



NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

**NATIONAL OCCUPATIONAL RESEARCH AGENDA FOR HEALTHCARE AND
SOCIAL ASSISTANCE (HCSA)**

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Developed by the NORA HCSA Council

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INTRODUCTION

What is the National Occupational Research Agenda?

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and workplace interventions. In combination with other initiatives, the products of this program are expected to reduce the occurrence of injuries and illnesses at work. Unveiled in 1996, NORA has become a research framework for the Nation and the National Institute for Occupational Safety and Health (NIOSH). Diverse parties collaborate to identify the most critical issues in workplace safety and health and develop research objectives for addressing those needs.

NORA enters its third decade in 2016 with an enhanced structure. The ten sectors formed for the second decade will continue to prioritize occupational safety and health research by major areas of the U.S. economy. In addition, there are seven cross-sectors organized according to the major health and safety issues affecting the U.S. working population. While NIOSH is serving as the steward to move this effort forward, it is truly a national effort. NORA is carried out through multi-stakeholder councils, which are developing and implementing research agendas for the occupational safety and health community over the decade (2016-2026). Councils address objectives through information exchange, partnership building, and enhanced dissemination and implementation of evidenced-based solutions.

NORA groups industries into ten sectors using North American Industry Classification System (NAICS) codes. The Healthcare and Social Assistance (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). Veterinary medicine and animal care industries (NAICS codes 541940, 812910, 712130) were moved from the Services Sector to HCSA in 2013. The rationale for this transfer was that many of the issues faced by veterinary and animal care workers are similar to those faced by their counterparts caring for or providing healthcare services to humans.

What are NORA Councils?

Participation in NORA councils is broad, including stakeholders from universities, large and small businesses, professional practice organizations and societies, government agencies, and labor organizations. The Councils have two co-chairs, one from NIOSH and one from a partner organization.

Statement of Purpose

NORA councils are a national venue for individuals and organizations with shared interests in occupational safety and health to work together to improve safety and health in the workplace. Councils will start the third decade by identifying broad occupational safety and health research objectives for the nation. These research objectives will build upon advances in knowledge from the last decade, address understudied and emerging issues, and be based on council member and public input. Councils will spend the remainder of the decade working together to address the agenda through information exchange, collaboration, and enhanced dissemination and implementation of solutions that work.

Although NIOSH is the steward of NORA, it is just one of many partners that make NORA possible. Councils are not an opportunity to give consensus advice to NIOSH, but instead a way to maximize resources towards improved occupational safety and health nationwide. Councils are platforms that help build close partnerships among members and broader collaborations between councils and other organizations. The resulting information sharing

and leveraging of efforts promotes widespread adoption of improved workplace practices based on research results.

Councils are diverse and dynamic, and are open to anyone with an interest in occupational safety and health. Members benefit by hearing about cutting-edge research findings, learning about evidence-based ways to improve safety and health efforts in their organizations, and forming new partnerships. In turn, members share their knowledge and experiences with others and reciprocate partnerships.

HCSA Council

The HCSA Sector Council brings together experts and stakeholders representing the diverse perspectives of industry, labor, academia, government agencies and others. The first formal meeting of the HCSA Council was held in August, 2006 in Atlanta. The initial challenge taken up by the group was to develop a sector-specific research strategy for the nation based upon the highest priority health and safety issues facing the HCSA sector, while maximizing impact through partnerships. As the HCSA Council enters the third decade of NORA, it plans to establish an updated research agenda for the Nation and establish research objectives for the upcoming decade.

What does the National Occupational Research Agenda for HCSA represent?

The National Occupational Research Agenda for HCSA is intended to identify the research, information, and actions most urgently needed to prevent occupational injuries, illnesses and fatalities in workplaces covered by the sector. This Agenda provides a vehicle for stakeholders to describe the most relevant issues, gaps, and safety and health needs for the sector. Each NORA research agenda is meant to guide or promote high priority research efforts on a national level, conducted by various entities, including government, higher education, and the private sector. Because the Agenda is intended to guide national occupational health and safety efforts for the HCSA sector, it cannot at the same time be an inventory of all issues worthy of attention. The omission of a topic does not mean that topic was viewed as unimportant. Those who developed this Agenda did, however, believe that the number of topics should be small enough so that resources could be focused on a manageable set of objectives, thereby increasing the likelihood of real impact in the workplace.

NIOSH used the draft Agendas created by the sector and cross-sector NORA councils as an input into the [NIOSH Strategic Plan](#). NIOSH programs will use [burden, need and impact](#) method to write research goals that articulate and operationalize the components of the NORA Sector and Cross-Sector Agendas that NIOSH will address. NORA Agendas and the NIOSH Strategic Plan are separate but linked.

Who are the target audiences?

The target audiences for the National Occupational Research Agenda for HCSA are researchers and stakeholders within the sector who can lead or partner to conduct research and help disseminate workplace interventions and public health information that improve health and safety in the workplace. Stakeholders include workers, employers, unions, regulatory agencies, legislators, professional associations, researchers, policymakers, and educators.

The HCSA Council identified subsectors and high-risk worker populations that were not specifically addressed in the first and second decades of NORA. For this reason, the Council developed objectives to specifically target these understudied groups during the third decade of NORA. These groups include workers in veterinary medicine and animal care, home healthcare, home care, environmental services, long-term care facilities/nursing homes, and childcare. In addition, aging workers and low-wage workers throughout the HCSA sector were specifically targeted as groups that have unique occupational health and safety research needs. The National Occupational Research

Agenda for HCSA may be an informative document for occupational health and safety researchers and stakeholders who already work in the area or have an interest in addressing research needs relevant to these targeted groups.

How was the research agenda developed?

The process to develop a research agenda for the third decade of NORA began in July 2016 with a preliminary discussion of research needs in a NIOSH Science Blog post [Casey 2016]. In November 2016, the agenda development process began in earnest with a round-robin activity to identify research gaps during a web-based meeting.

NIOSH HCSA program management staff compiled the research priorities identified by Council members into a comprehensive list and organized them into six topic areas: worker safety and patient safety; infectious diseases and sharps safety; safe patient handling and slips, trips and falls; hazardous drugs and chemicals; veterinary medicine/animal care; and setting-specific workers (e.g., home care workers, long-term care employees, correctional healthcare workers, childcare workers and other social service workers).

An overarching need identified by the Council was research addressing occupational health and safety of low wage workers and those working in settings that have been previously understudied. The Council noted that much of the highly productive research and successful interventions to improve worker health and safety during the second decade involved workers in acute care settings, large institutions such as hospitals and health systems, and that the workforce benefiting were often professional workers in higher paid jobs. The third decade offers an opportunity to investigate issues among a less visible and potentially more vulnerable workforce within the HCSA sector, but does not preclude research efforts in acute care and institutional settings.

In March 2017, the HCSA Council held another web-based meeting to develop workgroups around each of these six topic areas. Guided by one partner co-chair and one NIOSH co-chair, workgroups were tasked with developing objectives that reflected the research priorities along with justifications for each objective. A brief description of each workgroup follows:

- **Worker Safety and Patient Safety Workgroup:** The workgroup focused on the complex issues surrounding work conditions, the organization of work, and the interconnectedness between worker and patient safety. Healthcare workers serve people by providing a wide variety of medical services, often filling an essential role in the daily lives of sick adults, frail elders, people with disabilities, and children in many settings across communities. This work is physically and emotionally exhausting and yet provides an opportunity to engage in highly meaningful work. Healthcare workers frequently work in challenging or even dangerous work conditions. Intuitively, it follows that the health of the healthcare work force and the work conditions they share with patients ultimately impact patient health outcomes.
- **Infectious Diseases and Sharps Safety Workgroup:** The workgroup explored research needs related to infectious hazards during the provision of patient care (e.g., attending to patients with tuberculosis [TB] or HIV) and during public health emergencies (e.g., during the 2009 influenza pandemic, the Ebola epidemic, or the severe acute respiratory syndrome [SARS] outbreak). While recommended control measures may be available for many infectious disease risks in the healthcare setting, compliance with these guidelines remains a challenge.
- **Patient Handling and Slips, Trips and Falls Workgroup:** The workgroup reviewed the current body of research in this area and identified a number of gaps. Although healthcare organizations have been shown to reduce injuries using safe patient handling and mobility programs, many facilities have been slow to

adopt these programs. Despite effective prevention programs, slips, trips and falls remain one of the most common causes of lost-workday injuries in healthcare.

- **Hazardous Drugs and Other Chemicals Workgroup:** The workgroup evaluated knowledge gaps and identified research needs aimed at preventing occupational exposure to hazardous drugs and other chemicals. Low wage, difficult-to-access workers in a variety of human and veterinary healthcare settings have been understudied with respect to preventing exposure and promoting use of recommended safe handling guidelines for hazardous drugs and other chemicals. Although safe handling guidelines for hazardous drugs have been available for many years, universal adherence to these guidelines is lacking. There is a need to better understand methods to promote adoption of safe handling guidelines. There is also a need to better understand the role of cleaning and disinfecting agents and other chemical hazards with respect to adverse respiratory and dermal effects.
- **Veterinary/Animal Care Workgroup:** The workgroup focused on the specific needs of workers who provide medical, surgical and preventive health services for animals, as well as other workers who provide animal care services ranging from kennel care to laboratory animal care. These workers are exposed to a highly diverse set of hazards, which mimic, but also often exceed those in human healthcare. This workgroup identified research needs associated with physical, chemical, and biological hazards respectively. Following development of the objectives, this workgroup recommended that the research needs addressing veterinary and animal care chemical hazards be incorporated in the objectives developed by the Hazardous Drugs and Other Chemicals workgroup, primarily because of the overlap in many of the identified research needs. Overall, there is a need to address the safety culture within veterinary and animal care. Attitudes and beliefs around personal safety and the expectation that certain hazards are to be accepted and tolerated remains prevalent, despite the availability of prevention resources for most hazards, particularly those hazards shared with human healthcare. As tested interventions are developed in human healthcare, research should be directed at their implementation and evaluation in veterinary and animal care settings.
- **Setting-specific Workgroup:** Recognizing that the HCSA industry sector includes workers in many settings, the workgroup aimed to develop objectives that acknowledge specific worker safety and health needs in unique settings. In addition, this group also identified subgroups of workers that while not in a specific setting, have been traditionally overlooked in occupational health research. These subgroups include low-wage workers and aging workers.

These workgroups developed objectives and justifications that were compiled into a draft agenda. Some objectives were combined as several workgroups may have identified the same or similar research needs. The draft agenda was presented to the HCSA Sector Council for their comments and changes in July and August 2017. After a public comment period on the draft, the agenda was revised to respond to the comments received and then finalized.

THE OBJECTIVES

Objective 1: Assess how work organization impacts both worker and patient safety.

Work conditions in the HCSA sector involve intense physical and emotional labor in a complex social environment with unique pressures arising from the web of relationships among the patient or client, family members, the employing/care-providing institution and the HCSA worker [Folbre 2012; Lucian Leape Institute 2013]. Additionally, for the home healthcare workforce, the patient's home is redefined as a workplace, albeit one that is not always the same from day to day and posing a challenge to researchers in occupational safety and health.

