identify these impacts and the magnitude of their effects on U.S. workers.

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Chapter 10 ▪ The Business Case for Managing Worker Safety and Health

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Today's successful companies recognize that worker safety and health is not only the right thing to do but must be managed like any other part of the business. Many of these companies increasingly rely on a systems approach to occupational safety and health management and foster a culture where everyone in the organization—senior management, supervisors, and employees—values, takes responsibility for, and is accountable for health and safety performance. Additional advantages of the systems approach, compared to a more traditional programs approach, include the alignment of business and occupational safety and health objectives as well as the integration of occupational safety and health within a business framework, which in turn better accommodates performance measurement and continuous improvement [ILO 2001].

Making the Case for Occupational Safety and Health Management Systems

Although the differences between occupational safety and health management systems (OSHMS) compared to the traditional health and safety programs are not consistently defined, OSHMS are more proactive than programs, according to a recent systematic review by the Institute for Work and Health (IWH) [Robson et al. 2005]. Also, because systems integrate individual programs within the business operations and the external environment, they are more comprehensive than single programs [ILO 2001]. For example, companies participating in OSHA's Voluntary Protection Program (VPP) implement comprehensive safety and health management systems and have achieved exemplary occupational safety and health performance [OSHA 2008]. There is increasing evidence that companies that follow VPP guidelines experience reductions in rates and costs of lost-workday injuries and illnesses as well as other benefits such as lower employee turnover and increased productivity [OSHA 2007b]. According to OSHA, companies that implement effective safety and health programs can expect reductions of 20% or greater in the injury and illness rates and a return of $4 to $6 for every $1 invested [OSHA 2005]. Others have estimated the return on investment ranging from $3 to $8 for every $1 invested in improving workplace safety and health [Liberty Mutual 2001; ASSE 2002].

In healthcare and social assistance, implementation strategies of OSHMS interventions aim to prevent or minimize hazards and risks to workers, increase worker productivity, and, at the same time, improve the quality of service to patients or clients. This, in turn, results in better care and safety for these patients and clients—both of which are critical goals for organizations in healthcare and social assistance.

Assessing the Evidence on the Effectiveness of OSHMS

The IWH systematic review mentioned above assessed the overall effectiveness, facilitators and barriers to adoption and effectiveness, as well as cost-effectiveness of OSHMS [Robson et al. 2005]. From over 4,800 studies initially compiled through an extensive search of peer-reviewed literature, only 9 met the criteria for inclusion and extensive quality. Inclusion depended on whether the studies assessed an OSHMS intervention as defined by two conditions: (1) the studies under review had to contain 2 of the 27 elements of a comprehensive occupational safety and health framework [Redinger and Levine 1998], and (2) one of these elements had to be a management element rather than an activity or operational element. Nine of the 27 elements were considered distinctly system-like and were included in evaluation, improvement, or integration categories. The remaining elements were included in more common categories of occupational safety and health management programs and systems, such as management commitment, employee involvement, identification and control of hazards, and training [OSHA 2007a; NIOSH 1998; NSC 1994; BWC 1995; JCR 2004].

Both voluntary and mandatory management systems were assessed by the IWH review. The studies reviewed did not provide high-quality evidence on facilitators and barriers to adoption, but they did provide some information on the effectiveness of OSHMS interventions. Even though the evidence of the effectiveness of OSHMS is not strong because of the limitations of the studies that were considered, favorable outcomes were consistent among both the voluntary and the mandatory systems assessed. Outcomes of voluntary OSHMS interventions seem to include improved safety climate, increased hazard reporting by employees, more organizational action on occupational safety and health, and decreases in workers' compensation costs. Outcomes of mandatory OSHMS interventions seem to include increased health, safety, and environmental awareness; improved employee perceptions of the working and psychosocial environment; increased worker participation in health, safety, and environmental activities; decreases in loss-time injury rates; and increases in worker productivity [Robson et al. 2005].

Case Study 1: Savings From Utilizing Data Systems to Develop and Monitor Occupational Health Interventions Occupational Health Interventions

One of the nine studies that were included in IWH's review of OSHMS assessed occupational health in a large Canadian hospital with 6,000 employees [Yassi 1998]. Though the cost of the intervention was not assessed, the reduction in premium rates of the workers' compensation board resulted in a savings of over $2.8 million. Elements of this particular intervention included improved record keeping, improved data collection and analyses, risk assessment, assigning the responsibility for specific elements to specific individuals, performance measurement, continuous improvement, and economic evaluation [Robson et al. 2005].

Lack or Inconsistent Use of Standardized Methodology and Tools

Several issues prevent the meaningful synthesis of existing evidence and conclusive assessment of the effectiveness and cost-effectiveness of OSH interventions. Among these issues are the lack of consistent definitions of key concepts (such as programs versus systems), the inconsistent use of available standardized methodology for economic evaluation, and the lack of audit instruments that are proven to be reliable and valid. For example, published studies do not consistently adhere to guidelines on appropriate economic evaluation techniques developed by the Centers for Disease Control and Prevention (CDC) that are consistent with similar and more formal guidelines developed by the Office of Management and Budget [OMB 2003] and the Institute of Medicine [IOM 2006]. The published studies typically lack a standardized methodology for assessing the cost-effectiveness of interventions [Haddix et al. 1996]. Widespread adherence to standardized guidelines, such as those developed by CDC, IOM, or OMB, would represent a major improvement in the quality of economic evaluations. In addition, another systematic review by IWH revealed a limited number and weak quality of existing studies on audit instruments or tools for assessing OSHMS [Bigelow and Robson 2005].

Costs and Consequences Usually Not Considered in Economic Evaluations*

The first step toward a comprehensive economic evaluation is to identify all the costs and benefits most relevant to a particular intervention. Even though they

* The material in this section as well as parts of later sections on indirect costs, nonoccupational costs, and a more holistic approach that includes a focus on design draw from Pana-Cryan and Bushnell [2008].

might not easily be quantifiable, many costs and consequences associated with occupational safety and health programs have the potential to be substantial and would therefore be important to consider. A recent study [Bushnell 2007] that aimed to provide guidance on the specific costs and consequences that should be considered in economic evaluations, detailed a wide range of relevant potential costs and consequences from the employer's perspective. Some of these costs and consequences are summarized below.

Costs and consequences of intervention (not related to the safety and health of employees):

- Cost of the intervention (comprising investment in training and equipment, ongoing time expenditures of employees, and other costs).
- Productivity impacts, both positive and negative, of changes in work methods or technology.
- Impacts on quality of product or service due to change in methods or technology.

Costs of employee injury and illness to be reduced by intervention:

- Absenteeism due to injury or illness
- Work stoppage due to job-related injury or illness
- Presenteeism (when employees come to work in spite of an injury or illness)
- Workers' compensation
- Personnel turnover
- Medical costs
- Short- and long-term disability costs
- Return to work program costs and case management of injured or ill workers
- Physical damages due to injury-causing incident
- Response to injury- or illness-causing incidents and assistance of affected employees
- Additional required inspections
- Legal costs
- Poor relationships among employees and management
- Tarnished reputation with investors, business partners, and potential employees

Making the "business case" for a health and safety intervention usually means that it pays for employers to invest in worker safety and health. In other words, referring

to the business case implies reference to an economic evaluation conducted from the employer's perspective that by definition includes costs and benefits accruing only to employers. However, it is important to note that much of the cost of occupational injuries and illnesses is usually not visible on either the societal (that includes all costs and benefits) or the employer level. National surveillance systems miss many injuries and most illnesses and include only a small amount of information on their costs. Both epidemiological and intervention effectiveness studies typically include little or no economic evaluation. As a result, economic evaluations often are pursued after safety and health studies have been completed, resulting in a retrospective and incomplete collection of economic data. In addition, much of the information that could be very useful for assessing costs of injury and illness is often proprietary and therefore unavailable or expensive, although this is changing. Therefore, all stakeholders in our society have an incomplete understanding of the economic and other consequences of occupational safety and health interventions.

Towards a More Holistic Approach to Costs and Consequences of Occupational Injury and Illness

Evidence for the business case for managing worker safety and health is building. Such evidence comes from several sources: targeted interventions addressing specific hazards, an improved understanding of the importance of indirect costs, efforts that focus on the "whole" worker (rather than separating the safety and health issues workers face at work from those they face when they are away from work), a better understanding of work organization factors, and initiatives which "design out" or minimize hazards and risks early in the design process. As our understanding evolves in all these areas, our ability will improve to incorporate this knowledge into comprehensive and integrated business and occupational safety and health systems that also are proven to be cost effective. Employers are urged to invest in best practices and adopt a more holistic approach to enhance their understanding of the costs and consequences of occupational injury and illness.

Case Study 2: Return on Investment in Safe Patient Lifting and Handling

A NIOSH study evaluated the effectiveness of a safe resident lifting and movement intervention in six nursing homes [Collins et al. 2004]. Patient handling injury rates and workers' compensation costs for the first 3 years of the implementation of safe patient lifting intervention were compared with rates and costs for 3 years prior to the intervention. During the 3 years prior to the implementation of the intervention, the nursing home company spent $441,670 on workers' compensation.

After investing $158,556 for patient lifting and handling equipment and worker training, workers' compensation expenses were reduced 61% to $277,061, representing a cost savings of $164,609. Additionally, lost workday injuries fell by 66%, restricted workdays dropped 38%, and the number of nursing staff suffering repeat injuries also declined. As an additional benefit, better patient handling resulted in a 50% reduction in the rate of resident assaults on staff during lifts and transfers. The return on investment (ROI) for direct costs of the equipment and training was less than 3 years based on the savings from workers' compensation. The calculated ROI would have been shorter if savings from indirect costs, such as the cost of recruitment and training of new nursing staff, were calculated.

The Importance of Indirect Costs

Because of its intuitive appeal as a direct consequence of the intervention, workers' compensation is the cost category most commonly utilized in economic evaluations of safety and health interventions from the employer's perspective. However, recent research provides evidence of the importance and magnitude of productivity losses [Parry 2006]. Recent research also highlights that specific cost categories, other than workers' compensation, are much larger than previously recognized. For example, there is evidence that for many occupations and work settings, the cost of a worker's absence is substantially higher than the worker's wage during the period of absence [Nicholson 2007].

The importance of costs beyond direct payments to insured employees and medical providers also is revealed in a survey, sponsored by Liberty Mutual, of 200 executives responsible for workers' compensation and other commercial insurances at medium and large companies [Liberty Mutual 2001]. The survey showed that 93% of the executives surveyed recognize there is a relationship between direct and indirect costs (e.g., training and compensating replacement workers, low employee morale, increased absenteeism, and poor customer and community relations) with 40% of them reporting that $1 of direct costs generates between $3 and $5 of indirect costs.

The Interrelationship of Occupational and Nonoccupational Costs and Consequences

Employers have increasingly focused on the benefits of improving the health of their workforces, both to control healthcare costs and because they recognize the benefits of health for productivity. As a result, there is currently much more readily available information about the costs of ill health to employers. However, there is still relatively little appreciation of the potential role of occupational conditions in health and

health costs. NIOSH's WorkLife Initiative is, in part, an attempt to correct this and focuses on the integration or coordination of comprehensive employer programs, policies, and practices for worker health and wellbeing [NIOSH 2008a] Therefore, the WorkLife Initiative promises to help employers recognize some of the costs and consequences of occupational safety and health interventions that usually are not included in economic evaluations of safety and health investments.

The Importance of Work Organization: Costs Associated with Negative Outcomes Attributable to Fatigue and Sleepiness

Demanding work schedules (e.g., long work hours per week, extended work shifts, unpredictable working hours) which can lead to fatigue and sleepiness are not uncommon among many healthcare workers particularly nurses and doctors. Several studies show evidence for similarities between fatigue-related impairment in neuro-cognitive and physiological functioning and impairment due to alcohol intoxication [Arnedt et al. 2005; Dawson and Reid 1997; Williamson and Feyer 2000]. In these studies, participants' performances were tested and compared under two separate conditions: (1) after staying awake for extended periods, and (2) after drinking alcohol to a certain blood alcohol concentration (BAC). These studies report similarities in performance when sleep deprived and when intoxicated—17 hours awake is similar to BAC of 0.05%, and 24 hours awake is similar to BAC of 0.10%. As a reference, the United States defines legal intoxication for purposes of driving as having a BAC of 0.08% or greater. Because driving impairments are seen at 0.05%, some European countries use a 0.05% cutoff. These impairments can lead to reduced performance on the job, motor vehicle crashes, and medical errors. Costs associated with these negative outcomes can be significant, especially if lives are lost.

Studies report that physicians and nurses working shift work and long work hours are at a higher risk of making medical errors and place patients' safety at risk [Landrigan et al. 2004; Rogers et al. 2004; Gander et al. 2000]. A recent report from the National Academy of Sciences concluded that as many as 100,000 patient deaths per year may be due to medical errors [NIH 2003]. Based on surveys of medical residents and other information, it is widely believed that substantial numbers of these adverse events result from fatigue among doctors and nurses due to prolonged work hours and inadequate sleep.

Adverse effects of staff fatigue from shift work and long work hours also include increased injuries and illnesses for the workers themselves as well as for others in the communities where these workers live and work. Fatigue resulting from long

working hours in medical trainees was associated with a three-fold increase in the risk of sharps-related injuries [Fisman et al. 2007]. In addition, doctors, nurses, and other healthcare providers who work long hours were found to be at higher risk for automobile crashes and as a result could be a danger to other drivers on the road [Barger et al. 2005; Kirkcaldy et al. 1997; Novak and Auvil-Novak 1996].

Employers should have a financial interest in reducing detrimental effects of shift work and long work hours. According to a study by Circadian Technologies, the excess costs of work schedules in the 24/7 economy is estimated at $206 billion per year, or $8,600 per shift worker per year, due to increased absenteeism, turnover, healthcare costs, workers' compensation, and lost productivity [Circadian 2007].

The legal system also has been pursuing both workers and their employers for the consequences of errors due to fatigue and sleepiness. In a recent case, a hospital settled for almost $2 million with a family of a 16-year-old woman who died as a result of a medication error; the experienced nurse who had worked long hours gave the patient an intravenous anesthetic instead of an antibiotic [Rathbun 2007]. In another case, a nurse's aid was charged with vehicular manslaughter for crashing into and killing a utility worker who was working on the side of the road [Gettys 2008]. The press reported she was driving home after completing a 12-hour-long night shift and apparently fell asleep while driving.

In addition to these more immediate consequences of adverse work organization factors on worker and patient safety and well-being, another negative impact on society is the loss of workers with critical public safety skills who leave the workforce because of demanding work schedules. Long work hours may be contributing to the U.S. nursing workforce shortage that is expected to accelerate by 2010; long work hours are a top reason given by nurses for leaving their jobs [Hart 2001].

"Designing Out" Hazards

In integrated management systems there is a reciprocal relationship between business and occupational safety and health objectives, so that focusing on business objectives, such as efficiency and quality of service, leads to improvements in occupational safety and health. This relationship demonstrates that when integrated and holistic management systems focus on design, the result is effective solutions for occupational safety and health issues. The reverse argument also seems true: the improved awareness of the variety of benefits of reducing worker injuries and illnesses can support consideration of a more holistic approach to designing management systems, specifically with respect to economic evaluation.

The components of such a holistic approach have long been recognized in other contexts. Occupational safety and health needs are addressed in the design process to

prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of materials, facilities, and equipment. Such an anticipatory design approach to problems affecting worker safety and health naturally leads to reconsideration of other fundamental systemic issues, such as environmental impacts and lapses in product and service quality, all of which can be reduced early in the design process, rather than coped with later on.

Design considerations lead to eliminating hazards or risks through a fundamental change of process by focusing on the top levels of what is referred to in the field of industrial hygiene as "the hierarchy of controls." Some intervention strategies are designed to accept the presence of hazards and deploy protections that usually are not wholly effective or consistently used. Therefore, interventions planned during the design phase are nearly always more effective than interventions at lower levels in the hierarchy of controls, such as warning systems or personal protective equipment [Manuele 2007].

In addition to the direct economic benefits of NIOSH's Prevention through Design (see Chapter 8, Healthy Healthcare Design), examples of its application in different environments point to the ways an emphasis on design helps to focus on safety and health in a systemic way. These examples also show that the economic and other benefits of doing so extend beyond safety and health. NIOSH, its partners, and others are working to better understand and quantify the hidden economic benefits and other consequences of early occupational safety and health interventions [NIOSH 2008b]. In addition, work is planned on some economic aspects of Prevention through Design, focusing on management systems.

Case Study 3. Better Design of Healthcare Facilities

Beginning in 2000, a research collaborative of progressive healthcare organizations came together with the Center for Health Design to evaluate the impact of new or renovated building designs of healthcare facilities. Using evidence-based design principles, the collaborative looked at the quality of patient care, employee well-being, medical outcomes, improved safety, cost efficiency, resource conservation, and financial performance. To illustrate the business case for better healthcare facilities, researchers created "Fable Hospital," a composite of recently built or redesigned healthcare facilities that have implemented facets of evidence-based design [Berry et al. 2004]. For example, at Bronson Methodists Hospital in Michigan, replacement of the existing facility with a new 348-single-room facility helped reduce nosocomial infections by 10.1% in the 2 years following the move. Based on such evidence of the effectiveness and cost of specific design elements, Fable Hospital's case study was created.

Fable was assumed to be a new 300-bed regional medical center built to replace a 50-year-old facility. Its design was assumed to reflect core values of superior quality, safety, patient-focused care, family friendliness, staff support, sensitivity to cost, eco-sustainability, and community responsibility. As a result, design innovations and upgrades presumably added $12 million to Fable's basic construction costs and include the following:

- Oversized single rooms with dedicated space for patient, family, and staff activities and sufficient capacity for in-room procedures; the design maximizes daylight exposure to patient rooms and work spaces.
- Acuity-adaptable rooms with a standard shape, size, and monitoring and communications technology to eliminate the need to move patients as their conditions change.
- Double-door bathroom access, enabling caregivers to more easily assist patients.
- Decentralized, barrier-free nursing stations that place nurses in close proximity to their patients and supplies.
- Alcohol-rub hand hygiene dispensers located at the bedside in each patient room to reduce staff-to-patient transmission of pathogens.
- Ventilation using high-efficiency particulate air (HEPA) filtered outside air and the elimination of recirculated air.
- Flexible spaces for advanced technologies, such as operating rooms sized for robotic surgery.
- Peaceful settings that incorporate art displays, piano music, and gardens with fountains and benches to moderate the stress of the building's occupants.
- Noise-reducing measures, including sound-absorbing floors and ceilings and a wireless communications system to moderate the stress of the building's occupants.
- Consultation spaces to facilitate private communication between caregivers and families.
- Patient education centers on each floor and online support groups that improve patient and family understanding of illness.
- Staff-support facilities such as meditation rooms and a gym.

The financial impact of each of these design changes was calculated based on specific assumptions on their effectiveness and associated costs. A cost savings of $7.8 million was estimated for reductions in patient falls, patient transfers, nosocomial infections, patient drug usage, and nursing turnover. Also, nearly $3.7 million was

estimated in increased revenues from increased market share and philanthropy. Collectively, the reduced costs and increased revenues totaled $11.5 million, showing that the added costs to achieve a better building could be recouped in about a year. According to the authors, this figure was a conservative estimate because there is insufficient empirical data on potential additional cost savings such as reduced medical errors due to improved lighting and less noise.

