National Strategy for Personal Protective Technologies Research for the Health Care and Social Assistance Sector

A DRAFT Prepared for NIOSH

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This draft is formatted into four parts: an overview, assessment, research plan, and appendixes. The assessment is structured using the five questions that NIOSH is using for its NORA town hall meetings, and the research plan is structured similar to the White House strategy for preventing a pandemic.

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National Strategy for Personal Protective Technologies Research for the Health Care and Social Assistance Sector

"Providing National and World Leadership to Prevent Illnesses and Injuries"

Overview

Every day, in nearly every type of U.S. work setting, personal protective technologies are used to reduce workers' risk of job-related injury, illness, and death. These technologies include personal protective devices such as respirators, chemical-resistant clothing, hearing protectors, and safety goggles and glasses that provide a barrier between the worker and an occupational safety or health risk. In particular, respirators are a required component of many occupational safety and health programs, and may represent a worker's last line of defense against exposure to toxic fumes, vapors, microorganisms, or dust. More generally, personal protective equipment (PPE) is a last line defense after engineering controls.

PPE are tools that ensure the basic health protection and safety of users. PPE is any device designed to be worn by an individual when exposed to one or more safety and health hazards. PPE includes all clothing and other work accessories designed to create a barrier against or restraints from workplace hazards, and using PPE requires hazard awareness and training on the part of the user. Employees must be aware that the equipment does not eliminate the hazard; and if the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition. Personal protective technologies also include devices that provide a worker with early warning of a hazard or otherwise help keep the worker safe from harm, such as sensors that detect toxic atmospheres and communication devices used for safe deployment of emergency workers.

At the request of the Congress, the National Institute for Occupational Safety and Health (NIOSH) established the National Personal Protective Technology Laboratory (NPPTL) in Pittsburgh, PA in 1999.[1] NPPTL focuses expertise from many scientific disciplines to advance federal research on respirators and other personal protective technologies for workers. NPPTL's efforts are essential for applying state-of-the-art science to meet the increasingly complex occupational safety and health challenges of the 21st Century. NPPTL's strategic research program ensures that the development of new PPE keeps pace with employer and worker needs as work settings and worker populations change and new technologies emerge. NPPTL research also responds to the need for effective protective technologies for first responders in terrorist events and other disasters. NPPTL incorporates NIOSH's longstanding program for testing and approving respirators for use in traditional work settings.

The NPPTL mission is to prevent work-related illness and injury by ensuring the development, certification, deployment, and use of PPE and fully integrated, intelligent ensembles. This will be accomplished through the advancement and application of personal protective technology standards.

Assessment

1. Who is most at risk?

A distinguishing characteristic of the health care and social assistance sector is that labor inputs of health practitioners or social workers are contingent upon requisite expertise. This sector comprises establishments providing services for individuals and includes both health care and social assistance because it is at times difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals, and many of the industries in the sector are defined by the educational degrees held by the practitioners included in the industry.

Injury and illness rates provide a measure of the success of worker protection strategies. Those portions of industry with the highest rates indicate failures in protection and opportunities for intervention research to improve the safety and health of these workers.

An estimated 16.6 million private and public workers are employed within the health care and social assistance sector. Workers are at risk for illness and injuries due to long hours, changing shifts, physically demanding tasks, violence, and exposures to infectious diseases and hazardous radiation or chemicals. The Bureau of Labor Statistics (BLS) reported an estimated 649,000 occupational injuries and illnesses in 2003 in this sector, which is further described as shown in Table 1. Hospitals accounted for an estimated rate of 7.9 injuries per 100 full-time workers; nursing and residential care facilities, 9.7 injuries per 100 full-time workers: 68% and 106% greater than private industry, respectively. Almost 500,000 health care workers are self-employed under contract.[2]

Table 1. List of Health Care and Social Assistance Subsectors

Code*	Health Care and Social Assistance Subsectors	Employment 2003		Rates, 2003‡	
		Private	Percentage	Injury	illness
621	Ambulatory health care services	4,783,400	34.9%	3.0	25.4
622	Hospitals	4,201,300	30.6%	**7.9**	**73.4**
623	Nursing and residential care facilities	2,776,500	20.2%	**9.7**	**48.0**
624	Social assistance	1,960,700	14.3%	3.9	23.5
62	*Sector-wide*	*13,721,900*	*100.0%*	*6.0*	*44.7*
	Private Industry, all sectors			4.7	30.7