In spite of these difficulties, healthcare workers express a desire to avoid burnout, to be respected for the valuable work they are doing in the community, and to pursue more pathways for professional development. Low-wage care workers face particular challenges. Their demanding schedules and sometimes unclear work arrangements resemble many other low-wage workers. They experience unstable and unpredictable work lives, reporting financial strain, hazardous conditions at work, difficulty accessing healthcare including workers' compensation, and an overall lack of dignity on the job [Zoeckler et al. 2015]. Additionally, healthcare workers face a variety of occupational health risks including injuries from previously used sharp medical devices (i.e., sharps injuries); slips, trips and falls; acute and cumulative musculoskeletal injuries; and exposures to hazardous drugs and other chemicals [Canivet et al. 2008; Collins et al. 2010; Howard and Adams 2010; McCaughey et al. 2012 & 2014; NIOSH 2004].

Most researchers who study occupational stress characterize job strain as a condition in which high demands are placed on the worker in combination with low control over how the job is done, which is additionally moderated by low workplace support [Karasek et al. 1981]. Additionally, job strain is believed to be the result of an imbalance between high effort and low reward [Siegrist 2000]. Evidence that adverse health effects occur when workers work under conditions of job strain have been accumulating for decades. These factors are likely impacted by emerging or underappreciated sociological contexts that affect work organization, such as changing economic or institutional conditions. Furthermore, although worker health and patient health are inextricably linked, little is known about how work organization impacts outcomes. Even less is known about effective intervention at the agency level [Muntaner et al. 2010; Pearlin et al. 2005; Schnall et al. 2016].

Workers involved in healthcare across a range of institutions (hospital, clinic, home healthcare agency, etc.) experience a unique set of exposures at work that impact both mental and physical health. Psychosocial stressors taking place at work are a threat to good health and contribute to the risk of chronic disease [Johnson 2004]. Conditions such as hypertension, cardiovascular disease, disordered sleep, musculoskeletal injury, anxiety, and depression have been implicated as the evidence mounts [Landsbergis 2014; Rugulies and Krause 2008; Rugulies et al. 2006]. Links between this exposure and other conditions, such as musculoskeletal disorders, may also be emerging. Because occupational stress is a modifiable health risk, research should consider the redesign of work environments and organizational culture to ameliorate the threat. Healthcare is experiencing rapid changes that add to job stress. Therefore, researchers must continually assess the impact of these changes on healthcare workers and patients and investigate the work environment to reduce risks from these new hazards. Healthcare delivery is more complex and more frequently delivered in the community, with earlier post-surgical releases from the hospital. These shifts create different demands on the U.S. healthcare workforce as agencies struggle to manage care in "hospitals without walls."

To date, peer reviewed literature has generally been developed that independently addresses workers and patients. Such reports strongly indicate that total systems approaches are needed to establish safety cultures for patients, which should include attention to supporting the healthcare workforce [TJC 2012]. Worker health and

safety evidence has generally been developed external to the industry by occupational health professionals and internal to the industry through the efforts of human resources departments and unions. Although the externally-generated studies appear in the peer-reviewed literature, much of the available internally-generated knowledge is held within human resources departments of individual institutions and networks [Kaplan et al. 2009].

Connecting the experience of work-related stressors to workers' health requires an advanced understanding of how stress arises and persists in healthcare settings. A multidisciplinary approach incorporating the fields of demography, sociology, epidemiology, labor studies, gerontology, human resources, and organizational development would elucidate the relationship between work-related stress and health to inform policy aimed at improving work conditions at the agency and individual worker and patient levels.

Research must continually characterize occupational health burdens experienced by healthcare workforce. Paying attention to the healthcare and social assistance workers simultaneously with the quality of care for patients and clients is especially responsive to an urgent need for cost-effective healthcare solutions [Lucian Leape Institute 2013].

Research Needs

- Identify evaluation metrics and data systems necessary to assess linkages between worker and patient health outcomes in a variety of occupations and institutional settings.
- Focus on the connections between work organization and staffing (especially with regard to work locations, hours and job quality) and adverse health and safety outcomes in workers and patients.
- Interrogate fully the relationship between work organization and sleeping problems [Canivet et al. 2008]; for example assess the Accreditation Council for Graduate Medical Education (ACGME) rule changes and other policy shifts that affect work organization and sleep health that emerge in the healthcare fields.
- Examine the relationship between work organization factors (i.e. full range of job demands, workload, and physical factors) and musculoskeletal injuries in patients and healthcare workers. Also, evaluate impact on recruitment and retention of healthcare and social assistance staff and best practices for safe patient handling.
- Characterize and develop interventions that address occupational health inequality and health inequality for both workers and patients due to low-wages, racial tension or discrimination, lack of education, and low socio-economic status. This includes research that includes people of color, immigrants, and the LGBTQ (Lesbian, Gay, Bisexual, Transgender, and Queer/Questioning) community.
- Analyze practices and policies of safe patient handling programs to clarify the extent to which organizational factors impede or enhance effectiveness, especially comparing and contrasting worker and patient outcomes across a variety of care settings.
- Conduct in-depth case studies of institutions that experience sustained success in recruitment and retention of healthcare workers to obtain detailed information about their relevant policies and protocols, including communication structures and the functions and protocols of departments that deal with worker safety and health and patient safety and health. This would help to more clearly determine the potential drivers that can lead to further integration of these two areas.
- Develop tools and methods to develop organizational structures that can strengthen data sharing between worker safety and health and patient safety and health programs. Shared data might include personnel and program structures, policies, protocols, plans, and priorities identified through the case studies described in the previous bullet as being linked with better outcomes.

- Develop an online library or clearinghouse of scientific evidence dedicated to relating workplace organizational factors with worker health and patient health outcomes.
- Foster interdisciplinary research questions that leverage knowledge both internal and external to healthcare institutions.
- Evaluating community reputations for patient safety and worker safety such as surveying newly graduated nurses or medical residents on their job search and selection.

Objective 2: Assess the impact of organizational culture and leadership on worker and patient safety including satisfaction/quality of life.

The recognition that the health and safety of patients is inextricably linked to the health and safety of those who care for them has grown in recent years due in part to several major reports [IOM 2004; Lucian Leape Institute 2009; The Joint Commission 2012]. In healthcare, leaders and managers set priorities and greatly influence work culture, the entire organizational and interpersonal environment that influences attitudes and behaviors of individuals toward safety, injury/illness prevention and management, productivity demands, communication, and work relationships [Murphy et al. 2017]. An organizational culture that prioritizes safety for both workers and patients is essential for achieving the goals of a safe and healthy workplace.

Though there is growing evidence that culture and leadership affect outcomes for both workers and patients, much of the evidence comes from non-experimental studies with substantial limitations. As described below, better quality research is needed on these relationships to understand causal factors and the effectiveness of interventions. Ultimately, knowledge gained from prioritized research in this area will provide greater incentive for senior leadership attention and organizational efforts to improve safety for both workers and patients. It will also inform stakeholders of the vital role that occupational health and safety performs in patient safety and in advancing national aims for improvement.

In 2016, the American College of Occupational and Environmental Medicine (ACOEM) and Underwriters Laboratories Integrated Health & Safety Institute (UL IHSI) hosted a *Summit on the Interaction of Health Care Worker Health and Safety on Patient Health and Safety in the U.S. Health Care System*. As described in the summit report [Loeppke et al. 2017], the importance of leadership and accountability in worker and patient safety initiatives cannot be overstated. Leaders are accountable for creating a safe and healthy workplace for workers and for safety for patients. Leaders determine resource allocations and alignment of workplace incentives. Leadership engagement and support from all levels of management is critical to the success of initiatives.

An oft-cited quote by W. Edwards Deming, a founder of the quality management field, is “Management’s overall aim should be to create a system in which everybody may take joy in [their] work” [Perlo et al. 2017]. Included in Deming’s seminal 14 Points of Management are the notions that management (and leadership) must drive out fear so that everyone may work effectively and break down barriers between departments [Best and Neuhauser 2005]. The essential role of leadership in establishing organizational culture is well known [Lucian Leape Institute 2009; Schein 1985].

As described in a 2017 *Joint Commission Sentinel Event Alert* newsletter on the essential role of leadership in developing a safety culture, inadequate leadership can contribute to adverse patient and worker events and organizational outcomes in several ways including: insufficient support of patient safety event reporting, lack of feedback or response to staff and others who report safety vulnerabilities, allowing intimidation of staff who report events, refusing to consistently prioritize and implement safety recommendations, and not addressing staff burnout [The Joint Commission 2017].

There are several subtopics related to this area. Examples of existing research in these subtopics are described below.

1. Culture, leadership and patient and worker outcomes

There is evidence from several systematic reviews that organizational culture and leadership is associated with patient and worker outcomes. Examples include the following:

- A review of 19 qualitative studies addressing high-performing hospitals by Taylor et al. [2015] found positive organizational culture (respect and trust between colleagues at all levels in clinical and nonclinical services; a relentless quest and unwavering focus for excellence; recognition and compensation for good work; a safe, nonthreatening environment; and promoting values for improvement consistent with mission and vision) were the most frequently identified themes.
- Stone et al., [2008] reviewed 14 studies related to organizational climate and patient outcomes and found positive organizational climates were generally related to improved patient safety and worker satisfaction, with mixed results related to worker turnover.
- An evidence scan of more than 100 articles on the relationship between safety culture and patient and staff outcomes conducted by The Health Foundation [2011] of the UK found mixed results related to patient outcomes, but more evidence that improving safety culture impacts on staff safety behaviors and injury rates among staff.
- Increased burnout and poor teamwork, related both to working conditions and culture, has been associated with adverse outcomes. Studies suggest over 50% physicians and nurses experience feelings of stress, overwork and/or burnout which has been associated with increased medical errors and decreased empathy and reduced patient satisfaction [ANA 2011; Bodenheimer and Sinsky 2014; Shanafelt et al. 2015].
- Hessels and Larson [2016] reviewed 7 studies on the relationship between safety culture and adherence to standard precautions for infection control, all of which reported a statistically significant relationship between better safety culture and greater adherence.

This growing body of evidence has contributed to recommendations to modify the nation's improvement goals from the triple aim (improve care, improve the health of populations, and reduce healthcare cost) to the quadruple aim [Berwick et al. 2008; Bodenheimer and Sinsky 2014; Sikka et al. 2015]. The fourth aim is to improve the experience of providing care through restoring joy and meaning for the workforce. Objectives include enhancing shared core values of mutual respect, civility, transparency and truth telling as well as improving physical and psychological safety of the workforce [Sikka et al. 2015]. Toward that end, the Institute for Healthcare Improvement began their *Joy in Work* initiative [IHI 2017], which will partner with experts to share principles and techniques to enable the workforce to thrive. Other initiatives aimed at improving the physical and psychological safety of the healthcare workforce include the National Academy of Medicine's the Action Collaborative on Clinician Well-Being and Resilience [NAM 2017] and the Critical Care Societies Collaborative (CCSC) efforts to prevent burnout among intensive care clinicians [CCSC 2017].

2. Worker satisfaction and quality of life and patient outcomes

A recent systematic review examined the relationship between physician burnout and acceptability (patient satisfaction and physician communication) and patient safety [Dewa et al. 2017]. Based on 12 studies, the findings suggest there is moderate evidence for the relationship between burnout and safety

but the evidence is weaker for the patient-related acceptability aspects of quality. Most studies were observational and they reiterated the need for stronger research designs.