Influencing OSHMS through Effective Business Systems

The business community increasingly recognizes the interrelation of quality, efficiency, and improved outcomes for workers and customers. An example from the business world that focuses on the efficiency of a business process and the safety and interest of patients rather than workers demonstrates the reciprocity in the ways the components of integrated systems influence each other; focusing on quality and work organization practices that benefit the business and patients results in improved outcomes for the business, the patients, and the workers.

An article on design that was recently published in the Harvard Business Review illustrates the benefits of following a holistic design approach [Brown 2008]. Four Kaiser Permanente hospitals reengineered nursing staff shift changes by focusing on process design and utilizing a project team that included, among others, a strategist (who was a former nurse), an organizational development specialist, a technology expert, a process designer and other designers, and a union representative. Nurses were spending the first 45 minutes of each shift at the nurses' station debriefing the departing shift about patients' status. Despite the time invested, incoming nurses were unsure about basic patient information, including whether specific tests had been administered, which could result in poor quality of patient care and safety. When nurses started exchanging information in the presence of the patient using a simply formatted software that continuously added data and provided a customized view for each nurse, preparation time was reduced due to the high quality of knowledge transfer. The time between arrival and first patient interaction was reduced by half, and the quality of nurses' work experience increased (i.e., their work-related stress was reduced) across all four hospitals. By applying human-centered design principles, the interdisciplinary team achieved improved patient experience as well as improved nurse job satisfaction and productivity. Consistent with results that focus on the occupational safety and health component of holistic and integrated systems, this case study concluded that designing early, often, and for the longer term incorporates better judgment and results in great long-term benefits for the organization, employees, and patients.

Summary and Next Steps

The holistic approach advocated by the integration of OSHMS with business systems aims to help employers and society overall better understand and quantify the frequently hidden costs and consequences of occupational safety and health interventions. Several ongoing efforts, best practices, and initiatives support this holistic and integrated approach and include (a) the consistent use of CDC's economic evaluation methodology; (b) improved systems of measuring and tracking of fundamental occupational safety and health indicators and related economic indicators; and (c) a process to identify the full range of relevant costs and consequences through a better understanding the importance of indirect costs, WorkLife issues, work organization issues, and *Prevention through Design*. As we accumulate knowledge, we need to focus on translating evidence-based solutions to improved and wide-spread practice and policy. For example, we need to understand if and how we can transfer knowledge from evidence-based, cost-effective best practices, such as the use of patient-lifting devices in nursing homes, into practice and policy applicable to home healthcare environments.

Future challenges for healthcare and social assistance include chronic understaffing and long hours due to shortages in healthcare professions; an aging workforce in the face of increasing demand for services; potential exposures of first receivers to unknown hazardous agents; emerging infectious diseases such as SARS and avian influenza; exposure to a variety of antibiotic-resistant pathogens; a dramatic increase in workplace violence perpetrated by clients, their families, and coworkers; and increase use of high-hazard chemicals and other potentially hazardous new technologies [NIOSH 2007]. These challenges make a compelling case in favor of integrated, comprehensive OSHMS to address spill-over effects from one system to the other, whether they are work and personal life, work and community or environmental health, or business objectives and occupational safety and health objectives. Future challenges also make the need for effective translation to practice and policy more urgent. For instance, we need to understand if and how we can transfer best practices learned from patient lifting devices to increasingly complex environments and take appropriate action.

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Section III

Specific Health and Safety Problems

Chapter 11 ▪ Musculoskeletal Disorders and Ergonomic Issues

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Work-related musculoskeletal disorders (MSD) are defined as an injury of the muscles, tendons, ligaments, nerves, joints, cartilage, bones, or blood vessels in the extremities or back that is caused or aggravated by manual-handling work tasks such as lifting, pushing and pulling, and carrying; as well as working in awkward postures with very repetitive or static forceful exertions [IOM 2001; NIOSH 1997]. Work-related musculoskeletal disorders such as low back and shoulder pain, rotator cuff tendinitis, epicondylitis (tennis elbow) and carpal tunnel syndrome are common in healthcare workers (see also Chapter 3, Burden of Injury and Illness Documented by Surveillance Systems). Nursing staff have high rates of back and shoulder injuries. In 2005, more than 20,000 recordable cases of back and other pain, carpal tunnel syndrome, and tendonitis were reported in the HCSA sector by BLS; of these, more than 42% were among healthcare support occupations such as aides and assistants. The average workers' compensation cost for back pain is $10,689, and for upper extremity disorders, $11,411 [Silverstein and Adams 2006]. As the U.S. population becomes older and heavier, the problem of MSD in HCSA workers is likely to grow.

Employment for nurses is projected to increase by 25% by 2012 creating an expected shortage in the nursing labor pool of 20% by 2015 and 30% by 2020 [American Nurses Association 2003]. The high injury rate coupled with a critical nursing shortage [Buerhaus et al. 2000] raises serious concerns about the nursing workforce's capacity to care for our nation's expanding population. Compared with other workers, home healthcare workers take longer and more frequent sick leave as a result of work-related musculoskeletal symptoms [Brulin et al. 1998; BLS 1997; Moens et al. 1994; Ono et al. 1995]. Studies have also found that middle-aged and older home healthcare workers have reduced physical capacity and "work ability" compared with workers of similar ages in other occupations [Torgen et al.1995; Tuomi et al. 1991].

Table 26 presents Washington State MSD compensable claims rates by selected body area by healthcare subsector for claims resulting in more than three lost workdays. The highest MSD rates are back injuries among nursing and residential care and temporary healthcare workers.

Table 26. Washington state workers' compensation: compensable claims rate per 10,000 FTEs by selected parts of body affected for the HCSA sector 2001–2005

HCSA Subsector/ Industry	Back	Neck	Back/Neck	Shoulder	Elbow	Knee	Ankle	Other
Ambulatory healthcare	31.66	2.27	2.55	8.55	2.04	5.31	1.40	28.40
Hospitals	72.62	4.16	4.03	21.33	2.61	11.52	2.26	47.35
Nursing and residential care	132.36	6.21	12.70	27.75	3.05	17.25	4.12	53.35
Home care	75.65	3.78	7.56	9.46	3.78	9.46	3.78	20.80
Social assistance	36.18	1.77	3.79	8.08	1.77	6.46	3.08	22.88
Temporary worker; healthcare*	80.82	2.85	10.46	20.92	N/A	6.66	4.75	23.77

Source: [WA L&I 2007]
*Represents Washington State Workers' Compensation Risk Class 7111—Temporary staffing agencies who provide healthcare services

Risk Factors for Work-related Musculoskeletal Disorders in Healthcare

Every work system requires interaction between the environment, technology, organization, task requirements, and the individual. When the interactions are out of balance, the risks of developing musculoskeletal disorders in healthcare workers are increased (Figure 23). The single greatest risk factor for MSD in healthcare workers is the manual moving and repositioning of patients, residents or clients [BLS 2004], although MSD risks are also found in housekeeping, food service and other areas where workers manually handle heavy, awkward loads or do repetitive, forceful hand work.

Home Healthcare Workers

Contrary to popular belief, home care patients are not more ambulatory and capable of self care than hospital patients or nursing home residents. About 40% of them have one or more functional limitations [Jarrell 1997], in part because patients are being released after shorter hospital stays and require more intensive

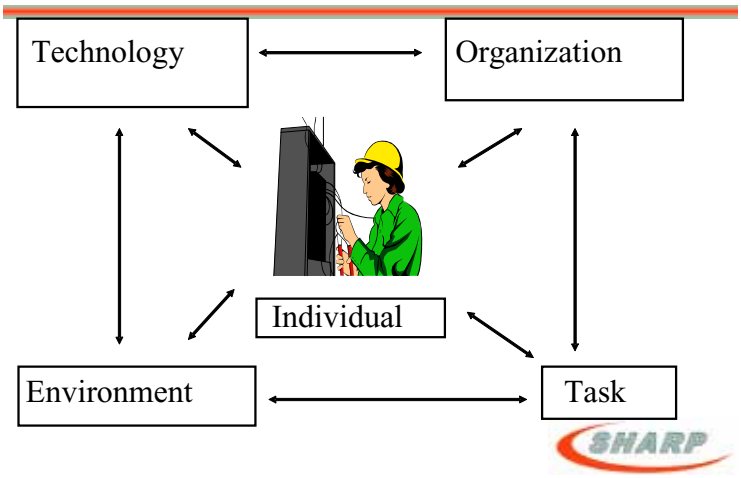

Figure 23. Five elements of the work system (Source: [Smith and Sainfort 1989])

care during recovery at home. Some of the risk factors faced by home healthcare workers are listed below:

Environment

- Confined areas (furniture and medical equipment clutter rooms/bathrooms) and beds prevent caregivers from assuming proper lifting postures.

Work organization

- Often work alone without assistance.
- Long periods of standing and walking.
- Lack of control over work planning.
- Many workers' schedules are overloaded with too many patients. Improvements in life-prolonging medicines have increased patient life expectancy, and shorter hospital stays contribute to an increasing demand for home healthcare services.

Technology

- Mechanical lifting devices are rarely available.
- Beds are typically not adjustable.

Tasks

- Frequent lifting and repositioning while bending, stooping, twisting, and reaching over low beds to assist with wound care, bathing, etc.
- Increasing size of patients makes it difficult to obtain a firm grip.
- Postural instability of patients.
- Combativeness of agitated or confused patients.
- Healthcare workers also perform physically demanding housekeeping activities including cleaning, cooking, laundry, and shopping. In some cases, these types of tasks have been found to represent an equal or greater risk of injury to home care workers than patient care tasks [NIOSH 2004].

Individual

- Home healthcare workers are aging and approximately 90% female.
- Often unaware of risks or access to alternative methods of handling clients.

Nursing Home Workers

When examining injury rates for female workers in the United States, nursing aides and orderlies have the highest prevalence (18.8%) and report the most cases of work-related back pain of all occupations [Guo et al. 1995]. In the last 5 years, there has been an increase in overall acuity of nursing home residents, including younger residents with multiple sclerosis, cerebral palsy, or brain injuries. There has also been a large increase in the number of bariatric residents with most facilities not having the beds, space or equipment to handle them. A related issue for nursing homes has been the serious decrease in funding reimbursement rates; for example, several reported going from $0.93 for every dollar spent in 1995 to $0.82 for every dollar spent in 2005.

Some of the risk factors faced by nursing home workers are listed below:

Environment

- Financial constraints on institutions due to lower reimbursement by federal/state agencies.
- Old facilities with inadequate structures for ceiling lifts or storage for floor lifts.
- Room layout is often too confined to allow for equipment-related transfers.
- Bathroom layout and size don't allow for two caregivers and equipment access.

Work organization

- Facilities often do not have safe lifting policies.
- Shortage of skilled staff.
- High turnover of management and workers creates challenges in training all newly hired caregivers.
- Low wages with limited benefits.
- Limited time for training due to competing demands.
- Perception that it often takes too much time to find and use lifting and repositioning devices.

Technology/Equipment

- Inadequate mechanical equipment and devices to lift and reposition residents.
- Sufficient slings of the proper size are often not available.
- Slings can be lost or misplaced when laundered.
- In some cases, the maintenance department does not have a tagout procedure for identifying broken equipment and repair procedures for servicing broken equipment.
- Storage space is limited for floor-based lifts.
- Many nursing homes do not have height-adjustable beds.
- Nursing assistants may not be competent in the use of lifting equipment and transferring devices.

Tasks

- Transferring residents from very low beds to wheelchairs requires extreme back flexion and twisting, neck extension, and high back and shoulder loading.
- Repositioning in bed requires forceful, awkward postures.
- Dressing, feeding, and personal care assistance requires awkward postures.
- Many residents suffer from dementia and are easily confused and agitated, particularly during a transfer, resulting in combative behavior.

Individual

- Certified nursing assistants (CNAs) are often female, unskilled, in their first job, and speak English as a second language.
- Caregivers are exposed to excessive psychological and physical job demands.

Hospitals

Some of the musculoskeletal risk factors faced by hospital employees are included in the following list:

Environment

- During the design phase of hospital construction, it is rare that patient transfer needs are considered in the design and layout of hospital rooms, surgical areas, emergency rooms, and other patient care areas.
- Installation of ceiling lifts is often structurally inadequate.
- Room size and layout limits the use of mechanical lifts, especially access to patient bathrooms.
- Storage space is often not available for lifting equipment.
- Transporting requirements include moving stretchers, wheelchairs, food and housekeeping carts over carpeted floors, often with poorly functioning wheels, and transferring heavy patients from bed to stretcher to imaging.

Work organization

- Staff turnover creates problems with training newly hired caregivers.
- Long shifts with mandatory overtime lead to mental and physical exhaustion.
- Perceived increase in time required to use transfer equipment leads to manual handling of patients.
- Lack of training and reinforcement on use of equipment due to competing demands.
- Use of temporary agency staff without adequate training in equipment use.

Technology/Equipment

- Ceiling lifts are expensive to install unless remodeling or building new facilities.
- Equipment that is mounted to the hospital structure requires hospital construction review approval.
- Slings are often difficult to put on patients, especially bariatric patients.
- Slings are frequently lost in laundering.
- Time to find floor lifts, slide sheets, and repositioning devices.
- Difficult to provide sufficient training to all staff who handle patients.

Tasks

- Manual transferring, lifting, and repositioning patients.
- Transporting patients.
- Wound care and other procedures require awkward postures.
- Rapid turnover of patients and changing condition of patients requires rapid mental and physical processing by nursing staff.
- Feeding bedridden patients often requires awkward postures.
- Imaging, ultrasound, radiology, physical, and occupational therapy workers are also engaged in moving patients as well as maintaining awkward postures and static high hand forces during diagnostic and treatment procedures.

Individual

- Strength requirements of lifting and moving patients often exceed the lifting capacity of healthcare workers.
- Largely female workforce increasing in age.
- No time for training.
- Perceived increase in time to use equipment.
- Perceptions and habits, focus is on the patient, not on oneself.

Temporary Workers in Healthcare

Temporary workers in hospitals and nursing homes have an added burden due to unfamiliarity with patients, patient-handling equipment, and safe-lifting policies and concern about asking for help. It is common that neither the temporary agencies nor healthcare institutions take on the task of training agency staff in use of patient-handling equipment. As long as there are staff shortages, particularly the nursing shortage, reliance on large numbers of temporary/agency nursing staff will continue to present problems regarding the safe handling and movement of patients.

Hospital and Nursing Home Support Staff

Within both hospitals and nursing homes, support services staff (such as laundry, housekeeping, and food services staff) has high manual-handling loads coupled with repetitive movements, often with high hand forces. Examples include mopping, food cutting and wrapping, handling large quantities of dishes and pans, cooking, and transporting and separating laundry. Additionally, in hospitals there are pharmacists, central supply workers, and laboratory workers with a myriad of

tasks requiring fine, manipulative hand motions, often combined with high pinch or power grip forces. The introduction of the electronic patient record has introduced new MSD risk factors to nursing staff who push computers on carts and do more typing than writing.

Research Overview—Evolution of Safe Patient Handling Research

Ineffectiveness of Body Mechanics Training

Training alone has not been shown to reduce the risk to nursing personnel of injuries related to lifting patients [Dehlin and Lindberg 1975; Dehlin et al. 1981; Nelson et al. 2003; Snook et al. 1978; Wood 1987]. After it became widely recognized that the hazard of lifting adult human bodies could not be alleviated by training alone, the next research examined patient lifting from an ergonomic viewpoint by conducting task analyses and biomechanical evaluations of patient-handling tasks.

For patient-handling tasks, one must consider (1) the weight of the patient, (2) the patient's ability to bear weight and assist with the transfer, and (3) the safest equipment and techniques for transferring and repositioning patients based on specific patient characteristics. The challenge of lifting and moving patients is further complicated by the patient's size, shape, deformities, level of fatigue, cognitive functioning, and cooperation as well as the worker's physical impairments, lower limb function, balance, and coordination [Lloyd 2004]. Cognitively impaired patients can be unpredictable and may suddenly become combative, resist the caregiver, or go limp during a transfer, creating a sudden unexpected load on the caregiver [Lloyd 2004] and resulting in excessively high forces that can injure the spinal muscles [Anderson et al. 2001]. The most physically demanding tasks are repositioning patients in bed, transferring physically dependent residents to and from the toilet, in and out of beds and chairs, and transferring residents for bathing and weighing [Garg et al. 1992; Marras et al. 1999; Gagnon et al. 1986; Ulin et al. 1997; Marras et al. 1999; Zhuang et al. 1999; Lloyd 2004].

In the early 1990s, published studies began to demonstrate that the risk of injury to caregivers in nursing homes could be reduced through the use of mechanical lifting equipment. Extensive research has documented high levels of biomechanical stress on caregivers when performing patient-lifting and repositioning tasks. The use of portable or ceiling-mounted mechanical lifts significantly reduces the back compressive forces of the caregiver and removes about two-thirds of the exposure to lifting activities per transfer as compared to the manual methods [Harber et al. 1985; Garg et al. 1992; Marras et al. 1999; Owen 1987; Zhuang et al. 1999]. The most recent

research demonstrating the effectiveness of safe patient-handling and movement programs is included under case studies at the end of this section describing ergonomic issues among healthcare workers.

Barriers to Reduction of Hazards

The musculoskeletal hazards of nursing work have not only been accepted as an inherent part of the job but also have been blamed on the healthcare worker's lack of strength and poor lifting technique. "Occasionally the complaint is made that a nurse has injured her back or strained herself in some way in moving a patient. This will generally be because she has failed to do the lifting properly" [Hampton-Robb 1893]. Amazingly, over 100 years later, U.S. nursing schools still teach body mechanics to show nurses how to use their physical strength to "properly lift" patients. Each year, nursing students are graduating without being trained on how to use mechanical lifts to safely lift patients despite the technological, scientific, and evidence-based revolution affecting all other aspects of care. Nurses' licensure exams [NCSBN 2006] continue to include outdated and unsafe manual patient-handling techniques. Having the right equipment at the right time used by the right people in the right way is affected by equipment availability and usability, staffing, turnover, training, and facility design as well as economic health of the institution and commitment of top management.

Several external factors have affected the progress and the impact of research in this area. High injury rates in nursing homes led OSHA to target worker safety problems in nursing homes. Staff shortages, demographics, and increasingly complex patients and treatments have linked patient safety to healthcare worker safety. This has contributed to increased awareness of research needs to address the underlying issues for healthcare workers.

Interventions Available and Benefits

Various mechanical lifting and transferring devices have been recommended to reduce physical loads on caregivers. Equipment such as adjustable beds, raised toilet seats, shower chairs, grab bars, etc. are also helpful for reducing musculoskeletal risk factors in the home setting. Adjustable "hospital" beds are ideal, but if a standard bed is too low, it should be raised on a stable frame or platform. Ergonomics programs should also seek to reduce other risk factors in home environments by providing, for example, appropriately designed equipment for house cleaning tasks.

While some mechanical lifting devices may reduce the physical load for caregivers, there are a number of circumstances in the different healthcare occupations where

it has been difficult to successfully implement use of these devices. Implementing ergonomic interventions in home healthcare settings is particularly challenging, because workers may think assist devices will be inconvenient and time-consuming.

- Patients may fear that assist devices will be unsafe or uncomfortable.
- Patients and families may be reluctant/unable to make changes in the home.

Critical to effective implementation of safe patient handling programs includes the following:

- Involving workers, patients, and families in identifying problems with lifting or patient transfers and designing and implementing solutions.
- Making workers aware of the advantages of using the right equipment and having the appropriate training (for example, saving time and avoiding injuries) [Garg and Owen 1992; White 1997].
- Teaching patients how assistive devices may benefit their safety.
- Involving direct care staff in equipment selection.
- Providing hands-on training and retraining in equipment use for staff including performing needs assessments.
- Choosing the right equipment.
- Assessing effectiveness of the program on an ongoing basis.
- Monitoring patient and staff transfer and movement injuries.
- Reporting results to staff.

Different sectors of healthcare have different challenges in implementing safe patient-handling programs. An understanding of the barriers in these sectors will assist in successful, future implementation. A recent Washington state labor/industry/government task force conducted site visits and interviews in many of the industry sectors to learn about the barriers and successes in these areas [WA L&I 2005].

Patient Lifting Legislation in the United States

While legislation continues to be introduced in numerous states and at the federal level, the following safe patient handling legislation has been passed:

1. Ohio House Bill 67 was signed into law on March 21, 2006, Section 4121.48 [State of Ohio 2006].
2. New York companion bills A11484 and A07836 and S05116 and S08358 were signed into law on October 18, 2005 [State of New York 2006].
3. Texas Senate Bill 1525 was signed into law on June 17, 2005 [State of Texas 2005]. 4. Washington House Bill 1672 was signed into law on March 22, 2006 [State of Washington 2006].

4. Washington House Bill 1672 was signed into law on March 22, 2006 [State of Washington 2006].
5. Hawaii House Concurrent Resolution No. 16 passed on April 24, 2006 [State of Hawaii 2006].
6. Rhode Island House 7386 and Senate 2760, passed on July 7, 2006 [State of Rhode Island 2006].
7. Minnesota HB 712.2 safe patient handling legislation signed into law May 2007 [State of Minnesota 2007a,b].
8. Maryland SB 879 safe patient handling legislation signed into law April 2007 [State of Maryland 2007a,b].
9. New Jersey S-1758/A-3028 safe patient handling practice act signed into law January 2008 [State of New Jersey 2008].

American Nurses Association's (ANA) Handle with Care Program

The Handle with Care Program of the American Nurses Association is an industry-wide effort designed to prevent back and other musculoskeletal injuries among the Nation's nurses. The campaign is helping reshape nursing education and federal and state ergonomics policy by highlighting safe patient-lifting research that shows technology-oriented safe patient-handling benefits both patients and the nursing workforce. Similar efforts are underway by other healthcare unions and employee organizations.

Recommendations for Research

While there has been considerable progress in recognizing the hazards for both patients and staff due to manual handling of patients and in developing equipment that can reduce the manual handling of patients, barriers to full implementation exist. These are likely related to several areas that require further research:

Environment

- Identify and test healthcare facility design options that allow for "ergonomic envelopes" in patient care and transport areas.
- Identify and test healthcare facility construction review processes to incorporate participatory design and review with staff to consider patient-transfer requirements including accommodations for mechanical lifting equipment.
- Identify and evaluate alternative methods for financing large scale implementation of safe patient-handling environments in all aspects of healthcare.

- Evaluate the effectiveness of legislative mandates in successful implementation of safe patient handling in all aspects of healthcare.

Work Organization

- Evaluate the relationship between staffing patterns, use of equipment, and patient outcomes.
- Evaluate different ways to successfully incorporate temporary staff into the standard of care that requires safe patient handling.
- Assess different models for incorporating safe patient handling as a standard of care.
- Test different models for implementing and sustaining effective safe patient-handling committees.
- Conduct case studies on how to successfully reduce resistance to change in implementing safe patient-handling programs.
- Identify the organizational barriers to implementing safe patient handling and how can they be overcome.
- Asses the effectiveness of nursing schools in preparing new nurses for using equipment to handle patients rather than "good body mechanics."

Technology

- Develop and test improved patient-handling devices in all healthcare settings.
- Develop and test systems for handling bariatric patients from the ambulance to the emergency room to the ward to the rehab center to the nursing home and back to the community.
- Slings are often difficult to get on and off the patient. More research is needed to improve sling technology or completely new technology that eliminates the strain of using slings, particularly on bariatric patients.

Task

- Develop a taxonomy of tasks by types of care requirements, environment, and organizational capacity. Evaluate how the physical and emotional strain for each of these can be reduced. Anticipate new technologies and their implications for caregiver tasks.
- Algorithms that describe how patients should be lifted have been developed for long-term care and surgical areas in acute care. Algorithms need to be developed for many other heathcare settings.

Individual

- Develop and test work-family balance models with respect to retention and recruitment of nursing staff as well as injury rates.
- Assess peer cohesion models in reducing WMSD injury rates and turnover.

Specific Research Recommendations and Questions Relating to Home Care Workers

- Develop better surveillance systems for tracking injuries and illnesses experienced by home care workers.
- Explore how known interventions to prevent MSDs can be effectively and appropriately used in the home setting.
- Identify barriers to use of those interventions (e.g., lack of access, client resistance, lack of available help, working alone) in the home and strategies for overcoming those barriers.
- Explore how housekeeping tasks contribute to rates of injuries and how risks associated with housekeeping can be addressed.
- Explore how solutions can be implemented in consumer-directed models of care; how the right of clients/consumers to direct their own care can be balanced with the right of home care workers to a safe workplace.
- Identify effective training programs for home care workers and consumers.

Case Studies—Field Studies and Demonstration Projects

The research literature on healthcare worker back and other musculoskeletal injuries has expanded rapidly since the 1980s. The research emphasis has shifted from describing the magnitude of the injury problem to testing the effectiveness of solutions. A strong body of research evidence has recently been amassed demonstrating that mechanical lifting equipment and repositioning aids as part of a safe patient handling and movement (SPHM) program can significantly reduce musculoskeletal injuries among healthcare workers [Collins et al. 2004; NIOSH 2006; Yassi et al. 2001; Garg and Owen 1992; Nelson and Fragala 2004].

One of the first comprehensive intervention evaluation studies demonstrating the effectiveness of mechanical lifting equipment in the context of a comprehensive SPHM program was conducted at the University of Wisconsin-Milwaukee [Garg and Owen 1992]. The evaluation included the following:

- Identifying and analyzing the most stressful patient-handling tasks.
- Evaluating alternative mechanical lifting methods in the lab and field.
- Training nursing staff how to use the equipment.
- Modifying toilet and shower rooms.
- Applying the techniques to resident care.

The study concluded that ergonomic intervention programs were effective in reducing the risk of low back pain to the small sample of nursing personnel in the study and stated that large-scale studies in different nursing homes were needed to confirm their findings. Building on these findings, a larger study assessed the long-term effectiveness of patient-handling programs in seven nursing homes and one hospital [NIOSH 1999]. Fifty-one months after the resident lifting program was introduced, injuries from resident transfers decreased by 62%, lost workdays decreased 86%, restricted workdays decreased 64%, and workers' compensation costs decreased 84%.

In a study conducted by the National Institute for Occupational Safety and Health [Collins et al. 2004], a safe resident handling and movement program reduced resident handling workers' compensation injury rates by 61%, lost workday injury rates by 66%, and restricted workdays by 38%. Additionally, the number of workers suffering from repeat injuries was reduced. During the 36 months before the intervention there were 129 workers' compensation claims attributed to resident handling, with 11 workers filing more than one workers' compensation claim for musculoskeletal injuries. During the 36-month post-intervention period, 56 workers' compensation claims were attributed to resident handling and only 3 employees filed more than one workers' compensation claim associated with resident-handling tasks.

The Veteran's Health Administration (VHA) evaluated a multifaceted program in 23 high-risk, long-term care units in 7 facilities including 780 nursing personnel [Nelson et al. 2006]. The multifaceted program included mechanical patient lifts, patient-care assessment protocols, no-lift policies, and training on the proper use of patient-handling equipment. During the postintervention period, there was a significant decrease in the rate of injuries and modified duty days, an increase in caregiver satisfaction, and a decrease in the number of "unsafe" patient-handling practices performed daily as reported by nurses. Ninety-six percent of the nurses ranked lifting equipment as the most important program element.

A randomized controlled trial compared the effectiveness of training and equipment to reduce musculoskeletal injuries, increase comfort, and reduce physical demands on staff performing patient lifts and transfers at a large acute care hospital [Yassi et al. 2001]. Self-perceived work fatigue, back and shoulder pain, safety, and

frequency and intensity of physical discomfort associated with patient-handling tasks were improved on both intervention units, but staff on the unit with mechanical lifting equipment showed greater improvements. The intervention group that combined training with mechanical lifting equipment and other assistive patient-handling equipment, most effectively improved comfort with patient handling, decreased staff fatigue, and decreased physical demands.

A study was conducted in the extended care unit of a Canadian hospital to examine the marginal benefit of replacing a traditional patient lifting program (which uses mechanical floor lifts) with overhead ceiling lifts [Ronald et al. 2002]. During the preintervention period there were five mechanical floor lifts, one manual transfer aid, and four beds serviced by two ceiling lifts. After completion of the resident lifting program, the unit included three floor lifts, 62 ceiling lifts, and three tubs serviced by ceiling lifts. The rate of musculoskeletal injuries caused by lifting/transferring patients was significantly reduced by 58% after the installation of ceiling-mounted lifts, but the rate of musculoskeletal injuries caused by repositioning did not decline. Although the ceiling lifts are designed for both lifting and repositioning residents, the ceiling lifts were actually not used for repositioning residents because of problems with the repositioning slings.

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Chapter 12 ▪ Slip, Trip, and Fall Incidents

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Issue

Occupational slip, trip, and fall (STF) incidents are a significant source of workers' compensation claims and costs in healthcare settings. Bureau of Labor Statistics (BLS) data indicate that STFs accounted for 22.7% of all nonfatal occupational injuries and illnesses involving days away from work in 2006 [Bureau of Labor Statistics, 2007] and accounted for 21% of lost-time injuries to healthcare workers (21%). Bureau of Labor Statistics data [Bureau of Labor Statistics 2007] report that the incidence rate of lost-workday injuries from STFs on the same level in hospitals was 35.2 per 10,000 FTEs which was 74% greater than the average rate for all other private industries combined (20.2 per 10,000 FTEs). Falls are the second leading global cause of accidental death, after motor vehicle collisions. In developed countries, STFs on the same level contribute to 20%–40% of disabling workplace injuries [Leamon and Murphy 1995; Courtney et al. 2001]. In the United States, STFs on the same level are a leading cause of occupational injury resulting in an annual average of 52 deaths and 220,000 nonfatal injuries [Courtney et al. 2001]. Falls incidents are generally categorized as either falls from elevation or as slips, trips, or falls on the same level. While falls from elevation typically result in more severe injuries, falls on the same level are much more common comprising over 60% of total falls [Courtney et al. 2001].

Risks

The risk of STF hazards is based on a range of factors including personal factors, environmental characteristics of the workplace, and housekeeping procedures. STF hazards exist outside the hospital in parking lots, garages, stairs, and walkways and throughout the interior of the hospital in the food preparation and cooking areas, cafeteria, dishwashing area, stairs, entrances, patient rooms, operating rooms, bathrooms, and public areas. The healthcare industry is the largest employer in the United States (~13 million workers) and ranks second among eight industries as to highest percentage of workers' compensation claim costs associated with falls on the same level [Cotnam et al. 2000]. In 2002, hospitals became the industry with the number of total injuries (over 296,000) in the United States [Wiatrowski 2004]. The large population of

workers at risk and the frequent occurrence makes STF incidents a substantial problem for healthcare workers.

Personal Risk Factors

Females have higher STF injury rates than male healthcare workers [Kemmlert and Lundholm 1998; Bell et al. 2008]. In addition, when slip, trip, and fall rates are examined by age group, older workers (both males and females) suffer higher rates of STF injuries than younger workers [Buck and Coleman 1985; Kemmlert and Lundholm 2001; Lipscomb et al. 2006].

Environmental Risk Factors

Studies have found that contaminants on walking surfaces such as water, soapy cleaning solutions, spilled drinks, snow, and ice are the leading environmental risk factor contributing to slip-related injuries in working populations. Cohen and Compton [1982] reported that wet floors were a contributing factor in 23% of STF incidents, and Manning et al. [1988] reported that wet floors contributed to 28% of STF incidents. Consistent with the fact that STFs are the most common injury in restaurants and eating establishments [Filiaggi and Courtney 2003], the highest rates in hospital settings are among food service workers (4.0 STF workers' compensation claims/100 food service workers per year) [Bell et al. 2008]. The food preparation, cooking, and dishwashing required for the thousands of meals served around the clock for patients, staff, and visitors lead to greasy, wet floors.

Cohen and Compton [1982] and Manning et al. [1988] found the percentage of falls due to ice and snow were 8% and 9%, respectively. In a study of hospital workers, Bell et al. [paper in review] found that approximately 6% of STFs were caused by ice/snow.

Research

Because STFs result from a wide variety of circumstances, a number of countermeasures have been cited as having the potential to reduce STF injury incidents. Companies who report success with slips and falls reduction programs typically include some combination of employee training, housekeeping procedures, slip-resistant floor treatment or flooring, and slip-resistant footwear [Norwich 1992; Lewis 1997; LaBar 1998; Morrison 1999]. Unfortunately, these success stories have not been rigorously evaluated. For example, there is no discussion of study design or methods, detailed results, comparison groups, or possible confounding factors, among other concerns. Ballance et al. [1985] reported a reduction in the number of reported injury incidents involving falls on the same level after replacing wood

and ceramic flooring with less slippery tiles and carpet with higher coefficients of friction. Manning et al. [1988] suggested one of every four STF injury incidents could have been prevented by quickly cleaning up spills and objects on the floor. In general, there are very few examples of STF prevention programs that have been rigorously evaluated in the literature.

Case Study—Opportunities for Prevention of STF Incidents in Healthcare Settings

NIOSH recently completed a multidisciplinary intervention trial [Collins et al. 2008] that evaluated the effectiveness of a comprehensive STF prevention program for preventing STF incidents among healthcare workers. The 10-year intervention trial demonstrated a 58% reduction in STF incidents during the post-intervention period among hospital workers in the three study hospitals. The comprehensive STF prevention program included a range of countermeasures inside and outside the study hospitals to reduce STF injury incidents. Program elements included efforts to keep floors clean and dry, wearing slip-resistant shoes, installing slip-resistant floor surfaces, laying water-absorbent mats, prompt cleaning of spillage and debris, keeping stairs and walkways clear, improving lighting, adding hand rails, and clearing ice and snow.

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

- A descriptive analysis of 6 years of STF workers' compensation injury data to identify the circumstances and trends of work-related STF incidents in three acute care hospitals was used to target prevention efforts.
- Workers who experienced a slip, trip, or fall were interviewed by telephone using a structured questionnaire, and a case-crossover methodology was applied to identify transient risk factors such as contaminants on the floor (e.g.,

water, ice, or body fluids). These efforts were used to describe STF circumstances that could be targeted for prevention during the intervention field study.

- Laboratory studies were conducted to evaluate the slipperiness of 7 shoe types (most commonly worn in hospitals and promising slip-resistant) and 10 types of hospital flooring (existing and promising slip-resistant) contaminated with soap, oil, and water.
- On-site hospital hazard assessments were conducted to identify environmental conditions and housekeeping procedures that could potentially contribute to STF hazards. The condition of walkway surfaces, contaminants on the floor, projecting objects and cords, lighting, handrails, and drains inside and outside the hospitals were examined. Areas inside the hospital that were examined included entrances, stairs, ramps, operating rooms, emergency room, scrub sink areas, nursing stations, pharmacy, histology lab, hallways, kitchen, dishwashing areas, cafeteria, patient rooms, bathrooms, instrument decontamination areas, engineering and carpentry shops, and the morgue. The outside areas examined included parking garages, ramps, sidewalks, and employee shuttle bus stops. The prevention program included analysis of injury records to identify common causes of STFs, on-site hazard assessments, changes to housekeeping procedures and products, introduction of STF preventive products and procedures, campaigns to raise the importance of preventing STFs among hospital staff, programs for external ice and snow removal, flooring changes, and slip-resistant footwear for certain employee subgroups. Hazards and preventive measures were provided in a written report to the hospital administrator, safety staff, and housekeeping and groundskeeper managers.

An intervention field trial used the findings from the descriptive analysis, case-crossover study, hazard assessments, and laboratory tests to design, implement, and evaluate a 'best practices' STF prevention program in three acute care hospitals. The field study compared the pre- and post-intervention injury experience of approximately 22,000 full-time workers during a 10-year intervention trial in three hospitals.

Specific Recommendations for Prevention

The healthcare industry has made a concerted effort to prevent patient falls but, in general, research to implement and evaluate programs to STF incidents among healthcare workers has been scarce. Contrary to the societal belief that falls are inevitable and not likely to be prevented, the examination of the detailed circumstances of STF incidents among hospital employees revealed that many of these injuries are preventable by mitigating hazardous environmental conditions in and around hospitals [Collins et al. 2006].

Opportunities

The following section describes known STF interventions and best practices that could be disseminated to stimulate hospitals to replicate comprehensive STF programs in their facilities and also includes suggestions on further research to reduce the risk of slip, trip, and fall injuries in healthcare settings. NIOSH is drafting a user friendly document that describes steps that can be taken by hospitals to reduce their risk of STF hazards. The following elements are described in this document.

Review past injury records

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

Hazard Assessments

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

Keep floors clean and dry

STFs due to water, wetness, greasiness, and slipperiness are the most common hazards for all hospital employees.

- Wall-mounted spill pads or paper towels dispensers should be located conveniently throughout the hospital so that employees who want to clean up a spill have access to cleaning materials.
- Conveniently located warning signs ("pop-up tents") to alert occupants to wet or slippery floors.

- Umbrella bags by building entrances.
- Paper towel holders near drinking fountains.
- Water-absorbent walk-off mats with beveled edges should be provided 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. In heavy traffic areas it may be necessary to place more than one mat. As a general rule, when a person steps off the last mat, the soles of their shoes should not be depositing ice or water on the floor.
- Telephone or beeper numbers for housekeeping should be prominently posted and emailed intermittently as part of a general awareness campaign.

Prevent entry into wet areas

- Use barriers to block access to wet areas (tension rod across bathroom doorways, cones with chains, hallway barriers).
- More noticeable STF signage (taller, flashing light, pop-up tent).
- Wet floor signs should be promptly removed within 10 minutes after the floor is dry.
- Completely block off areas where floor wax is being stripped or applied.
- Door-stopper that prevents wax from overflowing into adjacent areas during waxing.

Slip-resistant shoes

- Food services, housekeeping, custodial, and maintenance staff are at highest risk for a STF due to water, grease, or slippery surfaces and may benefit from slip-resistant shoes. Staff that work in areas that are continually wet, such as dishwashing and instrument decontamination areas, may also benefit from slip-resistant shoes.
- However, other hospital employees may benefit from slip-resistant shoes, such as nursing staff who suffer the highest total number of STF claims in hospital settings [Bell et al. in review].