3. Environmental sustainability

A 2009 report from the Healthcare Without Harm/Global Safety and Health Initiative (GHSI/HCWH) highlights the need for additional research related to the following 1) increasing leaders' awareness of waste and environmental impact concerns, 2) demonstrating the business case for sustainability in healthcare and 3) evaluating the impact of incorporating sustainability related designs, technologies, and product use into new construction and renovation initiatives [Kaplan et al. 2009]. Research evaluating the occupational health and safety aspects of environmentally-friendly products and design concepts is needed. [Schulte et al. 2013]

4. High reliability

High reliability organizations (HROs) have been described as *“systems operating in hazardous conditions that have fewer than their fair share of adverse events”* [Reason 2000]. Examples of industries or organizations often considered to be highly reliable include nuclear power, aircraft carriers, and air traffic control with the safety focus initially targeted to worker and customer safety. [Reason 2000] There is a growing call to apply the principles of high reliability to healthcare [Chassin and Loeb 2011 & 2013]. High reliability applies to safety for all and necessitates a culture that focusses on both safety for patients and workers. *“The organizational culture, principles, methods, and tools for creating safety are the same, regardless of the population whose safety is the focus”* [The Joint Commission 2012]. As described by Chassin and Loeb [2011], there are three interdependent and essential changes that healthcare organizations must undergo to become highly reliable: (1) leadership must commit to the goal of high reliability, (2) an organizational culture that supports high reliability must be fully implemented, and (3) the tools of robust process improvement must be adopted.

Despite the growing evidence base, there are serious limitations associated with most studies. Very few if any studies have rigorous designs, either controlled or longitudinal. Most studies are observational and are therefore limited by an inability to draw conclusions about causation without knowing temporality [Lucas and McMichael 2005]. One cannot say which came first: good leadership, safety culture or positive outcomes.

Research Needs

The ACOEM/UL summit identified the following gaps in existing information and research needs [Loeppeke et al. 2017]. These included:

- Descriptive epidemiology, seeking common risk factors for patient and employee injury/illness.
- Prospective interventional studies across topic areas, with rigorous experimental or quasi-experimental quality improvement designs. Most previous studies are observational and retrospective and lack the ability to determine causality.
- Studies of the direct and indirect financial benefits of efforts to address patient and worker safety. In particular, further research is needed on specific interventions and their cost-effectiveness.
- The building of integrated databases related to patient and worker safety (e.g., databases that link patient to employee safety events).
- The development of improved safety and injury surveillance systems, with alerts that help identify dual patient and employee health and safety outcomes across healthcare settings.

- Demonstrations of the value of non-punitive error and near-miss reporting for both worker and patient adverse events.
- Training to improve staff and administration awareness of interrelationships, and use of structured root-cause and other analyses to identify causes and contributing factors related to patient and worker safety.
- Training to raise awareness of payers, insurers and policy-makers of the benefits of considering safety for workers and patients using an integrated framework.

Additional research needs include:

- Evaluate the effectiveness of interventions aimed at improving culture and engaging leadership on worker safety and health using cluster randomized trials or non-randomized quasi-experimental designs.
- Include process and outcome measures related to both workers and patients in study designs.
- Demonstrate changes over time and address factors associated with long term sustainability of change.
- Assess the impact of worker involvement when setting policies and program development on safety programs/culture/patient safety
- Explore effective models of worker involvement and engagement in safety programs and identify barriers to involvement (e.g. lack of opportunity or time, lack of respect or valuing of worker input, fear of retaliation, etc.) and strategies for addressing those barriers.
- Studies on the impact of union engagement and joint labor management programs.
- Evaluate characteristics of hospitals seeking and achieving the Magnet designation offered by the American Nurses Credentialing Center or other similar types of recognition or credentialing and the impact of efforts to achieve and maintain recognition or credentialing on occupational safety and health.
- Research which demonstrates the business case for sustainability in healthcare and evaluates the impact of incorporating sustainability related designs, technologies, and product use into new construction and renovation initiatives.

Objective 3: Investigate the epidemiology of workplace violence in health care and identify effective strategies for prevention and mitigation.

Workplace violence is a significant occupational hazard for workers in the healthcare and social assistance industry. Multiple definitions of workplace violence exist [NIOSH 2016; OSHA 2017]. The California Division of Occupational Health and Safety recently finalized the most comprehensive workplace violence prevention standard in the U.S. and defines workplace violence as *“any act of violence or threat of violence that occurs at the work site. The term workplace violence shall not include lawful acts of self-defense or defense of others”*, and includes a detailed breakdown of types of violence [Cal. Code Regs 2016].

An important element of this definition is the inclusion of threats—threats of violence are important to consider as hazards to workers’ health both as risk factors for physical violence and as a cause of psychological harm. Prevention programs will not be fully effective unless they address threats of violence.

A myriad of surveys exist to demonstrate the widespread nature of workplace violence incidents as well as the scope of injuries [Gerberich et al. 2004; Miranda et al. 2011]. Gerberich et al. [2004] reported rates of physical and

non-physical violence of 13.2 and 38.8 per 100 employees per year, respectively, from a survey of nurses. Miranda et al. [2011] reported a significant association where nursing home workers experiencing more physical assaults had increased musculoskeletal pain over a period of three months. Underreporting of violent incidents has been named as a significant issue by direct care workers and has been documented in the literature [Arnetz et al. 2015].

Many existing studies have evaluated workplace violence risk factors and prevention measures, but most lack the comprehensive, facility- and work area-specific perspective that is needed to effectively prevent workplace violence. [Arnetz et al. 2017; Rees et al. 2010; Gillespie et al. 2014; Magnavita 2011; Meehan et al. 2006] Additionally, many of these studies examine the effects of training programs, showing little impact on workplace violence incident and injury rates. [Fernandes et al. 2002; Nachreiner et al 2005]

In most situations, staffing, including direct care, ancillary, and security staff, is the most important element of workplace violence prevention. [ANA 2012] More comprehensive research connecting staffing to risk factors and prevention measures as well as patient safety could be instrumental in implementation.

Physical layout is another aspect of workplace violence prevention where some research has been done [McPhaul et al. 2008; Pati et al. 2016]. More clarity is needed to determine building design and features most effective at preventing workplace violence.

Much of the published literature evaluating workplace violence prevention measures and programs does not draw on the expertise of direct care workers. Nurses and other healthcare workers have intimate knowledge of the patient care environment, including patient populations, physical environments, and facility and unit processes that must be part of employer workplace violence prevention plans.

Research Needs

- Develop and evaluate workplace violence prevention measures and comprehensive facility- and work area-specific prevention programs.
- Develop and evaluate the effectiveness of workplace violence prevention training programs for those working in the Healthcare and Social Assistance Sector, including training on working with persons with cognitive impairment and dementia.
- Identify and evaluate strategies to promote effective worker involvement in the development and implementation of workplace violence prevention programs.
- Determine building design and features most effective at preventing workplace violence.
- Explore the impact of staffing and other work organization issues on workplace violence risk.
- Identify barriers and incentives to adopting workplace violence prevention measures.

Objective 4: Determine the effectiveness of innovative technologies and organizational strategies to improve recommended standard and transmission-based precautions in healthcare settings.

Healthcare workers can be exposed to infectious hazards during the provision of patient care (e.g., attending to patients with TB or HIV) and during public health emergencies (e.g., during the 2009 influenza pandemic, the Ebola epidemic, or the SARS outbreak). Newly emerging pathogens, including both novel agents and known agents that have acquired multidrug resistance, continue to present high risk of exposure to healthcare workers. Even well-known pathogens, such as measles, continue to pose a hazard during local outbreaks [Baxi et al. 2014]. Studies

have found that compared to non-healthcare settings, healthcare workers are at a higher risk of exposure to infectious respiratory diseases [Kuster et al. 2011; Luckhaupt et al. 2012].

Infectious agents are transmitted through various routes. Infection control interventions spanning the full range of the hierarchy of controls are needed to minimize or eliminate healthcare workers' exposures. The Centers for Disease Control and Prevention (CDC) develops and periodically updates the 2007 CDC/Healthcare Infection Control Practices Advisory Committee (HICPAC) recommendations that contain the core standard and transmission-based precautions central to controlling the transmission of infectious agents [Siegel et al. 2007]. Like many other infection control interventions, standard and transmission-based precautions are most effective when compliance is high. Studies however, have shown that compliance with these precautions is highly variable and often far less than adequate [Blanco et al. 2016; May et al. 2012; Peterson et al. 2015; Zimmerman et al. 2016].

The reasons for non-compliance and barriers to proper execution of standard and transmission-based precautions among healthcare workers include both organizational and individual factors, including poor institutional culture of safety, lack of accountability for non-compliance, increasing workload demands, time constraints, risk perception, effectiveness concerns, and availability and accessibility of personal protective equipment, comfort, and interference with patient care.

Research Needs

- Evaluate methods to promote the use of engineering controls and increase compliance with hand hygiene practices and with the range of vaccinations recommended for healthcare workers.
- Develop and evaluate better and safer methods for environmental cleaning and disinfection.
- Promote strategies to operationalize prompt isolation of infected patients with known and suspected infectious diseases.
- Develop and evaluate new tools for prompt communication of hazards.
- Develop and evaluate new technologies and interventions (including training) to improve proper selection, use, and availability of personal protective equipment (PPE).

These studies can assist in better understanding the effectiveness of both new and existing standard and transmission-based precautions and inform strategies that employers of healthcare providers can use to improve compliance.

Objective 5: Promote development and identify impact of occupational infectious disease surveillance to improve infection control and biosafety practices in healthcare settings in order to minimize or eliminate healthcare personnel exposures to infectious diseases and to better understand how these diseases spread.

Occupational infectious disease surveillance is a critical step in the prevention of work-related injury and illness. As demonstrated during Ebola, global infectious disease surveillance is vital for prevention and control of disease [Gates 2015]. Within healthcare settings, data from occupational surveillance systems are used to identify infectious agents and to select and improve interventions to reduce disease transmission. For example, recent surveys estimated that only 79% of healthcare workers received the most recent influenza vaccine [Black et al. 2016]. Occupational incident data from U.S. hospitals, however, indicate that during an exposure to blood or body fluids, compliance with PPE can be as low as 2.0% [ISC 2015].

Another critical area for occupational infectious disease surveillance understanding how infectious diseases spread. Infectious agents are transmitted by various routes. While transmission routes for many diseases are well understood [e.g., bloodborne pathogens such human immunodeficiency virus (HIV), hepatitis B (HBV) and hepatitis C (HCV)] primarily through sharps injuries], the recent 2009 pandemic and various epidemics led to increased scrutiny of the evidence supporting the predominant transmission modes for infectious agents such as the 2009 H1N1 influenza virus [Shine et al. 2009], the Ebola virus [Osterholm et al. 2015] and the multidrug resistant bacterium, Methicillin resistant *Staphylococcus aureus* (MRSA) [Amiry 2015].

Research Needs

- Develop and evaluate surveillance systems to enable healthcare facilities to track, analyze, and minimize or prevent bloodborne, sharps, contact, droplet, and airborne exposure events that can lead to occupationally acquired diseases.
- Studies are needed to better understand the relative contributions of the different modes of occupational infectious disease transmission in healthcare settings.
- Studies are also needed to better understand and improve exposure incident rates and vaccination rates among healthcare personnel, use of and compliance with infection control practices, and the prevalence of sick leave and post-exposure policies.
- For existing surveillance systems, studies to promote their use and to identify impact are important.

Objective 6: Assess awareness and increase knowledge of sharps injury prevention programs, and improve injury surveillance programs designed to prevent sharps injuries among healthcare personnel.