Housekeeping

- Keep walkways clear of objects and reduce clutter.
- Secure loose cords and wires.
- Use cord bundlers and cord containers to secure cords under nursing stations, patient rooms, and under computer workstations.

- Cover cords on floor with a beveled protective cover.
- Organize operating rooms to minimize equipment cords across walkways.
- Consider retractable cord holders on phones in patient rooms and nursing stations.

Ice and snow removal

- Phone/beeper number for staff responsible for snow removal should be prominently displayed and emailed intermittently to staff.
- Ice cleats for home health and maintenance workers.
- Consider sending winter weather email warnings about pending storms.
- Conveniently place bins containing ice melting chemicals near outdoor stairs and heavily traveled walkways so that any employee can apply ice melting chemicals when they notice icy patches.

Knowledge Gaps

Extensive research has been done regarding assessment for falls risk and prevention for hospital patients and nursing home residents, but very little research has been conducted about the prevention of falls among healthcare workers. Although NIOSH has conducted research on STF fall prevention in acute care hospitals, research is needed in nursing homes, outpatient centers, and other healthcare areas. More research is needed to identify slip-resistant hospital flooring and shoes that can be worn by hospital staff. Research findings and existing information on preventing STF in hospital settings should be disseminated through user friendly documents and other publically accessible mediums.

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Chapter 13 ▪ Violence

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Introduction

Workplace violence ranges from offensive or threatening language to homicide. NIOSH defines workplace violence as violent acts (including physical assaults and threats of assaults) directed toward persons at work or on duty [NIOSH 2002]. The Healthcare and Social Assistance (HCSA) sector leads all other industrial sectors in the incidence of nonfatal workplace assaults. In 2006, 60% of the assaults and violent acts (by person) requiring days away from work occurred in HCSA and mainly involved assaults by healthcare patients [BLS 2007]. Rates of assault have been described in several large surveys and vary by occupational subgroup and area [Gerberich et al. 2004; Hodgson et al. 2004] and differ between cohorts. The Minnesota nurses study documented an overall rate of 14.2/100 person-years; over 25% of nurses in the Veterans Health Administration study experienced at least one assault each year. In both surveys, occupations with closer physical contact with patients have higher assault rates than do those with less contact. Emergency departments were associated with higher assault rates in one study, mental health and geriatrics units in the other than other areas. Better lighting, shorter working hours, and personal alarms (e.g., cell phones) were associated with lower assault rates.

Injuries resulting from violence such as lacerations, bleeds, and bruises which do not result in lost time away from work are not captured in Bureau of Labor Statistic's (BLS) data. Failure to report is common in healthcare due to the perception that exposure to violence is "part of the job" or that it cannot be totally eliminated. Additional reasons for not reporting include the amount of time required for reporting, lack of supervisory support, lack of change in response to reporting an incident, and the incident did not require time away from work [Gates 2004].

Healthcare workers are at risk for verbal, psychological, and physical violence. Violent acts occur during interactions with patients, family, visitors, coworkers, and supervisors. Working with volatile people or people under heightened stress, long wait times for service, understaffing, patients or visitors under the influence of drugs or alcohol, access to weapons, inadequate security, and poor environmental design are among the risk factors for violence [McPhaul and Lipscomb 2004; Gates 2004; Gerberich et al. 2005; Lipscomb and Borwegan 2000].

Rapid growth is projected for many occupations in the HCSA sector from 2004–2014. Sixteen of the 30 fastest growing occupations are health-related, including 13 in healthcare, 6 of which are in the top 10. This is being driven by changing national demographics. As the U.S. population ages, the number of elderly patients in nursing homes and long-term care facilities, often with dementia, is projected to increase dramatically. "Home health aide" is the Nation's fastest growing occupation and is expected to grow 56% [Decker, 2005]. The level of violence within the community has important implications for all HCSA workers including home care and community service workers. Increasing alcohol and drug abuse as well as concealed weapons, often legal, place emergency room staff at particular risk. Reducing the number of work-associated injuries due to violence will require effective violence prevention strategies and programs targeted to all sites where HCSA workers provide services.

Sexual harassment has been identified as a problem in healthcare that has serious implications for the individual as well as for the employing organization [Robbins et al. 1996]. "Unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitute sexual harassment when this conduct explicitly or implicitly affects an individual's employment, unreasonably interferes with an individual's work performance, or creates an intimidating, hostile, or offensive work environment" [Equal Employment Opportunity Commission]. There is often confusion as to what constitutes harassment and may be dependent on the perception of the victim. The nurse's role within the healthcare setting may increase their risk to unwanted or unwelcome behavior of a sexual nature. The intimate nature of patient care may be misinterpreted by patients. The difference in power and status between the roles of physician and nurse in the workplace can contribute to an abuse of power [Robbins et al,1997].

The victims of sexual harassment may experience physical and physiological symptoms including headaches, gastrointestinal disturbances, and sleep disturbances. Sexual harassment affects job performance and satisfaction as well as quality of life outside of the workplace. Costs to organizations include low morale among staff, increased turnover rates, lower productivity, and absenteeism.

Interventions

In 1996, OSHA issued *Guidelines for Preventing Workplace Violence for Health Care and Social Services Workers*. The guidelines cover a broad spectrum of workers who provide healthcare and social services in psychiatric facilities, hospital emergency departments, community mental health clinics, drug abuse treatment clinics, pharmacies, community-care facilities and long-term care facilities. They include physicians, registered nurses, pharmacists, nurse practitioners, physicians'

assistants, nurses' aides, therapists, technicians, public health nurses, home healthcare workers, social workers, welfare workers, and emergency medical care personnel. The guidelines may also be useful in reducing risks for ancillary personnel such as maintenance, dietary, clerical, and security staff in the healthcare and social service industries [OSHA 1996]. The major components of the guidelines are management commitment, employee involvement and feedback, hazard prevention and control, safety and health training, and record keeping and program evaluation.

Management Commitment

Management commitment, including the endorsement and visible involvement of top management, provides the motivation and resources to deal effectively with workplace violence. This commitment should include assignment of responsibility, authority, and accountability for various aspects of the violence prevention program as well as the establishment of a comprehensive counseling program and support of health and safety committees.

Employee Involvement and Feedback

Employee involvement and feedback enable workers to develop and express their own commitment to provide useful information to design, implement, and evaluate the program. Employee's responsibilities include compliance with workplace violence prevention programs reporting violent incidents, participation on committees, and in training and educational activities.

Hazard Prevention and Control

After hazards are identified through a systematic worksite analysis, the next step is to design measures through engineering or administrative and work practices to prevent or control these hazards. If violence does occur, postincident response can be an important tool in preventing future incidents.

Safety and Health Training

Safety and health training ensure that all staff is aware of potential security hazards and how to protect themselves and their coworkers through established policies and procedures.

Record Keeping and Program Evaluation

Record keeping and program evaluation of the violence prevention program are necessary to determine its overall effectiveness and identify any deficiencies or

changes that should be made. Records of injuries, illnesses, accidents, assaults, hazards, corrective actions, patient histories, and training can help identify problems and solutions for an effective program.

A recent evaluation [Lipscomb et al. 2006] suggested that the OSHA guidelines capture essential elements of violence prevention programs although little empirical evidence exists that documents their effectiveness.

One additional important intervention has major implications for record keeping and management practices. Evidence suggests that informing healthcare workers of the prior assaultive behavior of violent patients reduces violent incidents dramatically [Drummond et al. 1989]. Implementing this practice requires an electronic medical record, the establishment of a committee to evaluate and manage threatening patients, and formal threat assessment training.

Organizations should implement a strong policy against sexual harassment and maintain effective complaint procedures. Training for all levels within the organization should be conducted. Training should include how to recognize offensive behavior, as well as strategies and procedures to follow if a worker is a victim of, or a witness to, harassing behavior.

Some additional interventions, have been widely discussed and some well studied.

Patient Record Flagging

The vast majority of assaults on health care workers result from a small group of repeat perpetrators, in general psychiatric patients with multiple diagnoses (substance abuse, major mental illness, personality disorders, and post traumatic stress disorders) [Blow et al. 1999, Flannery et al. 2008]. Warning health care workers through electronic flags built into the medical record dramatically reduced assaults and associated injuries [Drummond et al,1989]. That approach requires infrastructure, including a committee with clinical, safety, threat assessment and management, and security skills.

Personal Safety Skills

Assaultive patients generate injuries to health care workers. Breaking away from holds represents a critical skill. Although commercial training programs exist, little empiric evidence identifies the superiority of one over another, and the commercial nature has precluded formal comparisons. Initial attempts in Europe to evaluate such skills, refine them based on theoretical and practical approaches, and assure competencies, represents an important addition to programs. Training health care workers, certification of the trainers who train health care workers, and refinement of the control programs themselves represents an emerging area.

Containment Strategies

Many injuries to health care workers occur during the process of containment, i.e., attempts to subdue assaultive patients. No scientific work exists comparing ideal ways of applying containment strategies, despite several recent national and international conferences [e.g., First International Conference on Workplace Violence in the Health Care Sector, 2008] http://www.oudconsultancy.nl/WorkplaceViolence/Resources/OUD_Workplace_Violence_leaa.pdf). Certification programs for training, for both personal safety skills and therapeutic containment, are controversial, in part because no empiric evidence supports them. Only one academic program was identified, developed for the Irish National Health Service, that represents a non-commercial approach. That system has defined containment as a therapeutic procedure, requiring the same kinds of development, testing, and validation as other invasive medical procedures [Dundalk Institute of Technology, http://ww2.dkit.ie/courses/dk976].

Gaps

Intervention Effectiveness Research

Rigorous research is needed to evaluate the effectiveness of all the components of comprehensive violence prevention programs [McPhaul and Lipscomb 2004], including personal safety skills and therapeutic containment.

Economics Research

Economic research is needed to assist businesses in assessing the cost-benefit of prevention and compare cost-effective options [NIOSH 2006] and should consider burnout and the nursing shortage.

Improved Reporting

Methods to ensure accurate and consistent reporting of workplace incidences are needed for the development of target prevention programs, to monitor trends, and to evaluate effectiveness of prevention efforts. In addition, the implications of an electronic patient medical record and opportunities for intervention must be explored.

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Chapter 14 ▪ Hazardous Drugs

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Issue Overview

The toxic effects of anticancer chemotherapy observed in treated patients are well known. Beyond the patient safety concerns arising from the necessary therapeutic use of these drugs, however, occupational risks to healthcare workers handling these drugs in the course of their duties also need to be fully addressed.

The term *hazardous drugs* was first applied to most anticancer and some other limited classes of drugs by the American Society of Health-System Pharmacists (ASHP) [ASHP 1990] and was adopted by the Occupational Safety and Health Administration (OSHA) [OSHA 1995, 1999] and NIOSH [NIOSH 2004] in their publications promoting safe handling practices. Drugs are classified as hazardous if studies in animals or humans indicate that exposures to them have a potential for causing cancer, developmental or reproductive toxicity, or other organ system damage. Most hazardous drugs are those used to treat cancer but also include HIV therapies and other antiviral agents [Galassi et al. 1996; McInnes and Schilsky 1996; Erlichman and Moore 1996]. Appendix A of the NIOSH Alert, *Preventing Occupational Exposure to Antineoplastic and Other Hazardous Drugs in Health Care Settings*, provides examples of hazardous drugs and a full discussion of criteria used to define and classify a drug as hazardous [NIOSH 2004].

Although the potential therapeutic benefits of hazardous drugs outweigh the risks of side effects for ill patients, exposed healthcare workers risk these same side effects with no therapeutic benefit. Occupational exposures to hazardous drugs can lead to (1) acute effects such as skin rashes [McDiarmid and Egan 1988; Valanis et al. 1993a, b; Krstev et al. 2003], (2) chronic effects, including adverse reproductive events [Selevan et al. 1985; Hemminki et al. 1985; Stücker et al. 1990; Valanis et al. 1997, 1999; Peelen et al. 1999], and (3) possibly cancer [Skov et al. 1992].

The initial concern about healthcare worker risk when handling hazardous drugs was driven by the evidence for 'second malignancy' development in cancer patients who were previously treated with a therapeutic agent. In support of these findings, numerous laboratory studies have identified these agents as rodent carcinogens and as genotoxic in various laboratory test systems [IARC 1979, 2004, 2006]. More than 10 of the commonly used anticancer drugs or combinations of

drugs have been classified by the International Agency for Research on Cancer (IARC) as carcinogenic to humans, and another dozen are thought to be 'probably' carcinogenic to humans. An additional 11 agents are listed as 'possibly' carcinogenic to humans [IARC 2006]. Given the mode of action of many of these agents, and with their ability to bind with NA, RNA, and proteins, it would be expected that many of them are both mutagenic and carcinogenic [Hardman and Limbird 1996].

In addition to their mutagenic and carcinogenic properties, many of the antineoplastic drugs have been associated with adverse reproductive effects that have been observed in animals as well as treated male and female patients. Currently, 45 antineoplastic drugs are listed as Pregnancy Category D (evidence of risk to the human fetus, but benefits may outweigh the risk of treatment) and five are listed as Category X (evidence of risk to the human fetus and the benefit of treatment does not merit treatment [FDA 2001; Smith 2002]. Reproductive and developmental effects similar to those observed in patients have been reported in healthcare workers who are exposed to antineoplastic drugs at considerably lower doses than those administered to patients [Valanis 1993; Valanis 1993].

Risk—Potential, Conditions for, and Routes of Worker Exposure

Workers may be exposed to a drug throughout its life cycle, from manufacture to transport and distribution, to use in healthcare or home care settings, to waste disposal. The number of workers who may be exposed to hazardous drugs exceeds 5.5 million [U.S. Census Bureau 1997; BLS 1998, 1999; NCHS 1996]. These workers include shipping and receiving personnel, pharmacists and pharmacy technicians, nursing personnel, physicians, operating room personnel, environmental services personnel, and workers in veterinary practices where hazardous drugs are used.

Workers may be exposed to hazardous drugs when they create aerosols, generate dust, clean up spills, or touch contaminated surfaces during the preparation, reconstitution, manipulation, administration, or disposal of treated patient waste or the hazardous drugs themselves [Connor and McDiarmid 2006].

Exposure routes include inhalation, skin contact, ingestion, or injection. Inhalation and skin contact/absorption are the most likely routes of exposure, but unintentional ingestion from hand-to-mouth contact and unintentional injection through a needlestick or sharps injury are also possible [Duvall and Baumann 1980; Dorr 1983; Black and Presson 1997; Schreiber et al. 2003].

Overview of Research

Environmental Contamination

While some studies attempt to measure airborne concentrations of antineoplastic drugs, most have detected little to no airborne contamination [NIOSH 2004]. However, the majority of surface wipe sample studies, greater than a dozen and many since safe handling guidance has been promoted, have documented drug contamination on work surfaces in pharmacies and patient treatment areas [Connor and McDiarmid 2006]. Such widespread contamination of work surfaces makes the potential for skin contact highly probable in both pharmacy and patient areas.

Evidence for Worker Exposure

Evidence indicates that workers are being exposed to hazardous drugs and are experiencing serious health effects despite claims of compliance with current work practice guidelines. Protection from hazardous drug exposures depends on safety programs established by employers and followed by workers. Factors that affect worker exposures include the drug-handling circumstances (preparation, administration, or disposal); the amount, frequency, and duration of drug preparation; and the adherence to safe handling guidance including use of engineering controls, warnings and administrative controls, safe work practices, and personal protective apparel and equipment.

Worker exposures have been assessed most specifically using biologic monitoring for drugs commonly handled. Sessink and Bos [1999] noted that 11 of 12 studies reported cyclophosphamide in the urine of healthcare workers, indicating continued exposure despite safety precautions. Recent studies continue to show various hazardous drugs in workers' urine, despite supposed compliance with safe handling procedures summarized in [Connor and McDiarmid 2006].

Evidence for Health Effects in Workers

As described above, the mutagenicity and carcinogenicity of many of these drugs in animals and treated patients drove early concern for worker safety. These and other health outcomes of concern among those potentially exposed to hazardous drugs are discussed below.

Mutagenicity

Early studies to assess mutagenic endpoints in potentially exposed workers in more than 20 such studies were mixed; however, the majority was positive for

some increased frequency of mutagenic measures in the body fluids (usually blood or urine) of workers [Connor and McDiarmid 2006].

Developmental and Reproductive Effects

A recent review of 14 studies described an association between exposure to antineoplastic drugs and adverse reproductive effects, and 9 studies showed some positive association [Harrison 2001]. The adverse outcome of spontaneous abortion is most consistently associated with exposure in these studies.

Cancer

Several reports have addressed the relationship of cancer occurrence to healthcare workers' exposures to antineoplastic drugs. A significantly increased risk of leukemia has been reported among oncology nurses identified in the Danish cancer registry [Skov et al. 1992], and the same group [Skov et al. 1990] found an increased, but not significant, risk of leukemia in physicians working in departments where antineoplastic drugs were given.

Barriers to Reduction of Hazards—Safety Climate

One outstanding barrier to healthcare worker compliance with recommended safety practices around hazardous drugs is the safety climate of healthcare facilities. Studies have been done to measure hospital safety climate regarding the facility's commitment to a bloodborne pathogen risk management program and its relationship to safety compliance with universal precautions. These studies have shown that there are six dimensions of the hospital safety climate that impact worker compliance. These include management support for safety programs, absence of job hindrances, cleanliness and orderliness of the worksite, minimal conflict among staff, safety-related feedback and training, and availability of personal protective equipment (PPE) and engineering controls [Gershon et al. 2000]. In applying this understanding of safety climate to safety compliance behavior of hazardous drug handlers, studies done on safe handling practices point to a need to improve both management support for safety programs and safety-related feedback, monitoring and analyzing safety data and correcting OSH problems, and training [McDiarmid and Condon 2005; Rogers 1987a,b; Ben et al. 2001; Valanis et al. 1991; Mahon et al. 1994; Nieweg et al. 1994].

Available Interventions and Benefits—Current Standards and Recommendations

Currently, no NIOSH-recommended exposure limits (RELs), OSHA permissible exposure limits (PELs), or American Conference of Governmental Industrial

Hygienists (ACGIH) threshold limit values (TLVs) have been established for hazardous drugs in general. A performance approach to safe handling is more appropriate, given the multiple drugs in clinical use, rendering a PEL-based approach unmanageable. Main elements of all the guidelines issued from both government agencies and professional organizations recommend a comprehensive approach using a combination of engineering controls (biologic safety cabinets (BSC)), administrative controls and warnings, work practices, PPE, worker training, medical surveillance, and record keeping.

OSHA

OSHA originally published guidelines for safe handling of antineoplastic drugs in 1986 [OSHA 1986]. Current OSHA standards that can be applicable to hazardous drugs include the OSHA Hazard Communication Standard [29 CFR 1910.1200] and the Personal Protective Equipment Standards: General Requirements [29 CFR 1910.132], Eye and Face Protection [29 CFR 1910.133], Respiratory Protection [29 CFR 1910.134], and Hand Protection [29 CFR 1910.138]. In addition, there is a guidance document specifically on hazardous Drugs—Hazardous Drugs: OSHA Technical Manual, Section VI, Chapter 2, "Controlling Occupational Exposure to Hazardous Drugs" [OSHA 1999].

Environmental Protection Agency

The Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) regulations require that hazardous waste be managed by following a strict set of regulatory requirements [40 CFR 260–279]. The RCRA list of hazardous wastes was developed in 1976 and includes only about 30 pharmaceuticals, 9 of which are antineoplastic drugs.

Additional Guidelines

Additional guidelines that address hazardous drugs or the equipment in which they are manipulated have been prepared by other government agencies and several professional organizations including the American Society of Health-Systems Pharmacists (ASHP) and the Oncology Nursing Society (ONS). A complete reference list for these documents and others are available on the NIOSH Web site.

Research Gaps

Evidence for work environment contamination and worker exposure has steadily grown and is not in dispute at present. The clinical significance of exposure is unclear, however. Surveillance systems designed to track both cancer and adverse

reproductive outcomes by occupation and specifically by specialization within an occupation (e.g., oncology nursing, oncology pharmacy practice) are sorely needed. As well, research into the efficacy of safety climate promotion and adherence to safe handling practices is needed.

Case Reports

The following cases illustrate examples of a chronic effect (Case 1) and an acute health effect (Case 2) reported after exposure to antineoplastic hazardous drugs:

Case 1. A 39-year-old pharmacist suffered two episodes of painless hematuria (blood in the urine) and was found to have cancer (a grade II papillary transitional cell carcinoma) [Levin et al. 1993]. Twelve years before her diagnosis, she had worked full time for 20 months in a hospital IV preparation area where she routinely prepared cytotoxic agents including cyclophosphamide, fluorouracil, methotrexate, doxorubicin, and cisplatin. She used a horizontal laminar-flow hood that directed the airflow toward her. Because she was a nonsmoker and had no other known occupational or environmental risk factors, her cancer was attributed to her antineoplastic drug exposure at work, though a cause-and-effect relationship has not been established in the literature.

Case 2. A 41-year-old patient-care assistant working on an oncology floor developed an itchy rash approximately 30 minutes after emptying a commode of urine into a toilet [Kusnetz and Condon 2003]. She denied any direct contact with the urine, wore a protective gown and nitrile gloves, and followed hospital policy for the disposal of materials contaminated with antineoplastic drugs. The rash subsided after 1 to 2 days. Three weeks later, she had a similar reaction approximately 1 hour after performing the same procedure for another patient. Upon investigation, it was found that both hospital patients had recently been treated with vincristine and doxorubicin. The patient-care assistant had no other signs or symptoms and reported no changes in lifestyle and no history of allergies or recent infections. After treatment with diphenhydramine (intramuscular) and oral corticosteroids, her symptoms disappeared. Although the cause could not be definitely confirmed, both vincristine and doxorubicin have been associated with allergic reactions when given to patients. The aerosolization of the drug present in the urine may have provided enough exposure for symptoms to develop.

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Chapter 15 ▪ Chemical and Other Hazardous Exposures

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Issue

Healthcare and Social Assistance (HCSA) occupations are among the fastest growing occupations in the United States [Hecker 2005]. Although often thought of as clean and safe, the healthcare setting features many of the same types of exposures to chemicals and other hazards that are found in "blue collar" industrial settings [McDiarmid 2006]. Furthermore, healthcare workers are at increased risk for many adverse health effects potentially caused by hazardous exposures including several types of cancer [Lie et al. 2007; MacArthur et al. 2007; Snedeker 2006; Steenland et al. 2003; Petralia et al. 1999], adverse reproductive outcomes such as spontaneous abortion and congenital malformations [Rowland et al. 1996; Florack and Zielhuis 1990; Hemminki et al. 1986; NIOSH 1999], and the three major forms of work-related asthma (occupational, irritant, and work-exacerbated) [Delclos et al. 2007; Mirabelli et al. 2007; Pechter et al. 2005; Dimich-Ward et al. 2004; Liss et al. 2003; Clapp 2006]. The development, implementation, and documentation of the effectiveness of interventions to reduce exposures is needed even though it is clear that hazardous exposures are causing occupational disease. This chapter will outline issues related to chemical and physical hazards in the HCSA sector, excluding hazardous drugs.

Risk

Table 27 presents potential exposures of HCSA occupations to selected chemical and physical hazards encountered in HCSA workplaces. Table 28 addresses potential health effects of many of these same chemical and physical agents. Although Tables 27 and 28 list some of the more prominent hazards encountered in the HCSA setting, they are far from complete. A wide range of activities, occupations, and exposures can be found that are potentially hazardous. For example, a range of chemical and physical hazards can be found in clinical and research laboratories. A variety of other hazards exists for employees who work in HCSA settings but whose duties are not specific to this industrial sector. The health and safety of these workers is sometimes overlooked. Examples of these work areas include

Table 27. Potential exposures of HCSA occupations to selected chemical and physical hazards

Hazard	Examples of specific agents/hazards	Examples of occupations with potential exposure	References
Aerosolized medications	ribavirin, pentamidine, tobramycin, amikacin, colistin	respiratory therapists, nurses, physicians	Charney 1999 Dimich-Ward et al. 2004 McDiarmid et al. 1993 NIOSH 2008a
Anesthetic gases	desflurane, enflurane, halothane, isoflurane, nitrous oxide, sevoflurane	anesthesiologists, anesthesiologist assistants, surgeons, dentists, surgical technologists, surgical assistants, perfusionists, nurse anesthetists, perioperative nurses, recovery room personnel	NIOSH 2007
Chemical sterilants	ethylene oxide, hydrogen peroxide gas plasma	medical supply technicians, surgical technologists	Bathina et al 1998 NIOSH 2008b Slaybaugh 2000
Cleaning agents (used to clean hard surfaces such as floors and countertops)	quaternary ammonium compounds, phenols, aldehydes, iodine, chlorine bleach, alcohols	housekeeping/environmental services personnel	Pechter et al. 2005
High level disinfectants	glutaraldehyde, orthophthaldehyde, peracetic acid, hydrogen peroxide	endoscopy technicians, surgical technologists, gastroenterology nurses,, dental assistants	NIOSH 2001 Rideout et al. 2005
Ionizing radiation	x-rays, gamma rays, beta particles	radiologists, radiologic and x-ray technicians, chiropractors, dental assistants, dentists, diagnostic related technologists and technicians, physicians, nurses, nuclear medicine staff	NIOSH 1999 OSHA 2008a OSHA 2008b
Natural rubber latex	latex rubber protein	physicians, nurses, dentists, dental hygienists and assistants, surgical assistants, perioperative nurses, emergency medical care personnel, endoscopy technicians	NIOSH 1997
Non-ionizing radiation	electric and magnetic fields, lasers, radiofrequency radiation, ultraviolet radiation	diagnostic-related technologists and technicians, ophthalmologists, dentists and dental assistants, dermatologists	OSHA 2008c
Surgical smoke (generated by lasers and electrosurgical devices)	acetonitrile, furfural, phenol, toluene and many other chemical agents; viable viruses, cells and nonviable particles	surgeons, perioperative nurses, surgical assistants, anesthesiologists, dermatologists, dentists	AORN 2008 NIOSH 2006a NIOSH 2006b

Table 28. Major health effects of selected chemical and physical agents encountered in the HCSA sector

Exposure	Areas of potential exposure	Major health effects	References*
Aerosolized medications	In patient and outpatient isolation rooms	Asthma, asthma-like symptoms associated with exposure to ribavirin and pentamidine	Dimich-Ward et al 2004 McDiarmid et al 1993
Anesthetic gases	Operating rooms Procedure rooms Dental offices	Adverse reproductive outcomes: spontaneous abortion, congenital abnormalities CNS effects: headache, nausea, fatigue, cognitive impairment	McGlothlin et al 1990 NIOSH 2007 Tompa et al. 2006
Cleaning agents (for use on hard surfaces such as floors and countertops)	Used in a broad range of settings occupied by patients, visitors, and HCSA personnel.	Asthma Irritation of eyes, skin, respiratory tract	Pechter et al. 2005 Purohit et al. 2000 Rosenman et al. 2003
Ethylene oxide	Used to sterilize medical devices, especially those not able to withstand autoclaving Affects areas potentially using this sterilization technology, especially central supply but also operating rooms, outpatient surgery clinics, dialysis units, etc.	Carcinogen Teratogen Potential long-term impact on CNS, liver, kidneys Cataracts Strong irritant; acute exposure can also cause nausea, vomiting, neurotoxicity	Coggon et al. 2004 Hogstedt et al. 1979 LaMontagne et al. 2004 Rowland et al. 1996 Snedeker 2006 Steenland et al. 2003 Tompa et al. 2006
Formaldehyde	Used as tissue preservative. Especially affects areas preserving tissues, such as pathology, operating room, clinics, research laboratories, etc. Used by dialysis units to disinfect lines, dialyzers, etc.	Carcinogen Sensitizer / Asthma Strong irritant; acute exposure also associated with numerous systemic symptoms	Gannon et al. 1995 Lemiere et al. 1995 Liss et al. 2003 McGregor et al. 2006 Quinn et al. 2006 Roy 1999 Vyas 2000
Glutaraldehyde	Used for instrument cleaning and high level disinfection of medical instruments. Especially affects areas disinfecting instruments with glutaraldehyde solutions such as endoscopy units, ORs, clinics, central supply	Asthma, asthma-like symptoms Allergic Contact Dermatitis Mucous membrane irritation Headaches, nausea	Chan-Yeung et al. 1993 Charney 1991 Di Stefano et al. 1999 Gannon et al. 1995 Liss et al. 2003 NIOSH 2001 Rideout et al. 2005 Shaffer and Belsito 2000 Vyas et al. 2000

(Continued)

Table 28 (Continued). Major health effects of selected chemical and physical agents encountered in the HCSA sector

Exposure	Areas of potential exposure	Major health effects	References*
Surgical smoke from lasers and electrosurgical devices)	Lasers and electrocautery used in a range of surgical settings	Irritation of eyes, upper respiratory tract Smoke has mutagenic potential	AORN 2008 Baggish 1991 Garden et al. 1988 NIOSH 1988 NIOSH 1996 NIOSH 2006a,b Tomita et al. 1981 Winstin 1994
Mercury	Older equipment: thermometers, sphygmomanometers, Coulter counters, etc.	Mercury poisoning Neurotoxicity Pulmonary toxicity Nephrotoxicity GI toxicity Fetal injury	NIOSH 2008 Sustainable Hospitals Program 2008
Natural rubber latex (NRL)	Used in medical devices and personal protective equipment (PPE), including examination and surgical gloves Glove powder is an important vehicle for airborne transmission of NRL allergen	Asthma Hives Anaphylaxis Allergic rhinoconjunctivitis Allergic contact dermatitis (frequent use of occlusive gloves of any material can cause irritant dermatitis)	Bubak et al. 1992 Dillard et al. 2002 NIOSH 1997 Zeiss et al. 2003
Noise	Noise-inducing procedures and equipment, such as saws and drills used in orthopedics and neurosurgery.	Hearing loss Impaired communication	Busch-Vishniac et al. 2005 Hodge and Thompson 1990 Kracht et al. 2007
Ionizing radiation	Ionizing radiation is used both in diagnostic and therapeutic radiology, including brachytherapy	Cancer—leukemia, breast, thyroid, skin (basal cell) Cataracts Adverse reproductive outcomes Subclinical genetic changes (chromosomal translocations)	NIOSH 1999
Non-ionizing radiation	Strong magnetic fields used in diagnostic MRI, lasers used in vision correction and general surgical procedures	Burns to skin and eyes Thermal effects Neurological, behavioral and immunological effects	NIOSH 1998

*References at end of chapter.

housecleaning, laundry, food service, building maintenance, and engineering. In addition to hazardous materials, workers in some of these areas may be exposed to physical hazards such as heat (laundry, food service) or noise (building maintenance, engineering).

HCSA workers are generally employed in indoor environments. As is the case in other industrial sectors, indoor air quality (IAQ) is also an issue for the HCSA sector. Exposure to poor IAQ can occur in office and administration areas of the hospital and have multiple sources including dust, dampness, mold, pesticides, cleaning agents, and chemical emissions from carpeting and paneling. Poor IAQ can be exacerbated by poorly functioning heating, ventilation, and air-conditioning (HVAC) systems. These exposures can cause symptoms of respiratory and mucosal irritation and have been associated with development and exacerbation of asthma.

Available Interventions

As is the case in other industrial sectors, the industrial hygiene prevention hierarchy of elimination, substitution, engineering controls, administrative controls and warnings, and personal protective equipment (PPE) applies equally to the HCSA sector. Substitution is an extremely important issue in the sector because of its potential to eliminate hazards from the workplace.

An example of elimination is the following:

- Floor wax and floor strippers: the use of these products is unnecessary to keep the hospital environment clean and sanitary.

Examples of substitution include the following:

- Glutaraldehyde: several substitute disinfectants are available such as orthophthalaldehyde (OPA), peracetic acid and hydrogen peroxide mix, and hydrogen peroxide solutions [Sustainable Hospitals Program 2008]. Acidic electrolyzed water has also been reported as an effective disinfectant.
- Ethylene oxide: substitute cold sterilants are available such as hydrogen peroxide gas plasma or peroxyacetic acid/hydrogen peroxide gas plasma.
- Powdered NRL gloves: nonpowdered NRL gloves and nonlatex gloves are widely available.

As is also the case in other industrial sectors, information dissemination and education are very important. Communication of health and safety issues to management encourages and informs management commitment to addressing them. Furthermore, knowledge empowers workers to take measures to reduce exposures, as well as recognize and report hazardous conditions. Worker monitoring is a key

intervention. Monitoring of radiation exposure with measures to reduce exposure based on radiation dose is an excellent example of exposure surveillance. Medical monitoring and surveillance are also important, so that problems like latex allergy can be recognized and responded to at an early stage.

The hospital's health and safety committee can be charged with instituting a facility-wide program to decrease exposure to chemicals as well as other hazards in the workplace. The committee should be multidisciplinary, including front-line workers, unions or employee representative organizations, management, and representatives from the key departments. The tasks of the committee should include [Gochenhour et al. 2001; Health Care Without Harm 2008] the following:

- Evaluate hazards in the hospital. This can be accomplished by conducting walk-throughs and surveys of the facility, reviewing incident reports and employee complaints, and examining work processes.
- Research and evaluate safer alternatives to hazards and develop plans for adopting alternatives. Where elimination or safer alternatives are not available, apply other hierarchy of control interventions (i.e., administrative controls, engineering controls, and use of PPE).
- Conduct follow-up inspections and evaluations to ensure effectiveness of interventions.
- Communicate with and educate the hospital staff regarding hazards and appropriate means to avoid exposure and protect themselves.

Knowledge Gaps and Other Barriers to Reduction of Hazards

A number of knowledge gaps and other barriers to reduction of hazards exist in the HCSA industrial sector. A key barrier is overcoming the misconception that HCSA work is safer than other work involving exposure to chemical and physical hazards. Recognition and anticipation of potential hazards is the first step in preventing work-related illness. In this regard, a key knowledge gap is in the areas of hazard and health surveillance. Only limited surveillance data exist characterizing the exposures of HCSA workers. Similarly, surveillance data that would allow quantification of illnesses affecting HCSA workers and comparison of illness rates to other industrial sectors are also lacking. Although useful for tracking injury rates, data from the Bureau of Labor Statistics are not useful for tracking many types of illnesses, particularly illnesses not viewed by the employer as work-related (as might be the case for conditions such as asthma or cancer). Mortality data obtained by the National Death Index have not been coded for decedents' usual occupation or industry since 1999, markedly limiting the usefulness of mortality data

for occupational surveillance of the HCSA and other industrial sectors. Thus, a key need for the HCSA sector is the development of improved, innovative surveillance that takes advantage of available and developing data sources, such as state cancer registries, health insurance data, and electronic medical records.

In addition to tracking trends using surveillance data, epidemiological data are needed to better evaluate relationships between hazardous exposures and work-related diseases in healthcare workers, such as asthma [Delclos 2007]. In some cases, these studies may lead to the development of new technology for exposure assessment, such as biosensors and chemical sensors. Since some diseases can be caused by multiple agents, it may be difficult to identify which exposures are responsible for development of disease, as well as dose-response relationships, and what levels of exposure can be considered "safe." Studies must be carefully designed to take into account potential confounders and effect modifiers. For example, a study evaluating impact of combined exposures to ethylene oxide and ionizing radiation exposure in nurses showed an association between this particular combination of exposures and breast cancer [Tompa et al. 1999].

Epidemiological studies are particularly needed in the area of work-related cancer. Increased rates of cancer have been documented in healthcare workers, particularly nurses. These include breast, ovarian, and other cancers. While some chemicals (e.g., ethylene oxide) have been implicated in these studies, much more work needs to be done to understand the underlying causative factors.

Another issue is overcoming barriers to establishing a "safety culture." As important as worker education, worker monitoring, and surveillance are, these interventions will not be effective without a strong safety culture in place. As in other industries, all levels of organization, from top to bottom, must be committed to safety and health, but management commitment is key. Making workplace safety a top priority can help to overcome other issues such as financial pressures, time pressures, and reluctance to adopt new practices and technologies. Decisions to adopt new practices and technologies in the face of these issues are best supported by good quality evidence that these changes make the workplace safer and do not hurt patient outcomes. For example, minimizing the use of powdered latex gloves in HCSA settings was facilitated by strong evidence of effectiveness and availability of acceptable substitutes. Similarly, adoption of new approaches to hazardous processes such as disinfection and sterilization will require good toxicological and epidemiological evidence that new agents and approaches used to accomplish these tasks are safer for workers, as well as evidence that they are as effective for use in patient care as older, "tried and true" methods.

New practices and technologies also create the potential for emerging health issues. For example, radiation doses associated with computed tomography are much greater than for conventional radiographs, creating the potential for HCSA workers to

have greater exposure to radiation. Substitute agents for disinfection and sterilization will, without doubt, be associated with health impacts of their own and will need to be studied to understand their health effects and to determine acceptable levels of exposure. A prominent example is the association between OPA and anaphylaxis in patients with bladder cancer, which has raised concerns that the agent might cause sensitization and allergic problems in HCSA workers. Another potential emerging issue is use of nanomaterials in medicine. As new technologies emerge in the HCSA industry, well-designed studies, including appropriate environmental monitoring techniques, will be needed to evaluate their occupational health impacts.

Scientific uncertainty can act as a barrier to adopting preventive measures to protect workers. However, even in cases where a definitive cause-and-effect relationship has not been established scientifically, but where there is a reasonable suspicion that risk exists from exposure to a chemical or combination of chemicals, prudent action should defer to a precautionary approach. A precautionary approach is reasonable in cases where there exists biological plausibility that an exposure presents a threat to human health, despite the presence of scientific uncertainty, and especially when there are safer alternatives available.

An important barrier is the need to effectively communicate information about hazards and strategies for prevention to all elements of the HCSA sector. Best practices are adopted more rapidly and more widely if an effective approach to transferring information to users and diffusing information among users is in place. The HCSA sector is large and diverse. Different elements of the sector receive information from different sources. An especially important consideration is effective communication to the many people working in the HCSA sector that have a primary language other than English.