Occupational exposure to bloodborne pathogens may be more relevant than ever as hepatitis C (HCV) and human immunodeficiency virus (HIV) prevalence in the general population grows. One in thirty baby boomers (born 1945-1965) has HCV and more of them have died from HCV than from 20 other infectious diseases combined [CDC 2013a; CDC 2013b]. Additionally, only 1 in 4 people with HCV and only 1 in 7 people with HIV know they are infected [CDC 2017]. This means that risks are greater to workers now more than in previous years. Despite regulations in place to protect healthcare personnel from occupational exposures to blood, body fluids, and other potentially infectious materials (OPIM), injuries from contaminated sharps continue to occur at unacceptable rates [ISC 2017; MDPH 2017; TX DSHS 2017].

Sharps injuries among healthcare personnel continue to occur for many reasons at many levels, from the institutional to departmental to professional levels. These reasons often relate to the lack of adherence to the hierarchy of controls including failure to: eliminate sharps whenever they are not needed (e.g., use skin adhesives instead of sutures when appropriate, use innovative non-sharps medication delivery methods), substitute sharps hazards (e.g., use blunt rather than sharp tip sutures for internal fascia), utilize engineering controls (e.g., use devices with sharps injury prevention features and activate injury prevention feature/mechanism on these devices), and implement safe work practices (e.g., dispose of sharps immediately after use, implement no-hands passing neutral zones during surgical procedures). [ISC 2015; Mitchell et al 2017] There is also a lack of strong injury surveillance within facilities and across health systems and regions resulting in an overall under-reported, under-represented risk to those working in healthcare delivery settings where medical devices/sharps are used and occupational exposure to blood, body fluids, and other potentially infectious materials is present.

Research Needs

- Identify collaborations, partnerships, methods, practices, and controls that are most effective in reducing and ultimately preventing sharps injuries
- Study how institutions and organizations increase awareness and knowledge, how they improve injury/exposure surveillance, how they work together, and how these efforts impact overall injury incidence.

Objective 7: Determine the impact of current and new interventions and technologies designed to prevent sharps injuries among healthcare personnel.

According to the latest peer-reviewed publications and published data, healthcare institutions are using engineering controls including devices with sharps injury prevention features more frequently than ever because of requirements set forth by the *Needlestick Safety and Prevention Act* and the *OSHA Bloodborne Pathogens Standard*. However, more needs to be known about the ability of the current device technologies to reduce sharps injuries among healthcare personnel to the lowest feasible extent. In fact, many facilities are experiencing a rise in injuries from devices with safety features because users may not activate the injury prevention feature/mechanism or may become injured during or after mechanism activation for many reasons including poor device design [OSHA 1991; ISC 2017; Kanamori 2016; MDPH 2017; Mitchell 2017].

Research is needed to determine the impact of current and new interventions and technologies designed to prevent injuries from contaminated sharps.

Many engineering and work practices can prevent injuries, including the use of devices with engineered sharps injury prevention features, activation of those injury prevention features, safe work practices (e.g. immediate disposal, no hands passing, no recapping), and the inclusion of frontline healthcare personnel on the evaluation and use of engineered devices with safety features to increase use of these devices and new sharps alternatives. In order to determine if these interventions and technologies are effective means of reducing injuries, there is a critical need to conduct both qualitative and quantitative research in a variety of healthcare delivery settings.

Research Needs

- Determine the impact of current and new interventions and technologies designed to prevent injuries from contaminated sharps, including evaluation of both active and passive injury prevention features.
- Conduct both qualitative and quantitative research in a variety of healthcare delivery settings to determine if interventions and technologies are effective in reducing injuries.

Objective 8: Facilitate safe patient handling and mobility in healthcare systems by conducting research to develop and assess cost-benefit tools, workplace design and equipment management protocols, and strategies to improve sustained support of safe patient handling and mobility programs by workers, managers, and executives.

Despite substantial evidence that safe patient handling and mobility programs produce savings through reduced injury costs [OSHA 2013], healthcare facilities are still slow to adopt safe patient handling and mobility, and/or they fail to provide necessary organizational support to effectively maintain previously-implemented safe patient handling and mobility programs [Weinmeyer 2016].

Competing and constantly changing business, service and regulatory demands can make it challenging to maintain sufficient organizational support for healthcare worker safety programs such as safe patient handling and mobility.

However, if such programs demonstrate a direct contribution to the achievement of healthcare organizations' business objectives and stakeholder needs such as patient and worker safety and satisfaction they are more likely to be sustained and effective in facilitating an essential shift in work culture [Enos 2011a; 2011b; 2013]. Thus, economic, administrative, and behavioral research is needed to identify factors influencing safe patient handling and mobility acceptance and compliance through many levels, all the way from the 'C' suite to individual workers and their patients.

The development and validation of "Cost-Benefit Tools," such as those used for ergonomics programs in non-healthcare organizations [Goggins et al. 2008], are essential for demonstrating the economic feasibility and benefits of safe patient handling and mobility to financial decision makers. Cost-benefit analyses using many forms of data (e.g., costs of personnel, procurement, training, injuries to staff and patients, patient clinical outcomes) enable decision makers to estimate and quantify return on investment and subsequent savings. Research is needed to develop and evaluate user-friendly cost-benefit analysis tools that can be used to plan, monitor, and maintain safe patient handling and mobility programs in different healthcare systems, including hospitals, long-term care, home healthcare, ambulance services, etc.

Effective safe patient handling and mobility requires sufficient financing for inclusion of safe patient handling and mobility equipment in new structures and renovations. Little is known about the impact of incorporating ergonomics in design of new construction and existing structures or the ergonomic requirements to design a safe work environment in various healthcare facilities [FGI 2010].

In addition to research for promoting acceptance and investment by organizational leaders, studies are needed to develop strategies to promote management buy-in, worker and patient acceptance, and sustained adherence to equipment use. Comprehensive efforts are needed at all of these levels in order to overcome the tremendous safety hazards, economic losses, and impaired care quality associated with manual patient handling.

For example, missed nursing care is increasingly recognized as an important factor that contributes to negative patient outcomes [AHRQ 2016]. Missed care is defined as any aspect of required care that is wholly or partially omitted or delayed by nursing staff. Two of the most frequently missed tasks in U.S. hospitals are ambulating and repositioning patients. Failure to perform these tasks can have serious consequences for patients such as pressure ulcers, pneumonias, extended length of stay, hospital readmissions, and death. Failure to perform these tasks can also have serious impacts on health care organizations in terms of costs and implications for personal and professional legal liability [AHRQ 2016; Enos 2013].

Studies are needed to determine the impact of safe patient handling and mobility program factors on several aspects related to worker compliance, including the frequency of missed nursing care. For example, safe patient handling and mobility equipment can be used to facilitate safe repositioning and ambulation of patients, but only if workers use it and use it properly. Training and information provided by the safe patient handling and mobility program must be tailored, based on behavioral studies, to address and overcome potential obstacles such as workers' misconceptions, e.g., 'I can safely lift patients without equipment if I use good body mechanics,' or 'using equipment takes too much time,' etc. Research to promote compliance must also address factors such as inadequate staffing, workload, and unavailability of mechanical lift equipment [Noble 2017].

Standardized safe patient handling and mobility equipment inventory and tracking systems are needed to address reported problems associated with equipment availability and accessibility. Research and tools are needed to determine optimal and minimal levels of safe patient handling and mobility equipment, including possible alternatives, and inventory of slings and harnesses for recipient care and mobility activities [DuBose 2014]. Research should include specifications on definition of "accessible", and should investigate impact of enacting actionable threshold levels for loss of inventory. Mechanisms are also needed to periodically review technology advances, and the role(s) of new technologies in equipment portfolios for facilities. Research should include input

from end users (both healthcare providers from all disciplines who would use the technologies as well as healthcare recipients) about relative effectiveness of technologies.

Research Needs

- Conduct economic, administrative, and behavioral research to identify factors influencing safe patient handling and mobility acceptance and compliance.
- Develop and evaluate user-friendly cost benefit analysis tools that can be used to plan, monitor, and maintain safe patient handling and mobility programs in different healthcare systems, including hospitals, long-term care, home healthcare, ambulance services, etc. Disseminate and provide users with easy access to well-validated tools.
- Determine the impact of incorporating ergonomics in design of new construction and existing structures and the ergonomic requirements to design a safe work environment in various healthcare facilities and clinical areas.
- Develop strategies to promote management buy-in, worker and patient acceptance, and sustained adherence to equipment use that address factors such as inadequate staffing, workload, and unavailability of mechanical lift equipment.
- Determine the impact of safe patient handling and mobility program factors on several aspects related to worker compliance, including the frequency of missed nursing care.
- Develop standardized safe patient handling and mobility equipment inventory and tracking systems to address reported problems associated with equipment availability and accessibility.
- Determine optimal and minimal levels of safe patient handling and mobility equipment, including possible alternatives.
- Review technology advances and the role(s) of new technologies in equipment portfolios for facilities.

Objective 9: Conduct special topics research to improve safety in areas with distinct safe patient handling and mobility needs and explore the potential use of new, non-traditional assistive devices.

Safe Patient Handling and Mobility interventions involving the use of ergonomic equipment and methods to lift, move and mobilize patients have been demonstrated to significantly reduce caregiver injuries, with savings from injury cost reductions surpassing program costs within three years on average [Nelson et al. 2006]. However, certain patient populations and specialized environments in the HCSA sector present unique challenges to adopting safe patient handling and mobility interventions. Research is needed to address unique challenges presented by certain patient populations and specialized environments in the HCSA sector, and to explore the potential utility of non-traditional assistive devices being developed through the emerging technology of bionics.

1. Bariatric Patients

There is wide, evidence-based consensus among safe patient handling and mobility experts that unassisted manual lifting of patients imposes a high risk of musculoskeletal injury to healthcare personnel [NIOSH 2017c]. Biomechanical risk increases as patient weight and size increase [Marras et al. 1999].

More than one-third of adults and 17% of youth in the United States were obese in 2011–2014 [Ogden et al. 2015]. In addition, the heaviest Americans have become heavier over the past decade [Gallagher et al. 2013]. Thus, healthcare personnel are encountering obese and morbidly obese, i.e., “bariatric” patients with increasing frequency, including, at the extreme, patients weighing more than 1,200 pounds [Harrell and Miller 2004]. Moreover, extended stays and readmissions are more common among bariatric patients due to numerous comorbidities of obesity, e.g., cardiovascular disease, diabetes, and many forms of cancer. [OAC 2017]

Research specifically on bariatric patient handling hazards and safety interventions is in its infancy [Galinsky et al. 2010]. Such research must aim to maximize the safety and health of patients as well as workers. Studies are needed to improve facility design and safe patient handling and mobility equipment design and application methods for accommodating the various weights, anthropometrics, and mobility needs of bariatric patients [FGI 2014; Gallagher et al. 2013]. Studies are also needed for the development of adult and pediatric bariatric safe patient handling and mobility protocols to guide work organization, staffing, communication, mobility and equipment assessments and evaluation of these protocols. Such protocols should be tailored through studies of hospitals, long term care facilities, and home healthcare programs to reduce the risk of injuries from the point of entry of a bariatric patient through discharge from the facility or program [Sauceda et al. 2013].