Knowledge gaps exist relative to research on the efficacy of prevention measures, such as engineering controls, especially concerning novel technologies that create new exposures.

Case Study: Latex Allergy

As the HIV epidemic evolved over the 1980s and 1990s, use of natural rubber latex gloves to prevent transmission of HIV and other blood borne pathogens markedly increased. This, in turn, was associated with an epidemic of latex allergy. In 1997, the National Institute for Occupational Safety and Health issued NIOSH Alert: Preventing Allergic Reactions to Natural Rubber Latex in the Workplace [NIOSH 1997], which included recommendations for a comprehensive approach to preventing latex allergy. A key recommendation was to avoid the use of powdered gloves, since glove powder could carry latex

allergen aloft, resulting in aerosol exposure of glove users and others in the same air space. The results of these prevention efforts in the United States and abroad document that occupational allergy caused by latex can be prevented.

In 1997, Johns Hopkins Hospital set up an interdisciplinary latex task force to create, implement, and evaluate a latex-safe environment [Brown et al. 2003]. The group sought out alternatives to latex gloves, especially powdered latex examination gloves, which were used in all patient care areas. An attempt was made to switch to vinyl examination gloves, but there was only minimal acceptance due to their poor fit. Subsequently, a successful switch to nitrile examination gloves was completed. Conversion to nonlatex surgical gloves was less successful, with cost being a major factor.

Starting in 1998, two hospitals associated with the Medical College of Wisconsin prospectively determined the incidence of latex sensitization before and after replacing powdered gloves with powder-free latex or nonlatex gloves [Kelly et al. 2003]. Latex sensitization was evaluated using allergen skin prick tests. Healthcare workers from both hospitals developed new latex sensitization during the 12 months before the intervention (7 of 705 tested). No healthcare workers developed new latex sensitization over a period of 32 months after switching to powder-free gloves. Before the switch, no healthcare workers with positive skin tests reverted to negative; after the switch, four reverted.

In December 1997, Germany established a regulation stating that only low-allergen, powder-free natural rubber latex gloves should be used in the workplace. Use of powdered latex gloves was forbidden. In the period immediately before establishing the regulation, intensive public health information campaigns targeting hospitals and hospital administrators, physicians, and dentists communicated the hazards of powdered latex gloves and the benefits of changing to nonpowdered gloves. Several publications have documented the impact of these interventions [Allmers et al. 2002; Allmers et al. 2004]. Incident latex-induced occupational asthma decreased from 365 cases in 1997 to 165 cases in 2000 [Allmers et al. 2002]. Reduction in latex-induced occupational asthma closely paralleled reduction in the use of powdered latex gloves (Figure 24). Similarly, incident latex-induced contact urticaria cases decreased from 607 cases in 1997 to 131 cases in 2002 (derived from data presented in Allmers et al. 2004). Reduction in latex-induced contact urticaria also paralleled reduction in the use of powdered latex gloves (Figure 25).

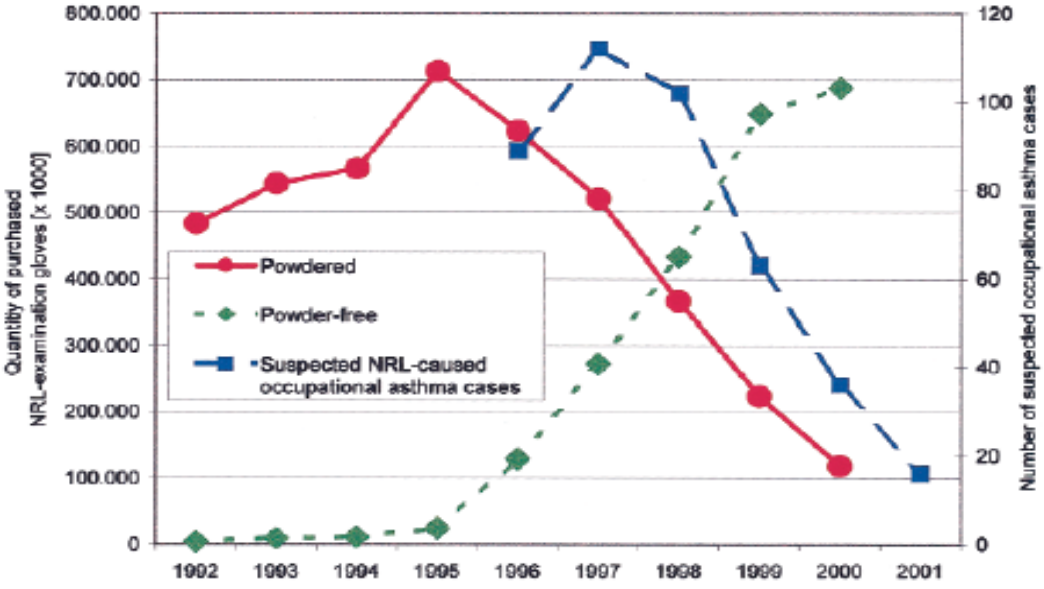

Figure 24. Quantity of powdered and powder-free latex examination gloves purchased and number of suspected cases of latex-induced occupational asthma in German healthcare workers, 1992-2001 (Source: [Allmers et al 20054])

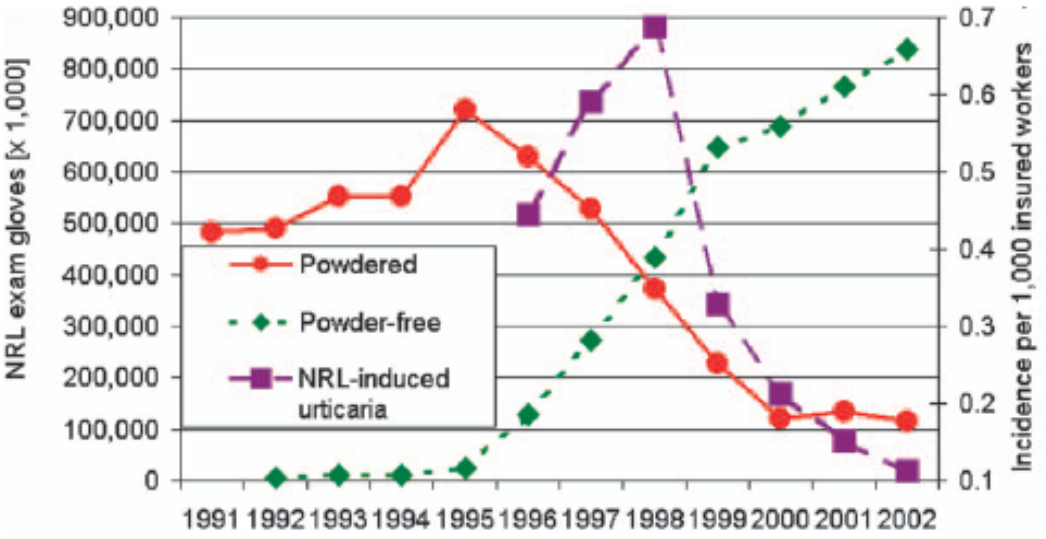

Figure 25. Quantity of powdered and powder-free latex examination gloves purchased and suspected cases of latex-induced contact urticaria in German healthcare workers, 1991-2002 (Source: [Allmers et al 2004])

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Chapter 16 ▪ Bloodborne Pathogens and Sharps Injuries

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Issue

Healthcare personnel are at risk for infection with bloodborne pathogens such as HBV, HCV, and HIV following occupational exposures to blood and body fluids (see Chapter 3 "Burden of Injury and Illness Documented by Surveillance Systems"). Bloodborne pathogens are disease-causing microorganisms that may be transmitted through contact with blood and certain other body fluids. Exposure to these pathogens through needlesticks, cuts, or other sharps injuries (referred to as percutaneous injuries), as well as through splashes and direct contact with mucous membranes or nonintact skin has been associated with the occupational transmission of more than 60 pathogens [Pike 1976; Collins and Kennedy 1987; Devereaux et al. 1990; Alweis et al. 2004; Shapiro 1995; Bell 1997; Wagner et al. 2004;Tarantola et al. 2006]. In the healthcare industry, the three pathogens noted above are of special concern because, of all possible bloodborne pathogens, these pathogens are the most likely to be transmitted occupationally through percutaneous injuries and because of they can cause severe illness.

There have been 57 documented cases of occupational HIV transmission among healthcare personnel as reported by the Centers for Disease Control and Prevention (CDC), through December 2006 [CDC 2007]. In 1997, the incidence of occupationally acquired HBV among healthcare personnel was less than 500 [Mahoney et al. 1997]. Based on the estimated number of percutaneous injuries per year and the average transmission rate, Sepkowitz and Eisenberg [2005] suggest that 50–150 transmissions of HCV would be expected each year.

There are several strategies to prevent occupational transmission of bloodborne pathogens. Hepatitis B vaccine largely prevents HBV infection and postexposure prophylaxis can be given for either HBV or HIV exposure. But there are currently no vaccines to prevent HIV or HCV infection nor recommended postexposure prophylaxis for HCV exposure. Therefore, strategies that focus on the prevention of sharps injuries and other blood and body fluid exposures are

essential in preventing occupational transmission of these and other bloodborne pathogens to healthcare workers.

Occupational transmission of bloodborne virus infection is a relatively rare event. Nevertheless, the direct and indirect costs associated with sharps injuries can be substantial. The estimated cost of providing care following an exposure to blood and other body fluids can range from hundreds to thousands of dollars, depending on the type of medical care that is required, possibly including postexposure prophylaxis (PEP) [GAO 2000; O'Malley et al. 2007]. Additional costs may stem from drug toxicity related to PEP, lost time from work, and the societal costs associated with bloodborne pathogen infections, such as potential reduction in productivity, the economic burden of additional medical care, and the cost of litigation [O'Malley et al. 2007]. Percutaneous exposures also take an emotional toll that is more difficult to quantify, but no less significant [Gershon et al. 2000].

Risk

The average risk of HIV transmission after a percutaneous exposure to HIV-infected blood is estimated to be 0.3% [Bell 1997]. Following a known HBV exposure, there is a 6%–30% risk that nonvaccinated healthcare personnel will become infected [Grady 1976; Grady et al. 1978; Werner and Grady 1997]. The risk of HCV transmission following percutaneous exposure to HCV is approximately 1.8% (range: 0%–7%) [Kiosawa et al. 1991; Mitsui et al. 1992; Hernandez et al. 1992; Sodeyama et al. 1993; Lanphear et al. 1994; Puro et al. 1995;].

Exposures that pose a risk of transmission of bloodborne pathogen infection to healthcare personnel include percutaneous injuries or contacts of mucous membrane or nonintact skin (e.g., exposed skin that is chapped, abraded, or afflicted with dermatitis) with blood, tissue, or other body fluids that are potentially infectious [CDC 2001]. In a case-control study of personnel who sustained percutaneous injuries to HIV-infected sources, significant risk factors for seroconversion were (a) injury with a device visibly contaminated with the source patient's blood, (b) a procedure that involved placing a needle directly in the source patient's vein or artery, (c) a deep injury, and (d) exposure to a source patient in the terminal stages of AIDS [Cardo et al. 1997].

The actual number of needlestick and other percutaneous injuries sustained by healthcare personnel each year cannot be determined for several reasons. There is no single "national" sharps injury surveillance system, nor is there a system to collect injury data from nonhospital settings such as private medical and dental clinics, home care settings, long-term facilities, or correctional institutions. Another limitation is underreporting of injuries. It is estimated that perhaps only half of

exposures are reported, with reporting rates varying by occupational group [Roy and Robillard. 1995; CDC 1997; Osborn et al. 1999; Abdel et al. 2000; Makary et al. 2007].

To arrive at a national estimate of the number of hospital-based sharps injuries occurring in the U.S., sharps injury data reported to the Exposure Prevention Information Network (EPINet™) [University of Virginia Health System 2003] system, developed at the University of Virginia and the National Surveillance System for Healthcare Workers (NaSH) of the CDC [2000], were combined. In 2004, Panlilio et al. reported that U.S. hospital-based healthcare workers sustain approximately 385,000 percutaneous injuries each year [Panlilio 2004]. Data from EPINet™, NaSH and other state-based systems [MA DOPH 2007] provide a general description of the epidemiology of percutaneous injuries: nurses sustain the highest number of percutaneous injuries; most injuries occur on the patient wards, in the operating room or in recovery; the majority of injuries occur during injections and suturing; hollow-bore needles were the type of device used in the majority of incidents [CDC 2000; University of Virginia Health System 2003;MA DOPH 2007].

Overview of Research

The occupational risk to healthcare personnel of exposure to bloodborne pathogens through percutaneous injuries is well documented. Data assessing this risk come from a variety of sources including surveillance reports, anecdotal reports, seroprevalence surveys, and observational studies. Much of the data relates to hospital-based healthcare personnel. The occupational risks of exposure to bloodborne pathogens among healthcare personnel employed in nonhospital settings is not well documented. Recent work by Gershon and colleagues indicates that risk of percutaneous injury in at least certain subpopulations of nonhospital based healthcare personnel may approximate the risk of hospital-based healthcare personnel [Gershon et al. 1999, 2000, 2002, 2007, 2008]. Beltrami et al., in 2000 found that healthcare personnel employed in home care were at risk for blood contact, although the rates of percutaneous injury were low [Beltrami et al. 2000]. First responders are also at risk. In a review of published studies describing exposures to blood or surveillance of bloodborne infections among U.S. firefighters and emergency medical technicians, Boal et al. [2005], concluded that while there is limited data available, it appears that these occupational groups may have needlestick injury rates comparable to hospital workers.

In 1981, McCormick and Maki [1981] first described the epidemiology of needlestick injuries among healthcare personnel and recommended a series of prevention strategies, including educational programs, avoidance of recapping, and better needle disposal systems. In 1987, CDC's recommendations for universal precautions included guidance on sharps injury prevention, with a focus on careful

handling and disposal of sharp devices [CDC 1987]. Several reports on needlestick prevention published between 1987 and 1991 focused on the appropriate design and convenient placement of puncture-resistant sharps disposal containers and the education of healthcare personnel on the dangers of recapping, bending, and breaking used needles [Ribner 1990; Ribner et al. 1987; Linnemann et al. 1991; Sellick et al. 1991; Edmond et al. 1988; Smith et al. 1991; Haiduven et al. 1992]. Most of these studies documented only limited success of specific interventions to prevent disposal-related injuries and injuries due to recapping [Edmond et al. 1988; Linnemann et al. 1991; Sellick et al.1991; Smith et al. 1991; Whitby et al. 1991]. Greater success in decreasing injuries was reported if the intervention included an emphasis on communication [CDC 1987; Whitby et al 1991].

Barriers to Reduction of Hazards

In 2000, the Needlestick Safety and Prevention Act [2000] directed the Occupational Safety and Health Administration to revise the Bloodborne Pathogens Standard [OSHA 1991]. The changes included the strengthening of the requirement for using engineering controls to prevent needlestick injuries and the requirement of employers to solicit input from frontline healthcare workers in the identification, evaluation, and selection of engineering and work practice controls. While these changes have been in effect since 2001, and 21 states [NIOSH 2007] have enacted sharps injury prevention laws that reflect the federal OSHA standard, sharps injuries continue to occur as demonstrated in a report from the Massachusetts Sharps Injury Surveillance System [Panlilio et al. 2004] showing that in 2004, thirty-three percent (1,072) of injuries were reported to have involved devices with engineered safety features. Contributing to the continuing occurrence of sharps injuries include lack of adoption of safety engineered devices, lack of availability of safety engineered devices for the full range of products, design shortcomings, and lack of activation of safety features [Wugofski 1992; Gerberding 1993; Hanrahan and Reutter 1997; Zafar et al. 1997; Gershon 1999; AHA 1999; Davis 1999;].

Behavioral factors such as recapping of sharps devices and the alteration of the safety device before use also contribute to sharps injuries [University of Virginia Health System 2003]. Attempts to reduce exposures to potentially infectious blood and body fluids through the modification of work practices (e.g., no recapping of needles) have been limited. One example of a national organization recommending work practices to facilitate sharps safety is the American College of Surgeons [American College of Surgeons 2007]. Chapter 6, "Health and Safety Culture", discusses safety culture in the healthcare setting as a barrier to worker protection.

Occupationally acquired HBV has diminished by > 90% since the introduction of standard precautions and a recombinant vaccine. Despite vaccine availability, however, coverage is incomplete because > 30% of workers refuse to be vaccinated [Mahoney et al. 1997].

Interventions Available and Benefits

Healthcare organizations have adopted the hierarchy of control prevention model, a concept used by the industrial hygiene profession to prioritize prevention interventions. In the hierarchy for sharps injury prevention, the first priority is to eliminate and reduce the use of needles and other sharps where possible. For example, the wide adoption of needleless IV delivery systems in ~70% of U.S. hospitals [Pugliese et al. 2000] have almost eliminated unnecessary use of needles to access IVs. These systems do not require (and in some instances do not permit) needle access. Next is to isolate the hazard, thereby protecting an otherwise exposed sharp, through the use of an engineering control. Engineering controls include sharps disposal containers and needles and other sharps devices with an integrated engineered sharps injury prevention feature. Again, many hospitals and other healthcare settings have switched to safety-engineered needles and syringes. When these strategies are not available or will not provide total protection, the focus shifts to work-practice controls and personal protective equipment.

Standard Precautions [CDC 2007], which combine the major features of Universal Precautions and Body Substance Isolation, are based on the principle that all blood, body fluids, secretions, excretions except sweat, nonintact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions include a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which healthcare is delivered. Standard precautions is an important concept and an accepted prevention approach with demonstrated effectiveness in preventing blood exposures to skin and mucous membranes [Wong et al. 1991; Fahey et al. 1991]. However, this approach focuses heavily on the use of barrier precautions (i.e., personal protective practices) and work-practice controls (e.g., care in handling sharp devices) and by itself could not be expected to have a significant impact on the prevention of sharps injuries. Personal protective equipment (e.g., gloves, gowns) provide a barrier to shield skin and mucous membranes from contact with blood and other potentially infectious body fluids. While most protective equipment is easily penetrated by needles, a laboratory study by Mast et al. [1987] demonstrates that the quantity of blood carried by the needle is reduced if a percutaneous injury occurs through gloves.

Although strategies introduced a decade or more ago to reduce the incidence of sharps injuries (e.g., rigid sharps disposal containers, avoidance of recapping) remain important today, given the incidence of needlesticks and other sharps injuries, additional interventions are clearly needed.

Gaps

The literature suggests that efforts to date have had only limited success in reducing the incidence of sharps injuries [Gershon et al. 2007; McCormick and Maki 1981; CDC 1987; Ribner et al. 1987; Ribner 1990; Linnemann et al. 1991; Sellick et al. 1991; Smith et al. 1991; Edmon et al. 1988], and it is believed that the successful elimination of all sharps injuries in healthcare settings will require a coordinated, multifaceted, and multidisciplinary approach. To this end, in September 2005, the CDC assembled stakeholders and experts for a one-day National Sharps Injury Prevention Meeting [CDC 2007] to develop action steps to guide future prevention activities. Priority action items resulting from this meeting can be grouped into the following areas: surveillance, education and training of healthcare workers, human and organizational factors associated with sharps injuries, and development and implementation of devices with engineered sharps injury prevention features. When asked to identify priority research needs for the healthcare industry in 2005, NIOSH stakeholders identified these same items as needing additional research.