2. Emergency Responders/Emergencies within Facilities

The rate of overexertion injuries in ambulance workers is six times the average rate across all U.S. industries, surpassing rates in other healthcare subsectors as well as other notoriously strenuous occupations such as construction and mining [BLS 2014]. To date, safe patient handling and mobility solutions have centered mainly around preplanned patient care activities. Although some tools such as air-assisted transfer devices and powered evacuation chairs are commercially available, research and application of ergonomic solutions for emergency personnel is generally lacking. Thus, these workers are at extremely high injury risk due to frequent manual handling of a patient population that has grown significantly in weight and size over the past four decades. While ambulance workers are found in and covered by the NORA Public Safety Sector, within healthcare facilities, even when a safe patient handling and mobility program is in place, personnel are sometimes compelled by necessity to use manual handling during emergencies such as codes, evacuations, etc. Studies are needed to advance safe patient handling and mobility research and innovation to protect emergency care providers within healthcare facilities, and patients receiving emergency care.

3. Emergency Rooms (ERs)

Research is needed to develop, evaluate, and identify technologies and processes that are most effective for meeting the safe patient handling and mobility needs of emergency room workers and patients. Of specific interest in this environment are solutions that: (1) accommodate transitions of care from the ambulance or other vehicle to the ER and to and from special diagnostics with patients who need to be immobilized or who have multiple trauma, (2) are compatible with diagnostic procedures utilizing radiographic and MRI approaches, and (3) allow seamless transition from ambulance care to ER care, to the operating room if needed, and admission to critical care or medical/surgical units. Research and focus should include communication models and bed placement models that are seamless with unit safe patient handling and mobility practices and include levels of mobility, size and weight of patients, and other information pertinent to mobility and handling requirements.

4. Home Healthcare

Home healthcare is the fastest-growing segment of the Healthcare and Social Assistance Sector. In fact, home health aides and personal care aides are the 3rd and 4th fastest growing occupations in the U.S. [BLS, 2018], yet very little research on safe patient handling and mobility in home healthcare has been conducted. In a NIOSH survey of 744 home healthcare workers from diverse geographic regions, (predominantly manual) patient handling was a significant predictor of musculoskeletal symptoms, even after adjusting for other potential predictors such as workers' age, weight, non-work-related physical activities, smoking status, medical conditions, work durations, and non-work-related caretaking of children and disabled family members [Waters et al. 2006]. Safe patient handling and mobility equipment and training are the exception in home healthcare settings. Research is needed to address the many obstacles to safe patient handling and mobility for home healthcare employers, workers, patients, and their families, which may include financial, personal and professional legal liability, and structural barriers.

5. Imaging/Radiology

Healthcare technicians who use radiological and imaging equipment for diagnostic and treatment procedures are at high risk of overexertion injuries from moving and handling patients during procedures and transfers. In a study of radiology technologists [Siegal et al. 2010], 70% reported repetitive stress symptoms and the most commonly cited factor was patient transfer. Studies are needed to examine risk factors, and to design and evaluate feasible interventions to overcome challenges specific to this unique care environment such as space constraints, fixed-height patient surfaces with raised edges, etc.

6. Long Term Care

Musculoskeletal disorders attributed to overexertion are even more prevalent in long term care facilities (three times the average rate for all industries) than in hospitals (two times the average rate) [BLS 2015a]. There is widespread awareness that these injuries are primarily due to patient handling, and some research has demonstrated successful outcomes of safe patient handling and mobility interventions in long term care [Collins et al. 2004]. OSHA published ergonomics guidelines for nursing homes in 2003 and updated them in 2009, yet injury rates remain high [OSHA 2009]. Long term care organizations are housing sicker and larger residents, and with the added burden of rehabilitation of such residents, caregivers are at greater risk for musculoskeletal disorders [Davis and Kotowski 2015]. Research is needed to determine ways in which safe patient handling and mobility programs in long term care facilities can be designed to enhance/maintain the safety and functional capacity of residents as well as provide a safer working environment.

7. Operating Rooms (ORs)

Research is needed to study safe patient handling and mobility in multiple areas of the perioperative setting. Research priorities include the number and type of musculoskeletal injuries experienced by perioperative personnel in the pre-op area, operating room and post-anesthesia care unit, and the physical forces involved in lateral transfers between stretcher and table, in positioning patients in prone, lateral, and lithotomy positions, and in holding patients' limbs while prepping and maintaining aseptic technique. Research is needed to design OR specific safe patient handling and mobility equipment that meets the unique needs of the operating room. For example, infection risks associated with the use of generic equipment designed for other settings must be quantified and addressed [Thomas-Olson et al. 2015], as well as spatial conflicts between surgical and ergonomic equipment. There is scant research [Choobineh et al. 2010; Sheikhzadeh et al. 2009; Sienkiewicz et al. 2007] specific to the operating room yet the perioperative team routinely confronts occupational hazards placing them at risk for work-related musculoskeletal disorders. Over ten years ago, seven high-risk tasks in the OR were identified as well as a

lack of equipment to safely perform these high-risk tasks [AORN 2007]. Unfortunately, today, little progress has been made in developing OR-specific safe patient handling and mobility equipment.

8. Physical Therapy and Rehabilitation

Research is needed to study the use of safe patient handling and mobility equipment to address the unique challenges faced by physical therapy personnel across the diverse range of settings where they provide rehabilitation services. These include nearly all healthcare settings and organizations, from hospitals to the home, to solo practitioner practices to large scale, multisite clinics. Preliminary evidence indicates that appropriate use of safe patient handling and mobility equipment can protect both workers and patients during physical exercise and early ambulation following surgery and/or illness, thereby speeding recovery and preventing health complications related to patient immobility [Waters and Rockefeller 2010]. Further studies are needed to expand the evidence base for these findings and disseminate this strategy to the broad range of rehabilitation settings. It is important to address the unique challenges posed by different settings and develop and disseminate effective solutions to better protect patients and practitioners alike.

9. Psychiatric Patients

To date research addressing safe patient handling and mobility with psychiatric patients is lacking. Not surprisingly, there is evidence for increased risk of musculoskeletal injuries in healthcare staff associated with the use of “physical interventions” to control or subdue agitated patients [Stubbs 2009]. However, even in non-combative situations, the behavior of patients with dementia or other mental health problems can be unpredictable. For example, when a worker is lifting, moving, or holding a patient who makes sudden unexpected movements, potentially injurious biomechanical loads are imposed on the worker’s spine and other joints while trying to maintain balance and prevent falling. Collins et al. [2004] found that safe patient handling and mobility interventions led to reductions not only in staff overexertion injuries, but also in reduced assaults of workers by patients, possibly due to increased comfort provided by safe patient handling and mobility compared to manual handling techniques. Research is needed to further pursue safe patient handling and mobility strategies for managing unpredictable movements and reducing combativeness in psychiatric patients.

10. Non-Traditional Assistive Devices: Bionic Exoskeletons

Currently, health care providers that properly utilize modern, state of the science assistive equipment such as ceiling lifts and air-assisted transfer devices set the “gold standard” for safe patient handling and mobility programs. Advancements in that technology and safety program management strategies are expected to continue and benefit from evidence-based research. At the same time however, advancements in bionics technology utilizing powered exoskeletons may provide alternative approaches to safe patient handling and mobility. Based on technology originally developed for the Defense Advanced Research Projects Agency to enhance the strength and load-bearing capacity of soldiers, such exoskeletons have been developed for use as “power suits” for healthcare workers lifting patients [Yoshimitsu and Yamamoto 2004]. In other applications, the patient wears the exoskeleton to mobilize during physical therapy, or in the case of a paralyzed individual, to walk independently [Mertz 2012]. In light of their potential to reduce workers’ musculoskeletal injury risk and to enhance safety and care quality for patients, these emerging technologies and methods certainly merit further research.

Research Needs

- Study the impact of ergonomic and patient handling interventions on facility design to accommodate the various weights, anthropometrics, and mobility needs of bariatric patients.

- Study safe patient handling and mobility equipment design and application methods for accommodating the various weights, anthropometrics and mobility needs of bariatric patients.
- Develop and evaluate of adult and pediatric bariatric safe patient handling and mobility protocols to guide work organization, staffing, communication, mobility and equipment assessments, etc.
- Conduct studies to advance safe patient handling and mobility research and innovation to protect emergency care providers within healthcare facilities, and patients receiving emergency care.
- Develop, evaluate, and identify technologies and processes that are most effective for meeting the safe patient handling and mobility needs of emergency room workers and patients.
- Address the many obstacles to safe patient handling and mobility for home healthcare employers, workers, patients, and their families, which may include financial, legal and structural barriers.
- Examine risk factors to design and evaluate feasible interventions to overcome challenges specific to imaging/radiology environments such as space constraints, fixed-height patient surfaces with raised edges, etc.
- Determine ways in which safe patient handling and mobility programs in long term care facilities can be designed to enhance/maintain the safety and functional capacity of residents as well as provide a safer working environment.
- Study the use of safe patient handling and mobility equipment in the practice of physical therapy and other rehabilitation settings, including effects on worker and patient safety and on patients' recovery quality and speed.
- Further pursue safe patient handling and mobility strategies for managing unpredictable movements and reducing combativeness in psychiatric patients.
- Explore the potential utility of an emerging technology -- bionic exoskeletons -- for improving safety and care quality by augmenting workers' lifting capacity and patients' mobility and balance.

Objective 10: Develop and evaluate updated safe patient handling and mobility education in nursing schools and healthcare workplaces, and initiate new research to address gaps in safe patient handling and mobility education.

Maintaining an updated safe patient handling and mobility curriculum requires fostering continued research to address gaps in safe patient handling and mobility education. The content of safe patient handling and mobility curriculum for schools of nursing developed by NIOSH and others should be updated to reflect recent data, newly standardized terminology, and advances in safe patient handling and mobility evidenced-based practices and technology during the past decade. The method of delivery also requires updating from the original written guide with narrated slides to a multi-media format with appropriate video demonstrations and current links.

Examples of topics that should be added or updated in the curriculum include, but are not limited to:

1. The American Nurses Association (ANA) *Interprofessional Standards for Safe Patient Handling and Mobility* [2013].
2. Updated algorithms and tools published by the Veteran's Administration (VA) in 2015 [Tampa VA 2016], including new content addressing safe patient handling and mobility for bariatric (obese, extremely obese) patients.

3. The growth of the safe patient handling and mobility movement in the U.S. including information about safe patient handling and mobility legislation and OSHA enforcement under the General Duty Clause.
4. The relationship of safe patient handling and mobility to patient safety and quality of care, e.g., prevention of skin damage using friction-reducing devices, fall prevention using new mobility assessment tools [Enos 2013].
5. Recent findings identifying previously unrecognized risk factors in need of further study, e.g., patient injuries due to misuse of gait belts [Rockefeller 2011]; high incidence rates of patient handling injuries in student nurses and new nursing school graduates [Lövgren et al. 2014; Menzel et al. 2016].
6. Expansion of recommended hands-on practice to include tasks such as limb holding, lifting a patient from the floor, and to address tasks that cannot always be performed with equipment, e.g., lifting a pannus or holding a patient during incontinence change.
7. Summaries and links to resource materials on safe patient handling and mobility in other healthcare subsectors such as Certified Nursing Assistance, Physical Therapy, Imaging/Radiology, Ambulance workers, etc.
8. Options for addressing patient or co-worker refusal to use safe patient handling and mobility equipment.

Studies are needed to follow up with early assessments of the NIOSH safe patient handling and mobility curriculum that were conducted in 26 participating schools [Nelson et al. 2007; Powell-Cope et al. 2008]. Follow up studies should address reported barriers to curriculum implementation, such as equipment problems including lack of access and difficulties with vendors, and lack of cooperation from colleagues who don't recognize or acknowledge the ineffectiveness of outdated methods which rely solely on manual body mechanics. Research is also needed to determine the extent to which U.S. nursing schools have implemented the curriculum, and to determine how to most effectively encourage more widespread implementation.