Surveillance

Surveillance of sharps injuries and other blood and body fluid exposures is necessary for monitoring of injury and exposure trends, identifying emerging problems, and targeting and evaluating the impact of prevention measures. For employers who are required to maintain a log of occupational injuries and illnesses under 29 CFR 1904, the OSHA Bloodborne Pathogens Standard requires employers to maintain a sharps injury log for the recording of percutaneous injuries from contaminated sharps [OSHA 2001]. Unfortunately, the information from these logs is not systematically collected, analyzed, and used to identify trends and evaluate prevention measures by organizations other than healthcare employers. An additional concern is that data from nonhospital settings are relatively nonexistent. As noted earlier, the EPINet™ and NaSH sharps injury surveillance systems are available, but they both rely on voluntary participation, and therefore the data is not based on a representative sample of hospitals and nonhospital healthcare settings. Accurate sharps injury surveillance data are needed in order to monitor progress toward the elimination of sharps injuries in the U.S.

Education and Training of Healthcare Workers

Educating healthcare workers about the risks associated with bloodborne pathogen exposures and methods to limit these exposures, including the importance of reporting all injuries, remain crucial to sharps injury prevention efforts. The education and training of healthcare workers has been mandated by the OSHA Bloodborne Pathogen Standard. It appears that there are substantial training gaps among certain occupational groups who are at high risk for bloodborne pathogen exposure, such as surgical and trauma staff, obstetricians/gynecologists (OB/GYNs), emergency department personnel, anesthesiologists, contract staff, medical trainees, and employees of nonhospital facilities such as dialysis facilities and ambulatory surgery centers. Standardized tools and methods for conducting training are also needed.

Human and Organizational Factors

Work practice and engineering controls have been the cornerstone of sharps injury prevention efforts for nearly two decades. The implementation of work practice controls (e.g., universal precautions/standard precautions) and engineering controls (e.g., devices with engineered sharps injury prevention features) in healthcare settings has reduced, but not eliminated, sharps injuries. Research has shown that adherence to universal precautions/standard precautions is less than optimal across a wide range of healthcare work groups [Gershon et al. 1991; Saghafi et al. 1992; Gershon et al. 1995; Kim et al. 2001; Michalsen et al. 1997; Osborne 2003; Vaughn et al. 2004; Bennet and Mansell 2004; Cutter and Jordan 2004], and evidence also suggests that healthcare personnel do not always properly utilize sharps injury prevention features on devices [Alvarado-Ramy 2003; Gershon et al. 2007; Alvarado-Ramy 2003]. The human and organizational factors associated with suboptimal compliance have been identified, but intervention research is needed to address the barriers to compliance [Gershon et al. 2000, 1995]. Organizational factors associated with sharps injuries include the changing healthcare working environment, the safety culture, and personnel management.

Engineered Sharps Injury Prevention Features

A wide variety of sharps with engineered safety features have been developed, and the efficacy of injury protection for some of these devices has been demonstrated in various studies [Younger et al. 1992; Orenstein et al. 1995; CDC 1997; McCleary et al. 2002;; Alvarado-Ramy et al. 2003 Rogues et al. 2004; Sohn et al. 2004; Trape-Cardoso and Schenck 2004; Tuma and Sepkowitz 2006; L'Heriteau et al. 2006;]. However, despite the utility of many of these devices, the adoption of devices with engineered sharps injury prevention features in healthcare facilities appears to be incomplete and inconsistent. Surveillance data in this regard is limited; little

is actually known about the utilization of these devices in hospital settings, and even less is known for outpatient settings. Additional research is needed to assess the degree to which safety devices are used and the continuing development and improvement of safety engineered device.

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Chapter 17 ▪ Infectious Hazards Other than Bloodborne Pathogens

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Issue

Healthcare and social assistance (HCSA) workers are at risk for a number of occupationally acquired infectious diseases. Many are well known, but new infectious hazards continue to emerge. Depending on the specific pathogen, transmission can occur via direct contact with patients and contaminated surfaces or by exposure to bio-aerosols generated mainly by sneezing and coughing. These bio-aerosols range in size from large projectile droplets that remain in the air for short periods of time and travel short distances to small particles that may remain suspended in air as evaporated droplet nuclei for long periods of time and travel in air over long distances. These agents can be transmitted naturally or as a result of intentional acts of terrorism. They can occur sporadically or cause epidemic disease and public health emergencies (as would be the case in an outbreak of pandemic influenza). A large number of pathogens are relevant to this short section; only a few prominent examples will be specifically addressed here. Several reviews have addressed the many pathogens encountered by HCSA workers and measures that can be used to prevent transmission [Sepkowitz 1996a, 1996b; Siegel et al. 2007]. It should be noted that protecting HCSA workers also benefits other groups that are potentially exposed to infectious agents in HCSA settings, such as patients and visitors.

Risk

Occupational infectious diseases have not been conquered. Instead, the HCSA sector is confronted by a range of challenges. Newly emerging pathogens, including both novel agents and known agents which have acquired multidrug resistance, have been important issues. In addition, long-standing problem pathogens, such as pertussis, continue to re-emerge. A number of factors contribute to these exposures. Ease and frequency of global travel can rapidly spread an infectious disease throughout the world. Patients live longer with chronic illnesses, including those that impair their host defense systems and make them susceptible to infectious diseases. Intensive use and misuse of antibiotics has resulted in the emergence of drug resistance. Understaffing of healthcare facilities can result in time stress and lack of adherence to preventive measures perceived as time consuming, such

as hand washing. Economic stress and insufficiently established safety cultures can lead to under-funded and under-supported infection prevention and control programs. The following text briefly describes a selected group of pathogens and diseases of current importance to the HCSA sector.

Bacteria

Methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant enterococcus (VRE): Over-prescribing and misuse of antibiotics has contributed to the emergence of important antibiotic resistant bacterial pathogens that represent threats to both HCSA workers and their patients [Siegel et al. 2006]. MRSA causes serious and potentially life-threatening infections, such as bloodstream infections, surgical site infections, or pneumonia. MRSA has recently been identified as a pathogen in both occupational and community settings [Klevens et al. 2007]. Vancomycin-resistant *Enterococcus* (VRE) is an important cause of nosocomial bacteremia, surgical wound infection, and urinary tract infection. VRE is often resistant to many, and sometimes all, standard therapies. These infections are passed to others by direct contact with stool, urine or blood containing the bacteria. They can also be spread indirectly via the contaminated hands of healthcare providers or on contaminated environmental surfaces.

Bordetella pertussis causes the disease pertussis. It is transmitted from person to person via droplets produced by coughing or sneezing or by direct contact with secretions from the respiratory tract of infectious individuals. Pertussis is highly contagious, with 80% secondary attack rates among susceptible persons (i.e., persons who have not been immunized or have not had a prior case of pertussis). Numerous outbreaks of pertussis have been reported in healthcare settings. In view of this problem, the Advisory Committee on Immunization Practices (ACIP) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) recommend that healthcare personnel engaged in direct patient care who have not previously been immunized against pertussis be immunized with tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap) [CDC 2006]. Immunization should be done as soon as can feasibly be achieved, since a 2-year interval is required since the most recent vaccination with tetanus and diphtheria toxoid vaccine. Recommendations for vaccination of healthcare workers with Tdap have also been supported by the American College of Occupational and Environmental Medicine [ACOEM 2006].

Mycobacterium tuberculosis causes the disease tuberculosis (TB). Although the prevalence of infection in the United States is low, one third of the world's population is infected with this pathogen. Aerosols of *Mycobacterium tuberculosis* created by coughing transmit TB via the airborne route and have caused outbreaks of

disease in HCSA personnel [CDC 2005]. Multiple drug resistant (MDR) strains, along with newly emerging extensively drug resistant (XDR) strains, are important concerns [CDC 2007a].

Viruses

Recently, several emerging viral pathogens have been sources of great concern, both from the standpoint of morbidity and mortality and from the standpoint of ability to cause epidemic disease. One example is severe acute respiratory syndrome coronavirus (SARS-CoV or SCV). An international outbreak of SARS was first recognized in 2003. China, Hong Kong, Taiwan, and Canada were prominently affected by the outbreak. Close patient contacts and healthcare personnel were at particular risk for SARS, with healthcare workers accounting for 25% of cases in Hong Kong and 65% of cases in Canada [Srinivasan et al. 2004]. Another example is influenza A virus subtype H5N1, or avian influenza. To date, human infections with this agent have been primarily been associated with exposures to diseased or dead birds and the agent has not demonstrated efficient, sustainable human-to-human transmission. Still, because of high mortality rates, potential risks associated with exposures to sick people have been a source of much concern [DHHS 2008]. There has also been great concern that avian influenza might undergo genetic and antigenic changes leading to a pandemic strain. Pandemic influenza efficiently transmits infection between humans and can cause a global outbreak. One way that such a change could occur would be by exchange of genetic material between strains when a human or animal host is co-infected with more than one strain. SARS and influenza are thought to be transmitted primarily by large droplets of respiratory fluid projected over short distances by coughing, sneezing, talking, etc; the role of true airborne transmission via small droplet or droplet nuclei aerosol and the appropriateness of measures to prevent airborne transmission have been controversial for these and other respiratory viral pathogens.

A number of viral agents present risks to HCSA personnel that can be prevented by vaccination. Transmission of seasonal influenza, varicella (the cause of chickenpox and shingles), rubeola (the cause of measles), mumps, and rubella can all be prevented by appropriate adherence to vaccination guidelines [CDC 2007b].

Mites

Sarcoptes scabiei var hominis causes human scabies, a skin disease that causes rash and itching. It is spread by direct contact with infected individuals and contaminated items of clothing. In healthcare settings, nurses and laundry workers are particularly at risk [Sepkowitz 1996b].

Bioterrorism Agents

A number of microbial agents and toxins have the potential to be used as weapons [CDC 2008]. Depending on the agent used to mount an attack, HCSA personnel might be exposed either as the result of direct attack, exposure to contaminated victims or materials, or exposure to infected victims with contagious disease. Bioterrorism agents are classified as Category A, B, or C in descending order of priority. Category A agents pose the greatest risk to national security because they can be easily disseminated or transmitted from person to person, result in high mortality rates and have the potential for major public health impact, might cause public panic and social disruption, and require special action for public health preparedness. Category A agents include *Bacillus anthracis* (anthrax), *Clostridium botulinum toxin* (botulism), *Yersinia pestis* (plague), variola major (smallpox), *Francisella tularensis* (tularemia), and viral hemorrhagic fevers [caused by filoviruses (e.g., Ebola, Marburg) and arenaviruses (e.g., Lassa, Machupo)]. Appropriate planning is of critical importance to assure that public health emergencies, whether of natural origin or the result of intentional attacks, are recognized and responded to as quickly as possible in order to minimize their impact on HCSA personnel.

Interventions

The spread of many kinds of infections can be prevented by several known interventions. Three interventions are especially important [Sepkowitz 1996b]. Hand washing prevents transmission of a range of pathogens transmitted by contact or large droplets, including MRSA and VRE [Boyce et al. 2002]. Vaccination can prevent infection and transmission of a number of pathogens [CDC 2007b]. Finally, rapid recognition of patients with potentially contagious conditions and isolation with appropriate precautions can be challenging, but is a well-established practice [Siegel et al. 2007]. Isolation precautions can be categorized as standard, contact, droplet, or airborne.

Other measures can also be used prevent transmission of infectious agents. Exposures of HCSA personnel to potentially infectious patients can be limited to those personnel carrying out patient care tasks that require close contact. Potentially infectious patients can be encouraged to practice respiratory hygiene/cough etiquette and social distancing, particularly in waiting areas. Assignment of nonimmune personnel to care for individuals with vaccine-preventable diseases can be avoided where possible. Environmental controls such as ventilation and air filtration, ultraviolet germicidal irradiation (UVGI), and use of airborne infection isolation rooms can be used to limit exposures.

Personal protective equipment such as examination gloves, gowns, eye shields, face masks, and respirators can also be used to limit exposures. Use of respiratory protection is a well-established intervention preventing transmission of some diseases,

such as TB. Respiratory protection is also recommended for preventing transmission of other diseases. For example, when entering the room of a patient with suspected avian influenza or SARS, CDC recommends use a fit-tested respirator, at least as protective as a NIOSH-approved N-95 filtering facepiece respirator [CDC 2004]. The U.S. Department of Health and Human Services (DHHS) has also made recommendations for use of respirators in the setting of pandemic influenza [DHHS 2006]. N-95 or more protective respirators are recommended in settings at high risk for aerosol generation, such as intubation, bronchoscopy, nebulizer treatment, resuscitation, and care of patients with pandemic-influenza related pneumonia. Use of N-95 respirators whenever caring for patients with confirmed or suspected pandemic influenza is noted to be "prudent." However, DHHS notes that "Development of authoritative responses is hampered by the lack of definitive data about the relative contributions and importance of short-range inhalational exposure, large droplet mucosal exposure, and direct inoculation via hands or inanimate objects contaminated with virus (i.e., fomites) on influenza transmission There is only limited information on optimal interventions to prevent influenza transmission and the effectiveness of interventions on an individual basis" [DHHS 2006].

Secondary prevention measures are also important. They can be used to prevent infection after exposure or to prevent progression from mild, asymptomatic to more severe infection. Examples of secondary prevention include postexposure prophylaxis and medical screening and surveillance to identify and treat people with asymptomatic, latent TB infection. Education of HCSA personnel, including both management and workers, is of key importance to achieve optimal adherence to prevention recommendations.

Knowledge Gaps and Other Barriers

A key barrier to understanding and effectively responding to occupationally related infections is lack of routine surveillance to track their frequency and where they occur. Although routine surveillance is performed for some specific diseases (such as tuberculosis), there is no broadly representative, ongoing general infectious diseases surveillance of the HCSA sector as a whole. The U.S. Department of Labor Survey of Occupational Injury and Illness (SOII) relies upon employers to report occupational illnesses. However, illnesses are underreported, especially if an occupational connection is not recognized. Federal governmental agencies such as CDC and OSHA, state public health departments, HCSA employers, and providers of healthcare to HCSA personnel all might potentially contribute to improved surveillance.

Another barrier is inadequate diffusion and implementation of currently recommended and effective infection control strategies across the HCSA sector. For example,

adherence to hand hygiene across a range of studies was reported to average about 40% [Boyce et al. 2002]. Vaccination is another important intervention for prevention of infection. Healthcare worker influenza immunization rates in the U.S. have recently been approximately 40% [Lugo 2007]. Thus, efforts to improve education about preventive interventions and ensuring adherence to them are important needs.

Many groups could contribute. Researchers could clarify and develop strategies to address organizational and behavioral barriers to known effective interventions. They could conduct demonstration projects, document effectiveness in preventing disease and economic benefits, and develop best practices for implementation. Employers play an important role in establishing a safety culture that emphasizes the importance of adherence to preventive recommendations. Actions such as making influenza vaccination available to personnel free of charge and making hand hygiene materials conveniently available can improve adherence to vaccination and hand washing recommendations. Having emergency plans in place can assist greatly in rapidly and appropriately responding to public health infectious emergencies. HCSA personnel must be aware of, and adherent to, recommendations. Education and public health marketing can potentially help to improve acceptance. Regulatory governmental agencies such as OSHA and private standard-setting groups such as the Joint Commission can potentially improve adherence rates by establishing, monitoring, and enforcing standards for adherence to known interventions.

In addition to improving implementation of known interventions, basic and applied research is needed in a variety of areas to assess and/or improve the efficacy of potential preventive measures and to improve the evidence base for public health recommendations. Improved methods for rapid detection of infectious agents and assessing their levels might be useful for rapid identification and isolation of infectious patients, as well as assessment of environmental contamination. New technologies, such as nanotechnology-based bio-sensors and chemical sensors, might be useful in methods development. Good measures of exposure to infectious agents would allow investigators to perform epidemiological and other studies to quantify exposure-infection relationships. Understanding these relationships, in turn, could inform recommendations on what levels of disinfection and what type of personal protective equipment would be required to protect against transmission of infection.

Work is needed to understand whether or to what degree that pathogens typically thought to be transmitted primarily by droplet—eg., SARS coronavirus, influenza—can be transmitted via the airborne route or via contaminated fomites or surfaces. This knowledge would provide very useful evidence for or against use of various interventions including surface decontamination, environmental controls, and personal protective equipment. Research is also needed to understand the vulnerabilities of pathogens to various forms of disinfection, so that optimal strategies

can be designed (e.g., new disinfectants) for eliminating pathogens that minimize exposure of HCSA personnel, patients, and visitors to potentially toxic chemical agents. Effectiveness of disinfection for decreasing infection rates should also be documented, so use of disinfection can be focused on situations where disinfection decreases rates of infectious disease.

Research is needed to objectively document and improve the abilities of various environmental controls (e.g., negative pressure, high-efficiency particulate air (HEPA) filters, laminar flow, ventilation design based on modeling approaches such as computational fluid dynamics, UVGI, room air cleaners, alternative air disinfection methodologies) to reduce exposures to airborne pathogens.

Research is needed to objectively document and/or improve of the ability of respiratory protective devices to reduce exposures to infectious agents and, ideally, to document efficacy in reducing transmission of infection. Such research could address important issues such as assessing and improving respirator fit and facial sealing, assessing and improving particulate filter performance, and assessing and improving respiratory program recommendations including approaches to training and fit testing. Improved understanding of the ability of contaminated respirators to transmit infection and approaches to decontamination of filtering face piece respirators might improve supply under conditions of high demand, such as during epidemic or pandemic influenza outbreaks.

An especially important need is research addressing the role of personal protective equipment (PPE) such as respirators, gowns, gloves, faceshields, and eye protection for protecting healthcare workers during an influenza pandemic. Early in an influenza pandemic, appropriate vaccines will be unavailable and healthcare workers will generally lack protective immunity. Under these conditions, use of PPE will be an important part of efforts to protect healthcare workers. In 2006, NIOSH requested the Institute of Medicine (IOM) to conduct a study addressing this area. In its report [IOM 2008], IOM notes that: "…there is an urgent need to address the lack of preparedness regarding effective PPE for use in an influenza pandemic. Three critical areas were identified that require expeditious research and policy action: (1) Influenza transmission research should become an immediate and short-term research priority so that effective prevention and control strategies can be developed and refined. The current paucity of knowledge significantly hinders prevention efforts. (2) Employer and employee commitment to worker safety and appropriate use of PPE should be strengthened. Healthcare facilities should establish and promote a culture of safety. (3) An integrated effort is needed to understand the PPE requirements of the worker and to develop and utilize innovative materials and technologies to create the next generation of PPE capable of meeting these needs…The committee believes that improvements can be made

so that healthcare workers will have PPE that provides protection against influenza transmission based on a rigorous risk assessment with solid scientific evidence." A detailed action plan to address the IOM recommendations has been developed by the NIOSH National Personal Protective Technology Laboratory (NPPTL) and is available for public review [NPPTL 2008].

Personnel in the HCSA sector can have health conditions that compromise their host defense systems and make them more susceptible to occupationally acquired infections. HIV infection, cancer chemotherapy, or treatment with other immunosuppressive agents and/or corticosteroids may predispose individuals to acquiring infections. Understanding the risks faced by this population and developing protective recommendations for this population are of great importance.