Although much of the content of the nursing schools curriculum is relevant for healthcare workers in general, additional safe patient handling and mobility curricula should be developed specifically for other healthcare education programs such as those in physical and occupational therapy, imaging/radiology, etc. -- settings which require unique safe patient handling and mobility accommodations. Further study is also needed to address problematic safe patient handling and mobility challenges across all healthcare settings, such as determining teachable strategies for protecting patients and workers during unanticipated patient falls. Due to the extremely high injury risk imposed by catching a falling patient, safe patient handling and mobility experts advise against trying to manually catch a falling patient. Yet, such guidance runs counter to workers' caregiving instincts and mission, and innovative methods are needed to address the conflict between patient and caregiver safety in such situations.

Research Needs

- Update safe patient handling and mobility curricula to reflect recent data, newly standardized terminology, and advances in safe patient handling and mobility evidenced-based practices and technology during the past decade.
- Develop multi-media formats using updated communication and teaching technology.
- Conduct follow up assessments of schools that have adopted safe patient handling and mobility curricula.

- Examine the extent to which U.S. nursing schools have implemented safe patient handling and mobility curricula. As updated curricula are developed, assess their utilization by nursing and other professional schools and their effectiveness in changing knowledge and behavior.
- Determine how to most effectively encourage more widespread implementation of safe patient handling and mobility curricula.
- Conduct studies to address gaps in safe patient handling and mobility education.
- Develop curricula for other healthcare education programs such as those in physical and occupational therapy, imaging/radiology, etc.
- Determine teachable strategies for protecting patients and workers during unanticipated patient falls.

Objective 11: Conduct research that develops, implements, and evaluates prevention programs and design strategies that decrease the risk of slip, trip and fall incidents and identify barriers to intervention implementation.

The HCSA Sector is the largest employer in U.S. private industry with over 19 million workers in 2017 [BLS 2017a]. Slips, trips and falls as a whole are the second most common cause of lost-workday injuries in healthcare, and the incidence rate of lost-workday injuries from slips, trips and falls on the same level in healthcare was 24.5 per 10,000 workers, which is almost 60% greater than the average rate for all other private industries combined (15.5 per 10,000 employees) [BLS 2015a]. Given the large number (42,700) of lost-workday slips, trips and falls in the HCSA sector [BLS 2015b], there is a need for increased prevention efforts to address the problem of slips, trips and falls.

Published research specific to the healthcare sector has identified risk factors for occupational slips, trips and falls, and designed, implemented, and evaluated slip, trip and fall prevention strategies [Bell et al. 2008 & 2013; Brogmus et al. 2007; Collins et al. 2008; Courtney et al. 2006; Drebit et al. 2010; NIOSH 2010]. Healthcare recipient (patient, resident, client) slips, trips, falls and staff injuries are inextricably linked. Healthcare recipient slip, trip and fall incidents are often clinical in nature, and, when they occur, caregivers are usually forced into ergonomically unsafe situations by the need to manually lift patients from the floor or attempt to catch a patient as they slip, trip or fall. Patient, staff, and visitor slip, trip and fall incidents are also directly associated with environmental and design aspects of a care environment [Matz and Nelson 2010]. Safety risk assessment guidelines have been developed to help identify fall risks and design strategies to mitigate them [CHD 2015]. Design strategies may address the following: 1) flooring and walkway surfaces inside and outside the hospital, 2) changes in walkway level outside the hospital, 3) grease, water and other liquids on floors in the hospital, 4) loose cords, 5) flooring contrasts, 6) lighting, 7) stair visibility, 8) handrail issues, and others [Gulwadi and Calkins 2008].

After implementing a comprehensive slip, trip and fall prevention program, hospitals saw an almost 50% reduction in their slips, trips and falls-related workers' compensation claims [Bell et al. 2008]. A user-friendly guide was created and made available to the public to educate healthcare workers and administrators on the problem of slips, trips and falls, as well as guidelines for surveillance and prevention in their own facilities [NIOSH 2010]. However, it is not known the degree to which the nation's healthcare facilities have used this and other published information. There is a need for research focused on identifying and replicating successful prevention strategies and evaluating the impact on facilities' worker injuries. Additional work could be done to determine barriers for implementation of known prevention strategies.

Research Needs

- Conduct studies focused on identifying and replicating successful prevention strategies and evaluating the impact on facilities' worker injuries.
- Determine barriers for implementation of known prevention strategies.
- Evaluate implementation of and adherence to Safety Risk Assessment Guidelines and effectiveness of design strategies to decrease slips, trips and falls.

Objective 12: Develop and implement methods to identify, assess, control and prevent exposure to hazardous drugs, biological pharmaceuticals, reproductive hormones and other chemicals (e.g., cleaners, disinfectants, sterilants) in acute care human and veterinary healthcare settings and for difficult-to-access, low wage and underserved workers in home care, animal care, day care and other social services.

Hazardous drugs and other chemical hazards abound in human and animal healthcare settings [Condon et al. 2009; McDiarmid 2006; McDiarmid and Leone 2009; Meggs 1999; NIOSH 2014a]. These include antineoplastic drugs, antiviral drugs, hormones, some bioengineered drugs and other miscellaneous drugs [NIOSH 2017a]. Many are known to adversely affect workers' health while others are new or unstudied in their potential health effects. Effective prevention measures exist in some settings and for some hazards, but significant gaps exist, particularly in veterinary and animal care settings.

NIOSH estimates that about 8 million workers are exposed to hazardous drugs in their work settings which includes not only clinical staff members with direct patient-care responsibilities, but also workers both 'up-stream' from the patient encounter, such as personnel responsible for research, shipping, and receiving, and also those 'down-stream' from the patient, including environmental services personnel. Newly included in this estimate are home-care workers who are now exposed to hazardous drugs due to the migration of cancer care outside of institutional settings [Cass et al., 2016]. As well, veterinary practices use these same drugs for treatment of animals, enlarging the population of potentially exposed workers by 500,000 [NIOSH, 2017a; BLS, 2007].

Although studies of antineoplastic drugs have been undertaken in the last two decades, the majority have occurred in treatment centers and among professional care staff (i.e., pharmacists and nurses) [McDiarmid and Leone 2009]. However, many other workers encounter this hazard along the 'life cycle' of the drugs in an organization, from receiving the drugs at the loading dock through the preparation and administration for the clinical encounter and finally to waste disposal. Thus, the workers potentially exposed also include those receiving and unpacking boxes, given documented external contamination of containers [Connor et al. 2005]. Other examples include nursing assistants who may handle patient waste after treatment [Kusnetz and Condon 2003] and environmental service (EVS) workers who handle contaminated drug packaging and drug administration kit waste. Animal care workers who care for animals treated with antineoplastic or other hazardous drugs are also at risk of exposure. These workers and exposure scenarios require study.

Usage and exposure estimates for antineoplastic drugs have been reported for veterinary personnel in Canada [Hall et al. 2013] and the Netherlands [Meijster et al. 2006], where concerning exposures were documented during preparation and administration of antineoplastic drugs. No such antineoplastic pharmaceutical usage or exposure data for U.S. veterinary personnel have been reported. This represents an important knowledge gap for clinical veterinary personnel, as well as animal research facility personnel, where antineoplastic and other hazardous drugs may be used for a variety of applications.

Apart from hazardous drugs, healthcare and veterinary and animal care workers are exposed to a variety of chemical hazards including cleaning and disinfecting agents, reproductive hormones, surgical smoke, anesthetic gases and others. Cleaning and disinfecting agents are important for infection control in healthcare settings and also play an important role in microbial control in veterinary and animal care facilities. In healthcare settings EVS workers are the main occupational group performing cleaning and disinfecting activities in healthcare facilities and thus are frequently exposed to the cleaning and disinfecting agents. Cleaning is also conducted by a variety of other healthcare occupations. In a recent study, investigators followed healthcare workers in five hospitals for entire shifts and recorded workers' activities every five minutes [Quinn et al. 2016]. This research confirmed previous observations: EVS workers cleaned environmental surfaces other than medical equipment on 96% of the person days observed. At the same time, many other occupations in healthcare also conducted cleaning as a routine activity. The spraying of cleaning solutions can facilitate inhalation of chemicals, and this method was used by EVS workers to clean surfaces such as windows and mirrors [Saito et al. 2015]. In addition, nurses and other healthcare workers who do not perform cleaning directly can experience airborne exposures if they are in the same room with someone else who is cleaning. In home care, cleaning and disinfecting is performed by aides. A study of a large population of aides in Eastern Massachusetts found that 80% of home visits conducted by aides involved cleaning and disinfecting [Quinn et al. 2016].

There is increasing evidence that regular exposure to cleaning and disinfecting agents may pose health risks to healthcare workers [Quinn and Henneberger 2015] and veterinary and animal care workers [Bello et al. 2009; Arif and Delchos 2012; Saito et al. 2015]. These agents have been linked to occupational asthma as well as respiratory and skin disorders [Hawley et al 2016; Mazurek and Weissman 2016; Waszniewska and Walusiak-Skorupa 2014]. Cleaning chemicals are among the leading causes of occupational asthma. However, quantitative exposure information is lacking. Research on safer, effective practices and products also is lacking [Quinn and Henneberger 2015]. There is a need to better understand the adverse impact of cleaning and disinfecting products and procedures on the health of human and veterinary healthcare workers and for assessing safer alternatives.

Biologic pharmaceuticals such as vaccines, adjuvants, and monoclonal antibodies represent potential hazards to veterinary and animal care workers through splash (dermal, ocular, oral, inhalation) and autoinoculation [Berkelman 2003]. Research is needed to better understand hazard knowledge among veterinary personnel related to these agents, and current prevention practices including use of PPE.

Laboratory animal workers in animal research facilities may utilize certain hazardous pharmaceuticals for a variety of applications other than the labeled indications. Reproductive hormones commonly used in equine and dairy veterinary practice pose serious reproductive risks specifically for female veterinary personnel [Gold and Beran 1983; Vanderwall 2012]. Usage and exposure estimates for reproductive hormones in veterinary practice are lacking. Information about when and how reproductive hormone pharmaceuticals are used in practice would provide an important basis for developing intervention strategies.

Surgical smoke, a byproduct of laser- and electro-surgery, poses a health risk for workers and patients, including respiratory irritation, infectious disease transmission, and mutagenic and carcinogenic agent exposure [Gatti et al. 1992; Garden et al. 1988; Okoshi et al. 2014; Ulmer 2008]. Although removal of surgical smoke at the source using local exhaust ventilation (LEV) has been recommended for many years, LEV is not always used [Steege et al. 2016], prompting additional studies to better understand barriers to use.

Exposure to waste anesthetic gases occurs in operating rooms and post-anesthesia care units (PACU) and has negative health effects including reproductive effects [Guirguis et al 1990; Sessler and Badgwell 1998]. Engineering controls and work practices need to be evaluated, especially in the PACU and in veterinary settings [Boiano and Steege 2016; Langley et al. 2014].

Nurses and other healthcare workers have experienced a broad range of acute and chronic health effects in response to the myriad chemicals and drugs used in the acute care setting. According to a recent analysis of national adult asthma survey data, workers in the healthcare and social assistance industry sector reported the highest prevalence of work-related asthma compared to other industries in the 21 states included in the survey [Dodd and Mazurek 2016]. Another survey of work-related asthma surveillance data from four states (California, Massachusetts, Michigan, and New Jersey) corroborated these results, finding that healthcare workers reported more work-related asthma than other occupations—such that healthcare workers accounted for 16% of the work-related asthma cases but only 8% of the workforce [Pechter et al. 2005]. Causes of occupational asthma in healthcare workers include cleaning and disinfecting agents, sterilants, aerosolized medications, and other exposures.

Several investigations have occurred into sources of occupational contact dermatitis with few solid answers or actionable protective measures identified [Molin et al. 2014; Nettis et al. 2002]. It is often difficult to assess which individual chemical among the many present in the working environment is responsible for respiratory or skin irritation, or what the combined impact of multiple chemical exposures may be. Further investigation is necessary to both characterize exposure and more fully assess health outcomes.

Research Needs

- Evaluate hazardous drug exposures among workers along the entire ‘life cycle’ of a drug.
- Characterize veterinary and animal care workers and their exposure to hazardous drugs and chemicals.
- Collect antineoplastic pharmaceutical usage and exposure data for U.S. veterinary personnel.
- Evaluate hazard knowledge among veterinary personnel related to these agents, and current prevention practices.
- Develop quantitative exposure information on cleaning and disinfection products.
- Identify safer cleaning and disinfection practices and products.
- Understand the adverse impact of cleaning and disinfecting products and procedures on the health of human and veterinary healthcare workers and assess safer alternatives.
- Develop more effective hazardous drug and chemical exposure prevention measures.
- Obtain a better understanding of impediments to using recommended best practices.
- Conduct surveillance of veterinary and animal care workers to assist in identification of risks from autoinoculation/iatrogenic exposure to biologic pharmaceuticals.
- Collect usage and exposure estimates for reproductive hormones in veterinary practice.
- Evaluate proper use of recommended engineering controls, work practices, and PPE especially in the PACU, surgical, and in veterinary settings.
- Describe barriers to local exhaust ventilation to control surgical smoke and strategies to overcome these barriers.
- Characterize exposure and health outcomes related to surgical smoke, hazardous drugs and chemicals

Objective 13: Identify and evaluate methods to promote adoption and implementation of hazardous drug safe handling programs in non-hospital settings and veterinary practices.

Despite the availability of harmonized hazardous drug safe handling program recommendations which are now endorsed by multiple stakeholder health agencies and professional groups, uptake of safe handling practices is variable and uneven [Boiano et al. 2014 & 2015; Polovich and Clark 2012]. This lack of adherence to safe practices can result in not only direct exposure to those handling drugs, but also to those who may come into contact with contaminated surfaces, which are reliably found on surface wipe testing globally [Connor et al 2010; Fleury-Souverain et al. 2015; Hon et al. 2013]. Hazardous drug surface contamination is often not easily visible, and can result in and enable secondary exposures to highly toxic drugs from touch contact with work surfaces, drug and waste containers, and administration/drug delivery equipment [NIOSH 2017b]. These direct and indirect exposures can cause both acute and chronic health effects including cancers and reproductive loss [Connor and McDiarmid 2006; Lawson et al. 2012].

While there has been some study of the barriers to uptake of safe handling practices, much of this work was focused in acute care settings among nurses and pharmacists [Crickman and Finnell 2016; Boiano et al. 2014, 2015; He et al. 2017]. A need exists to evaluate a wider group of the exposed population, including non-clinical health workers and to examine diverse, non-institutional settings where these drugs are found, especially given the movement of cancer care outside of traditional acute care patient and animal care settings. These populations and work settings are not currently well described by the existing knowledge base and therefore preventive interventions, including health messaging, may be of less utility and more poorly targeted than those tailored for acute care. Also, the utility and appropriateness of standard work practices and PPE used in acute care settings requires assessment in alternative settings of home and veterinary care to ensure feasibility of use and surety of protection and exposure prevention.

Strategies for adoption and implementation of safe handling programs for antineoplastic and other hazardous drugs (e.g., reproductive hormones) in veterinary clinical practice, particularly small practices, are needed. Such programs already exist in human healthcare, and have been tailored and adopted by many large veterinary institutions, yet smaller facilities have lagged behind. Pilot projects designed to help veterinary clinics and animal research laboratories improve practices regarding hazardous drugs are needed. Ascertaining how and to what extent veterinary and animal care facilities comply with OSHA's *Hazard Communication Standard* could provide information on whether compliance is associated with improved safety, which would be valuable to raise awareness and potentially guide outreach activities.

Research Needs

- Evaluate barriers to safe handling practices in non-clinical health workers and non-institutional settings.
- Understand utility and appropriateness of standard work practices and PPE in alternative settings of home and veterinary care to ensure feasibility of use and surety of protection and exposure prevention.
- Develop strategies for adoption and implementation of safe handling programs for antineoplastic and other hazardous drugs (e.g., reproductive hormones) in veterinary clinical practice.
- Pilot projects to help veterinary clinics and animal research laboratories improve practices regarding hazardous drugs.
- Measure the extent that veterinary and animal care facilities comply with OSHA's *Hazard Communication Standard* and characterize compliance/noncompliance.

Objective 14: Increase knowledge about, implement strategies to mitigate, and evaluate existing prevention strategies regarding biological, physical and psychological hazards to veterinary and animal care workers

Within the U.S., the risk of contracting various zoonotic diseases has changed over time [Bonini et al. 2016; Miller et al. 1987]. Some zoonotic diseases such as influenza A, hepatitis E, infections caused by various species of *Bordetella* and *Streptococcus*, and tick-borne diseases are emerging while others are declining [Rabozzi et al. 2012; Weese et al. 2002]. Although the transmission routes and risk factors for infection for many agents are known, workers continue to be exposed [Wright et al. 2008]. Transmission routes for some pathogens, however, are not completely understood [McElroy et al. 2010; Teoh et al. 2017]. Animal allergen exposure and disease have been identified in multiple sectors of the veterinary and animal care workplace but practical exposure risk assessment by job description is not adequate and therefore employees may not be properly protected. In addition, animal allergen exposure and its contribution to the development of allergy and asthma, with or without chemical sensitization such as from disinfectants used in the workplace, has not been established [Acton and McCauley 2007; Quinn et al. 2015].

Physical hazards in veterinary and animal care often parallel those found in human medicine. A key difference is the interaction with animals and animal environments, and other physical differences and stressors exist, such as the psychological impacts of administering euthanasia in animal patients. Psychological factors have not previously been included in hazard considerations for veterinary and animal care personnel but have recently come to the forefront as an important issue [Bartram and Baldwin 2010; Nett et al. 2015]. The following hazards were chosen due to their unique, ongoing, or emerging prevalence among the veterinary and animal care population. However, this is not a complete or exclusive list, and multidisciplinary or multi-hazard studies addressing these topics should be considered.

1. Animal/Human Contact

Substantial research has been performed on the incidence of animal-related injuries in veterinary and animal care settings, and it has been known for 30 years that these are the most common types of injuries in veterinary practices [Landercasper et al. 1988; Nordgren et al. 2014]. However, studies on the implementation of safety measures and training when working with animals, as well as the evaluation of new or existing interventions were noticeably lacking in the literature, and are needed.

Regarding biological hazards in veterinary and animal care, disease surveillance, detection methods, exposure limits and evidence for protections needed for different job duties are lacking [Whitney et al. 2009 & 2013]. Surveillance systems are needed to capture data on disease incidence, and case age, gender, morbidity, mortality, exposure history, loss of work, and healthcare costs to determine burden of disease, risk factors and potential interventions or controls. Disease surveillance of veterinary and animal care workers would also assist in identification of risks from particular exposures such as bioaerosols [Dutkiewicz et al. 2011]. In addition, environmental studies are needed to understand the factors involved in emergence and re-emergence as well as the decline of zoonotic diseases.

Inadequate emphasis on safety culture is largely responsible for lack of compliance with biosafety and infection control best practices [Sellens et al. 2016; Weigler et al. 2005; Williams et al. 2015]. Determination of the most effective training methods on proper infection control and biosafety practices for current veterinary and animal care personnel and veterinary program students are critically needed.

Although there are numerous recommendations available for prevention of exposure to biological hazards, data are lacking on how these measures are being implemented and how they are affecting outcomes

[D'Souza et al. 2009; RCVS 2017; Williams et al. 2015]. Pilot projects to determine if and how well standard precautions and infection control concepts are taught in veterinary programs are needed.

2. Psychological factors

Researchers, veterinary colleges, and veterinary organizations have begun to study the issues that affect mental health and wellbeing of veterinary personnel [Dawson and Thompson 2017; Epp and Waldner 2012; Witte et al. 2012]. Additional work is needed to further identify risk factors for psychological distress, suicidal ideation, and suicide among veterinary and animal care workers, in workplace violence prevention, and also to evaluate access to interventions and the effectiveness of intervention measures.

3. Reproductive risks

The proportion of women among veterinary and animal care personnel has increased in recent years, resulting in a growing interest in reproductive occupational health issues [Scheftel et al. 2017]. In a recent review of hazards to reproductive health, Scheftel et al. found that physically demanding work, standing for prolonged periods of time and working long hours have detrimental effects on reproductive health. Work demands may have detrimental effects on physical and mental health in addition to those identified for reproductive health. Most of the references cited were from research done outside of the United States and not specifically looking at veterinary and animal care personnel. More research is needed in this area, and work from analogous disciplines such as nursing may have great benefit to veterinary personnel.

4. Ergonomic risks

These hazards often take the form of musculoskeletal injuries and arise from the work environment itself. They include unsafe equipment, heat and cold extremes, and non-ergonomic workspaces. Some prevention methods and devices already exist in human medicine, yet research is needed in their translation and evaluation within the veterinary and animal care setting, in addition to testing of new interventions. Most research in this area has targeted certain veterinary specialties that are known for repetitive motion injuries [MacDonald and King 2014; Randall et al 2012], and there have been some international studies on back and other musculoskeletal injuries [Fritschi et al. 2006; Scuffham et al. 2010]. A broader understanding is needed to address the variety of environments and conditions veterinary and animal care personnel experience.

5. Exposure to sharps

Significant research has been done in human healthcare as well as animal care, both in the U.S. and internationally on the incidence of sharps and needlestick injuries [Weese and Douglas 2008]. While the scope of this injury type is well known, there is a need to transfer and assess prevention strategies from human medicine, as well as develop and evaluate veterinary and animal care-specific interventions for reducing sharps injuries when working with animals.

6. Hearing loss

Animal noise is a unique hazard to veterinary and animal care and is believed to contribute to hearing loss. Numerous Health Hazard Evaluations have been requested from NIOSH for animal noise concerns in dog and pig housing facilities [NIOSH 2007a; NIOSH 2007b; NIOSH 2007c; NIOSH 2007d] as a result, hearing loss prevention programs have been recommended. The direct association between animal noise and hearing loss, and whether hearing loss prevention programs have been or should be generally implemented in animal housing facilities should be determined. Although, there are hearing loss prevention programs, there is a lack of published literature regarding where and how hearing loss programs have been implemented. Of those hearing loss programs which have been implemented, there is a need to evaluate which ones are of most benefit in veterinary and animal care settings and how best to encourage implementation.