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Section IV

Research Opportunities

Overview

Available evidence shows that working in the Healthcare and Social Assistance (HCSA) sector is hazardous. In 2005, the HCSA sector experienced 668,000 episodes of nonfatal occupational illness and injury in the sector, equivalent to one episode occurring every minute of that year. Compared to other industrial sectors, the HCSA sector had the second largest number of such injuries and illnesses. In 2005, the combined number of injury and illness cases involving days away from work for nursing aides, orderlies and attendants, and registered nurses accounted for over 30% of all occupational injuries and illnesses involving days away from work. In the same year, two-thirds of personal assaults and violent acts associated with occupation occurred in the HCSA sector.

Although there are many commonalities between the occupational safety and health problems faced by HCSA workers and workers in other industrial sectors, such as exposure to hazardous chemicals, there are also a number of issues that are unique to the sector. About 80% of HCSA workers are women, a greater percentage than in any other industrial sector and nearly double that for all industrial sectors combined. Thus, women's health issues, such as adverse reproductive outcomes and obligations outside of the workplace, are especially prominent issues for the HCSA sector. The sector is burdened by the inappropriate, but entrenched, belief that patient-care issues supersede personal safety, and that to achieve better patient outcomes HCSA workers must accept the risks of hazardous exposures or injuries. There is the stress of dealing with the highly charged HCSA environment, exacerbated by traditional patterns of work organization including long work hours, rotating shifts, and understaffing. Other hazards unique to HCSA include risks associated with patient handling, exposures to hazardous drugs administered to patients, and sharps injuries with their associated risk of bloodborne pathogen transmission. HCSA workers must also face the unknown, as they are routinely on the front line in caring for those with emerging infectious diseases whether naturally occurring (severe acute respiratory syndrome (SARS), avian influenza, pandemic influenza) or the result of bioterrorism (anthrax, smallpox).

Registered nurses constitute the largest occupation within the HCSA sector and number over 2 million of which 70% are employed in hospitals. Nurses are perhaps the best studied group within the HCSA sector, and issues with nursing recruitment, retention, and burnout exemplify the importance of occupational safety and health issues faced by the entire sector. A recent survey by the American Nursing Association revealed that 88% of nurses reported that health and safety concerns influence their decision to remain in nursing and the kind of nursing

work they choose to perform. More than 70% said the acute and chronic effects of stress and overwork were among their top 3 health concerns. More than two-thirds reported being required to work mandatory overtime every month. Disabling back injury and fear of contracting immunodeficiency virus (HIV) or hepatitis from a needlestick injury were also among the top three health concerns. Seventeen percent had been physically assaulted and more than half were threatened or had experienced verbal abuse in the last year. Remarkably, less than 20% of respondents felt safe in their current work environment.

The occupational safety and health of HCSA workers impacts not only workers, but also their patients and clients and others entering the HCSA work setting such as families and visitors. An HCSA worker who is healthy, well rested, and focused is able to provide better care and improved patient outcomes. Appropriate equipment for safe patient handling protects not only the worker but also the patient. Protection from hazardous chemicals and infectious hazards in the HCSA work setting protects not only HCSA workers but also everyone else in the work setting.

This document identifies a range of opportunities where research could lead to improved occupational safety and health in the HCSA sector. These opportunities can be broadly categorized as those that impact many health and safety problems and those related to specific health and safety problems.

Research Opportunities Affecting Many Health and Safety Problems

Surveillance is an important need. A strong program of health and hazard surveillance in the HCSA sector would facilitate monitoring of exposure, illness, and injury trends; identifying emerging problems; and targeting and evaluating the impact of prevention measures. There is a need to develop a national approach allowing collection of data useful in identifying prospective or leading indicators of work-related hazards, injuries, and disease. Due to limitations in BLS data, there is particular need to develop innovative approaches for tracking nonfatal work-related injuries and illnesses. Examples of data sources not solely dependent on employer-based reporting (as is BLS data) include medical information obtained via insurers, electronic medical records, and workers' compensation claims.

A key research opportunity impacting many other health and safety issues is in the areas of safety culture and safety climate. Safety culture refers to the underlying principles, norms, values, and beliefs of an organization with respect to safety. Safety climate refers to employees' shared perceptions about safety within their work organization. Safety climate is therefore a manifestation of safety culture. A

strong safety culture facilitates effective responses to a range of health and safety hazards. Longitudinal studies, with repeated measures of safety culture/climate and injuries/exposures, employee retention and recruitment, and patient quality-of-care outcomes would be helpful in providing reliable estimates of these relationships. Studies are needed on the cost-effectiveness of programs that enhance and support safety culture, as evidence of this type might be beneficial in shifting organizational commitment toward a culture of safety.

Work organization refers to how jobs are designed and the way that jobs are performed and managed. There are six major components to work organization: work schedule, job design, interpersonal relationships with supervisors and coworkers, career concerns, management style, and organizational characteristics. Some also include the work-home interface as a component of work organization. There are many opportunities for research in this area. These include surveillance to better identify work organizational hazards, identification of the numbers of workers exposed, documentation of the types of negative outcomes experienced, development of better organization of work strategies, development of interventions to reduce risk, and testing of interventions including assessment of cost-effectiveness.

In public health emergencies, whether natural or manmade, the HCSA sector is part of the critical infrastructure needed to decrease public morbidity and mortality. Because of the vast array of types of emergencies, HCSA workers could potentially encounter a broad range of scenarios with very different specific occupational safety and health needs. Still, there are common needs to develop and implement best practices for "surge capacity" that provide good patient care yet protect workers. These practices must promote safety culture/climate and address issues of work organization. A particular need is to develop solutions for workers' outside obligations (such as caring for family members or pets) that might interfere with their ability to work during public health emergencies. Development of systems for worker education and implementation of prevention measures tailored to specific types of emergencies is also an important need.

The most effective way to prevent a broad range of occupational injuries, illnesses, and fatalities is to "design out" or minimize hazards and risks early in the design process. This approach has been called "prevention through design." Within the HCSA sector, design can be applied at all organizational levels, including the product-user interface; processes, materials, equipment, and associated work practices; work organization and policies; and design, construction, and maintenance of built environments. There are excellent opportunities for research in this area. Research and demonstration projects could be conducted to develop interdisciplinary collaborations between designers and HCSA workers. A clearinghouse of good practices could be developed. Training and education could be targeted to

both designers and HCSA workers to improve mutual understanding and improve incorporation of health and safety concepts into new designs. Surveillance could be used to gather information about relationships between design and injury or illness and used to guide efforts for redesign/design to improve occupational safety and health. Best evidence could be used to develop or improve recommendations for standards and guidelines for healthy building and product design for the healthcare industry.

Although little studied or appreciated, there are important links between the HCSA sector and the environment. Environmental events, such as natural disasters or degradation of environmental quality, create burdens for the HCSA sector. The HCSA sector, in turn, is an important polluter. Hospitals alone generate more than 2 million tons of waste annually and in recent years were the third highest source of pollution from dioxins and the fourth highest source of pollution from mercury. Up to now, many of the efforts to reduce pollution by HCSA facilities have focused on reducing hazardous materials causing pollution without regard for the work environment. Research is needed to develop integrated solutions that consider occupational and environmental health and safety in concert and do not simply shift risks from one to the other. Research is also needed to demonstrate the economic advantages related to environmental health and safety in the HCSA industry. Also needed are educational programs targeted to designers and HCSA workers.

Research across the broad range of areas noted in this document is relevant to addressing problems in nursing shortage, retention, and burnout. The issue of the nursing shortage and its ultimate effects on nurses' fatigue, injuries, and errors needs further exploration. How the work that nurses do impacts the quality of care patients receive is important to examine, along with work organization issues that create unsafe and unhealthy work environments. In addition, the role that nursing schools play in preparing nursing students to deal with occupational health and safety issues, including workplace risk and hazards associated with nursing, should be examined. Students should acquire not only knowledge regarding these hazards, but also how to protect against exposure to these hazards. The relationship between worker safety and patient safety should be explored. Nursing curricula should also encompass other issues that exist in the real world of nursing practice. The increase of acute care in the home setting, home infusion opportunities, and other alternate site nursing roles should be explored with nursing students. Additional research on why so many graduating students do not ever practice in the nursing profession may provide insight into the gaps that exist in preparing the student for a realistic nursing career. Another important area for additional research is how best to support practicing nurses, in particular the aging nurse.

Research Opportunities Related to Specific Health and Safety Problems

Work-related musculoskeletal disorders (MSD) are defined as an injury of the muscles, tendons, ligaments, nerves, joints, cartilage, bones, or blood vessels in the extremities or back that is caused or aggravated by manual handling work tasks such as lifting, pushing and pulling, and carrying, as well as working in awkward postures with very repetitive or static forceful exertions. MSDs occur frequently in the HCSA sector. In 2005, the incidence rate of sprains and strains involving days away from work was 82.3 cases per 10,000 workers. The part of the body most affected was the trunk, with an incidence rate of 66.8 cases per 10,000 workers, nearly 1.5 times greater than private industry as a whole. The healthcare patient was the most frequent cause of injury at a rate of 47.5 cases per 10,000 workers. Given that the average workers' compensation cost for back pain is $10,689, back injury alone represents a tremendous health and economic burden.

While there has been much progress in recognizing the hazards of manual patient handling to both patients and staff and in developing equipment that can reduce manual handling of patients, research is needed to address barriers to implementation of known interventions. There is still more to learn about how work system interactions between environment, technology, organization, task requirements, and individual factors can lead to MSD and to further improve interventions at all of these levels. There is a particular need to address MSD in the home healthcare setting where interventions such as lifting equipment are generally unavailable. Better surveillance systems for tracking illnesses and injuries among HCSA workers in the home healthcare setting are needed, as are interventions targeted to protect workers in that setting.

Slip, trip, and fall (STF) incidents are another important cause of injury in the HCSA sector. In 2005, the incidence rate for STF incidents in HCSA workers was 38.6 per 10,000, a rate 80% greater than for private industry as a whole. Risk of STF incidents is based on a range of factors including personal factors, environmental characteristics of the workplace, and housekeeping procedures. There are known effective interventions for reducing STF incidents. Research is needed to improve implementation of these interventions. In addition, more research is needed that is specifically targeted to HCSA workers, nursing homes, outpatient centers, and other areas where HCSA workers deliver services, including the home healthcare setting. More research is needed to identify slip-resistant hospital flooring and shoes that can be worn by hospital staff. Public health information dissemination is needed to raise awareness and facilitate implementation of interventions.

As already noted, violence is a major problem for HCSA workers. Available data from BLS, which is already compelling, is probably an underestimation of the true extent of the problem. More minor injuries resulting from violence, which do not result in lost time away from work, often go unreported. Failure to report is often the result of a perception that exposure to violence, often from confused, disoriented patients, is part of the job and cannot be totally eliminated. Proposed interventions exist. In 1996, OSHA issued Guidelines for Preventing Workplace Violence for Healthcare and Social Services Workers. A recent evaluation suggested that, although these guidelines capture what are thought to be the essential elements of a violence prevention program, little empirical evidence exists that documents their effectiveness. An additional intervention to those presented in the guidelines—that is, informing HCSA workers of the prior assaultive behavior of violent patients—has been suggested as very effective. Rigorous research is needed to evaluate the effectiveness of all the components of comprehensive violence prevention programs. Economics research is needed to assist employers in assessing the cost-benefit of prevention and compare cost-effective options. Assessment of benefits should consider burnout and nursing shortage. Methods to ensure accurate and consistent reporting of violent episodes are needed to target the development of prevention programs, to monitor trends, and to evaluate effectiveness. The implications and opportunities associated with using electronic medical records to identify patients with histories of violent behavior should be explored.

Drugs are classified as "hazardous" if studies in animals or humans indicate that exposures to them have a potential for causing cancer, developmental or reproductive toxicity, or other organ system damage. Most hazardous drugs are those used to treat cancer, but also include other types of drugs such as antiviral agents used to treat HIV and other viral infections. Although the potential therapeutic benefits of hazardous drugs outweigh the risks of side effects for sick patients, exposed HCSA workers risk these same side effects (especially cancer and adverse reproductive outcomes) with no benefits. Evidence for work environment contamination and worker exposure to hazardous drugs used for treating patients has steadily grown and is not in dispute at present. The clinical significance of exposure is unclear, however. Surveillance systems to track both cancer and adverse reproductive outcomes by occupation and specifically by specialization within an occupation (i.e., oncology nursing, oncology pharmacy practice) are sorely needed. Research is also needed to document the efficacy of safety culture/climate promotion and adherence to safe handling practices in reducing exposures to hazardous drugs.

Although often thought of as clean and safe, HCSA settings often are associated with many of the same types of exposures to chemicals and hazards found in "blue collar" industrial settings. HCSA workers are also at increased risk for many of the

types of adverse health effects potentially caused by hazardous exposures, including cancer, adverse reproductive outcomes, and work-related asthma. Although a wide range of hazards exists, a key barrier to addressing them is the misconception that HCSA work is safer than other work involving exposure to chemical and physical hazards. Improved health and hazard surveillance could help to address this issue, as would epidemiological studies to better evaluate relationships between hazardous exposures in the HCSA sector and development of work-related health outcomes such as cancer, adverse reproductive outcomes, asthma, and skin disorders. Research to document a beneficial impact of improved safety culture/climate is needed, especially with regard to implementation of measures to reduce exposure including elimination or substitution of known hazards; use of appropriate work practices, engineering controls, and personal protective equipment; and adoption of a precautionary approach in dealing with exposures of uncertain toxicity.

Sharps injuries and bloodborne pathogens remain an important issue in the HCSA sector. HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) are bloodborne pathogens of special concern because of their potential for occupational transmission and the severity of illness that they cause. A vaccine exists for HBV, but vaccines are not available for HIV or HCV. Thus, prevention of transmission in HCSA workers depends on prevention of sharps injuries and other blood and body fluid exposures. Unfortunately, sharps injuries continue to occur frequently. Although surveillance data is fragmentary, it has been estimated that approximately 384,325 percutaneous injuries are sustained annually by hospital-based healthcare personnel. Since hospital-based personnel only account for about half of all healthcare personnel, the total number of percutaneous injuries in the HCSA sector may be considerably higher, but little data is available. Elimination of sharps injuries will require a coordinated, multifaceted, and multidisciplinary approach. Priority action items developed during a recent stakeholder meeting sponsored by the Centers for Disease Control and Prevention included improved surveillance, education and training of HCSA workers, identification of human and organizational factors that reduce adherence to safe practices and developing interventions to address them, and continued development and implementation of devices with engineered sharps injury prevention features.

In addition to bloodborne pathogens, HCSA workers are also at risk for a number of other occupationally acquired infectious diseases. Depending on the specific pathogen, transmission can occur via direct contact with patients or contaminated surfaces, by exposure to large droplets projected by sneezing or coughing, or by small particulate airborne aerosols. The potential threats associated with new and emerging infectious hazards (e.g., SARS, avian influenza, pandemic influenza) and multidrug-resistant pathogens (e.g., methicillin-resistant Staphylococcus au'reus

(MRSA) and extensively drug-resistant tuberculosis (XDR-TB)) have caused much concern. Since the anthrax attacks of 2001, there has also been great concern about the risks that HCSA workers might face in subsequent attacks using highly contagious agents such as smallpox. In many cases, interventions exist to prevent transmission. Hand washing, vaccination, rapid recognition of the agents used, and appropriate isolation of potentially contagious patients are especially important interventions. There are a number of opportunities for research with relevance and impact. Although routine surveillance is performed for some infectious diseases, there is no broadly representative, ongoing surveillance for all infectious diseases across the sector. Research is needed to identify barriers to adherence and achieve better implementation of known, effective interventions such as hand washing and immunization for influenza. A particularly important need is better understanding of the potential for agents such as SARS and influenza to be transmitted via the airborne route. A related need is to better define the roles and optimal implementation of interventions to reduce exposures to aerosols, such as engineering controls and personal protective equipment, in protecting HCSA workers from infectious hazards. In the case of personal protective equipment, implementation issues such as appropriate frequency of fit testing have been particularly controversial; research could help to resolve this. An additional area for research is to better understand the risks faced by HCSA workers with illnesses or on medications that compromise their host defense systems and how best to protect them from occupational infectious diseases.

Section V

Recommendations

Recommendations

Many health and safety issues and knowledge gaps have been identified in this report that provide opportunities for research aimed at improving the health and safety of workers, patients, families, and others associated with the Healthcare and Social Assistance (HCSA) sector. This section provides recommendations that are common to many hazards. Specific recommendations are provided in the body of this report.

Improved hazard and health surveillance is an important need. Surveillance data can be used for multiple purposes, i.e., to identify new and emerging hazards, track the magnitude and distribution of exposures and the use of exposure controls among occupational groups, identify populations for targeted interventions, and track the effectiveness of interventions over time. Surveillance systems must recognize diversity in the HCSA workforce and be able to identify and track health disparities across the full range of at-risk populations, including minority groups, immigrants, and other potentially vulnerable populations.

Underreporting of nonfatal occupational illnesses and injuries has been an important barrier to health surveillance. To address the issue of underreporting, new nonemployer-based data sources need to be identified to augment the current employer-based system of reporting nonfatal injuries and illnesses and may include workers' compensation data, OSHA-IMIS data, and medical data such as insurance data or electronic medical records. Additionally, partnerships with states and others need to be expanded to the fullest extent possible to ensure availability of comprehensive and representative surveillance data.

In addition to strengthening and supporting surveillance, there is a need to support and fund research studies that are relevant to the needs of the HCSA sector and have a high likelihood of impact. These include demonstration projects to apply and refine best practices, research studies to demonstrate intervention effectiveness and to evaluate the impact of regulations (e.g., patient lifting, safe needle devices), economic studies to document the financial benefits of interventions that improve HCSA worker safety and health, research to develop new interventions (e.g., safer medical devices, personal protective equipment and clothing), and studies that evaluate the relationship between worker health and safety and patient outcomes.

Health and safety culture is viewed by many as the single most important driver in achieving a positive impact on worker health and safety. Studies are needed to improve measurement of HCSA safety culture/climate and to document the relationships between safety culture/climate and occupational safety and health metrics. Development of interventions that strengthen HCSA safety culture/climate, such as education and training for management and workers, is an important need.

Public health marketing is needed to improve awareness of occupational health and safety issues within the HCSA sector and those it serves. A particularly important need is to overcome the misconception that it is appropriate, acceptable, or necessary to risk HCSA worker safety and health in treating patients. On the contrary, improving HCSA worker safety and health also improves patient safety and care.

Advancing health and safety research in the HCSA sector will require strong partnerships. In order to address the problems, stakeholders in industry, labor, academia, and government must come together and share their different perspectives and abilities. Similarly, addressing the needs of the sector will require partnerships between many disciplines. Involvement of industrial hygienists, epidemiologists, laboratory researchers, social scientists, economists, communications experts, educators, and clinicians all are necessary to ensure that key research issues are adequately addressed. Although the challenges are great, so are the opportunities to address them through broad and inclusive partnerships.

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DHHS (NIOSH) Publication No. 2009–139

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