Research Needs

- Evaluate new or existing interventions to prevent animal-related injuries.
- Conduct surveillance and assessment of biological hazards in veterinary and animal care job duties.
- Determine the most effective training methods for proper infection control and biosafety practices for current veterinary and animal care personnel and veterinary program students.
- Determine the extent that guidelines in the *Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel* have been adopted.
- Evaluate trends in safety culture perception among veterinary and animal care personnel.
- Identify risk factors for workplace violence, psychological distress, suicidal ideation, and suicide among veterinary and animal care workers and evaluate access to interventions and the effectiveness of intervention measures.
- Translate research in preventing adverse reproductive outcomes in other settings to veterinary and animal care personnel.
- Characterize unique ergonomic risks faced by veterinary and animal care workers and test new interventions.
- Transfer and assess sharps injury prevention strategies from human medicine.
- Develop and evaluate veterinary and animal care-specific interventions for reducing sharps injuries when working with animals.
- Determine if hearing loss prevention programs have been or should be implemented in animal housing facilities and the effectiveness of these programs.

Objective 15: Develop or adapt, implement, and evaluate interventions found to be effective in acute healthcare and other settings for long term care, home care, home healthcare, correctional care, child care, and other social services.

One of the major challenges facing the U.S. in the 21st Century will be to ensure that individuals throughout their life will have the supports they need and will be treated with dignity [HHS 2003]. This support work is conducted by workers in healthcare and social assistance, the fastest-growing sector of the U.S. economy. The HCSA sector employs more than 19 million workers, including more than 1.5 million nursing assistants and orderlies working in nursing homes and other long-term care facilities and an additional 1.5 million home healthcare and personal care aides working in private homes [BLS 2017b]. These settings and their occupational safety and health challenges are diverse; for example skilled nursing facilities vs. less acute settings such as home settings, assisted living facilities, and nursing homes. Over 307,000 childcare workers [BLS 2017c] care for our population at the beginning of the life span.

In the next decades, the greatest demand will be for workforces to care for the rapidly aging population led by the “baby boomers” [HHS 2003]. The number of individuals using either nursing facilities, alternative residential care, or home care services is expected to nearly double from 13 million in 2000 to 27 million in 2050 [HHS 2003]. After 2010, the demand for direct care workers in long-term care and home care settings will become even greater as the baby boomers reach age 85, beginning in 2030 [CBO 2013]. The demand for direct care workers is projected to grow by 200% to approximately 6 million workers between 2000 and 2050 [HHS 2003]. This increase in demand will be occurring at a time when the high growth rate of the labor force in the 1950-2000 period is followed by a

much lower growth rate in the 2000-2050 period; 1.7 percent and 0.7 percent annual growth respectively [Toossi 2012]. These projections indicate that it is critical to retain existing long-term care workers and attract new ones [HHS 2003].

Despite the social importance of and high demand for long-term care, home care, home healthcare and other direct care workers, research to protect and promote their occupational safety and health has been limited. In home care for example, existing research has mostly focused on exposure or injury assessment. These studies show that home care aides face a variety of occupational safety and health risks including musculoskeletal strain and injury, violence, needlesticks and other sharps injuries, exposures to blood and other infection hazards, second-hand cigarette smoke, chemical exposures from cleaning and disinfection, and psychosocial stress [Gershon 2009; Lipscomb 2009; Markkanen 2014 & 2015; McPhaul 2010; Quinn 2016]. Many of these occupational safety and health risks are similar to hospitals while others are unique to home care where workers are often alone and cannot control their work environment. These non-acute care settings vary in many factors, such as whether they are accredited or are subject to external standards such as those associated with participation in the Medicare, Medicaid or other programs. The impact of such factors on worker safety and health remains to be clarified.

Direct care workers in hospitals, nursing homes, homes, and childcare settings are predominantly female and increasingly immigrant, minority, and older workers. They are among the nation's lowest-compensated occupational groups: in May 2016, the median annual income for a home care aide was approximately \$22,000 (\$22,600 for a home health aide; \$21,920 for a personal care aide) and \$21,170 for a childcare worker [BLS 2017e; BLS 2017f; BLS 2017g]. Even though they care for others, many aides and child care workers lack adequate access to healthcare [Smith & Baughman 2007]. These workers are difficult to reach for occupational health research and services because they often work alone and/or in private homes or small-scale workplaces. All of these factors make direct care aides and social assistance workers particularly vulnerable to illness and injuries [BLS 2017b; BLS 2017c; BLS 2017d]. While hazard and injury assessment remain important for these workers, the highest priority is occupational safety and health intervention research: development, implementation and evaluation. There are only a few studies pointing to interventions [Markkanen 2014 & 2015] and few training materials to assist home care and home healthcare aides with safer practices [NIOSH 2014b].

To date, most healthcare interventions have been developed in the acute care setting. Some of these interventions may be directly transferrable from a hospital application to long-term care or home care. For example, vaccines for hepatitis B have been effective among hospital workers and may be implemented effectively in specific care settings if the programs to administer the vaccines are designed for each workforce. However, some interventions such as high technology lifting devices for patient handling and mobility may not be feasible for home care where individual clients cannot afford them and an aide cannot carry them from home to home. In many cases, no interventions exist and technologies, programs and practices will need to be adapted or newly developed and evaluated in the specific setting.

Research Needs

- Adapt, implement and evaluate intervention research found to be effective in acute care settings in other settings.
- Develop, implement, and evaluate new interventions for home care and home healthcare when existing acute care interventions cannot be adapted.
- Develop recommendations and explore equipment options for mobile workers who visit multiple workplaces particularly ones that are not controlled by the employer such as private homes.

- Research interventions that reduce the combativeness of clients, both children and older adults in care, as a protection for workers.

Objective 16: Explore the impact of emerging and existing work organization factors and nontraditional systems on worker health and safety, with a particular emphasis on low-wage occupations.

Low-wage jobs carry more occupational safety and health risks for workers than higher paying jobs and are associated with higher rates of chronic disease [Baron 2014; Benach et al. 2010; Leigh and Du 2012; Muntaner et al. 2010] and disabling pain in the working population [Herin et al. 2014]. Low-wage jobs are often carried out within the context of precarious work arrangements with high turnover rates such as temporary staffing and gig jobs, which are beneficial to employers but can be stressful and create challenges for employees. For example, these work arrangements are associated with irregular work schedules and pay for employees [Gonos and Martino 2011; Plumer 2013; Van Arsdale 2013].

In a number of ways, low-wage healthcare and social assistance workers mirror other parts of the low-wage workforce [Folbre 2012; Gerstel and Clawson 2014; Glasmeier and Farrigan 2012]. For example, in May 2016, the median annual earnings were \$22,600 for a home healthcare aide and \$21,920 for a personal care aide [BLS 2017e; BLS 2017f]. Additionally, many home care aides have limited access to health insurance [Markannen et al. 2014]. Home care workers also face unique work organization challenges resulting from working in isolation from other workers; minimal or no training, including safety training; lack of on-site support and supervision, including related to safety matters; and unclear job responsibilities. [Stone 2004; Muramatsu et al. 2017; Osterman 2017].

Informal work arrangements such as temporary staffing and gig work are often intimately tied to formal systems, but rarely specifically investigated by researchers across disciplines to clarify the potential impacts of these arrangements on worker health. Keeping up with the changing landscape of work in the healthcare and social assistance sector has been challenging for occupational health researchers especially because research agendas tend to move slower than economic and social change. In addition, other changes in the workplace such as organization restructuring and downsizing may cause reduced physical and mental health, including increased sickness absence and disability [Landsbergis et al. 2012; Quinlan and Bohle 2009; Vahtera et al. 2005; Virtanen et al. 2011].

Long-standing and robust traditions studying work organization [Karasek 1981; Siegrist 2010] need theoretical and empirical augmentation to better address quality of work-life leading to improvements in occupational health. Innovation in theory, methods, data collection for specific healthcare and social assistance occupations and settings will require a sustained effort for innovative solutions [Baron et al. 2014; Doussard 2013; Fine 2006; Schnall et al. 2016; Weil 2014;]. Challenges will require a multidisciplinary approach to elucidate the relationship between work organization factors and health to inform social policy aimed at improving work conditions.

Research Needs

- Conduct national surveillance on the prevalence of exposures and outcomes by occupation for low-wage workers and others working in precarious conditions.
- Determine the magnitude and distribution of unhealthy working conditions in order to formulate better work practices and public policies around work organization.

- Clarify the relationships between labor market changes and economic globalization and the resulting changing nature of working conditions especially to identify the links among work organization, workplace stressors, and health outcomes.
- Collect more information on the impact of alternative work structures, like temp work, on call work, and unpredictable work schedules on worker health and safety.
- Conduct intervention studies to ameliorate work stressors related to changing nature of work and work organization. These efforts should include workers, labor unions, labor-management partnerships, worker cooperatives and researcher-worker collaborations through participatory action research.
- Examine ethics in carework to inform job redesign in ways that focus on compassionate care and healthy jobs rather than on economics and the processes inherent in healthcare systems [Schnall et al. 2016; Tronto 2013].

Objective 17: Establish a strong focus on challenges to the safe care of people in their home environment that engages a broad range of stakeholders in identifying issues and developing solutions.

Home care and home healthcare services to the elderly are increasing both because of individual preferences to age in place and because of the associated cost savings, particularly for low-income older adults who are eligible for publicly-funded long term services and supports (LTSS) programs [Muramatsu et al. 2010]. Roles of care-givers vary but often overlap, and approaches to health and safety for these workers vary, creating confusion and sometimes conflict among workers and agencies.

Workers who provide personal care or basic health assistance in the homes of frail elderly or disabled individuals, personal care aides and home health aides, currently comprise the fastest growing segment of the U.S. workforce. Jobs for personal care aides and home health aides are projected to increase 25.9% and 38%, respectively, between 2014 and 2024, with over 900,000 new positions needing to be filled. These jobs have few entry requirements and offer very low pay – the median income in 2016 was \$21,920 for personal care aides and \$22,600 for home health aides [BLS 2017e; BLS 2017f]. The workforce is disproportionately female, African American, foreign-born; workers are older than the general working population and have less education [Bercovitz et al. 2011; BLS 2015c]. They often piece together part-time work for different clients, resulting in less than fulltime status, and typically have few or no benefits, such as paid sick leave, paid vacation time, employer-provided healthcare insurance or pension plans. [Christman et al. 2017] The work may require high levels of exertion, as when assisting a paralyzed client with toileting and transfer, and psychological strain and physical assaults, as when working with a confused or agitated client. Workers are isolated from co-workers and supervisors throughout the workday, and home environment itself often presents numerous hazards [Bercovitz et al. 2011; Kim et al. 2013; Quinn et al. 2015]. Despite these challenges, workers express satisfaction with the care-giving aspects of the work [Bercovitz et al. 2011; Zanoni et al. 2007].

While factors contributing to slips/trips/falls and other hazards are generally well understood, implementing interventions in the home is challenging given the unique nature of each setting. In addition, healthcare equipment and supplies designed for use the home are often developed to maximize patient safety and may be detrimental to worker safety. Insurance companies and public agencies have developed programs to supply home equipment or to make small structural improvements [DCOA 2017] but these programs have not been extensively implemented and evaluated for their impact on improving worker safety.

Research Needs

- Evaluate the impact of work organization for paid care-givers on occupational health and safety.
- Explore communication among different care-givers, clients and families. Develop and evaluate the usefulness of a forum for stakeholders of care at home, e.g. homecare, home healthcare, hospice, elder and other social services – to promote dialogue, exchange knowledge and experience, and identify challenges to the safe care of people in their home environment.
- Evaluate participatory interventions to address hazard reduction in the home.

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