* North American Industry Classification System (NAICS)
‡ injury rates per 100 employees/yr; illness rates per 10,000 employees/yr
Yellow indicates the transportation and warehousing average rate
Red with bold lettering indicates those average rates that exceed the sector-wide average

Injuries

The health care and social assistance sector has a 22% higher annual injury rate of 6.0 injuries per 100 full-time workers than all private industry, which has 4.7 injuries per 100 workers. Both the hospitals and the nursing and residential care facilities subsectors have above average annual injury rates, respectively, of 7.9 and 9.7 injuries per 100 full-time workers as compared to the sector-wide average injury rate for the health care and social assistance sector. Workers in nursing home and residential care facilities are at the highest risk of injury in this sector.

The annual rate of traumatic nonfatal occupational injuries involving days away from work for the health care and social assistance sector exceeded the rate for the U.S. workforce in 2003, respectively, at 16.3 and 13.8 injuries per 1,000 full-time workers. Most of cases were due to traumatic injuries to muscles, tendons, ligaments, and joints (59%). The annual incidence rate of traumatic injuries involving days away from work in this sector was 60 injuries per 1,000 full-time workers as compared to an annual rate for all workers of 47 injuries per 1,000 full-time workers.

Illnesses

The health care and social assistance sector had a 22% higher annual illness rate of 44.7 illnesses per 10,000 full-time workers than all private industry, which had 30.7 illnesses per 10,000 workers. Both the hospitals and the nursing and residential care facilities subsectors have above average annual illness rates, respectively, of 73.9 and 48.0 illnesses per 10,000 full-time workers as compared to the sector-wide average illness rate for health care and social assistance. Workers in hospitals are at the highest risk of illnesses in this sector.

Facility-related Exposure

Health Care Facilities

Health care facilities include hospitals, clinics, dental offices, out-patient surgery centers, birthing centers, and nursing homes. Health and safety issues associated with health care facilities include bloodborne pathogens and other biological hazards, potential chemical and drug exposures, waste anesthetic gas exposures, respiratory hazards, ergonomic hazards from lifting and repetitive tasks, laser hazards, hazards associated with laboratories, and radioactive material and x-ray hazards. Some of the potential chemical exposures include formaldehyde, used for preservation of specimens for pathology; ethylene oxide, glutaraldehyde, and paracetic acid used for sterilization; and numerous other chemicals used in health care laboratories. In addition to the medical staff, large health care facilities employ a wide variety of trades that have health and safety hazards associated with them. These include mechanical maintenance, medical equipment maintenance, housekeeping, food service, building and grounds maintenance, laundry, and administrative staff.

Nursing and Personal Care Facilities

Nursing and personal care facilities rank among the highest in terms of injuries and illnesses, with rates about 2½ times that of all other general industries despite the availability of feasible control that have been identified to address hazards within this industry. Most prevalent hazards in this industry include musculoskeletal disorders related to resident handling, needlesticks and

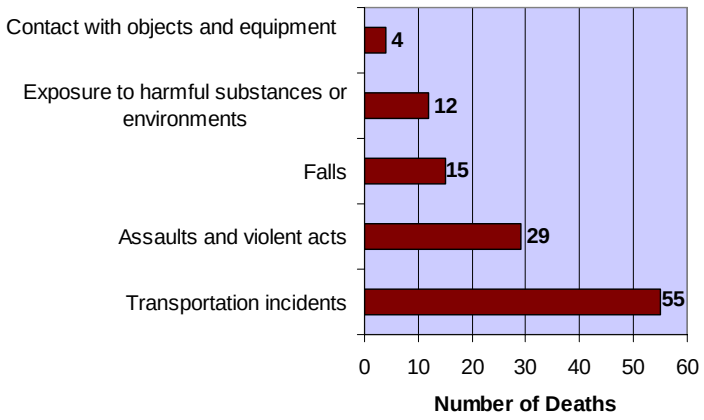
exposure to blood and other potentially infectious materials, exposure to tuberculosis (TB), and slips, trips, falls.[3]

2. How serious is the issue?

Fatalities

Fatal occupational injuries among workers in the health care and social assistance sector totaled 115 in 2003 at an annual rate of one per 100,000 employees.[4] This compares to a rate of four deaths per 100,000 employees for all occupations.[5] Most fatal occupational injuries in this sector were due to transportation incidents and assaults and violent acts as shown in Figure 1.

Figure 1. Occupational Fatalities in the Health Care and Social Assistance Sector by Event, 2003



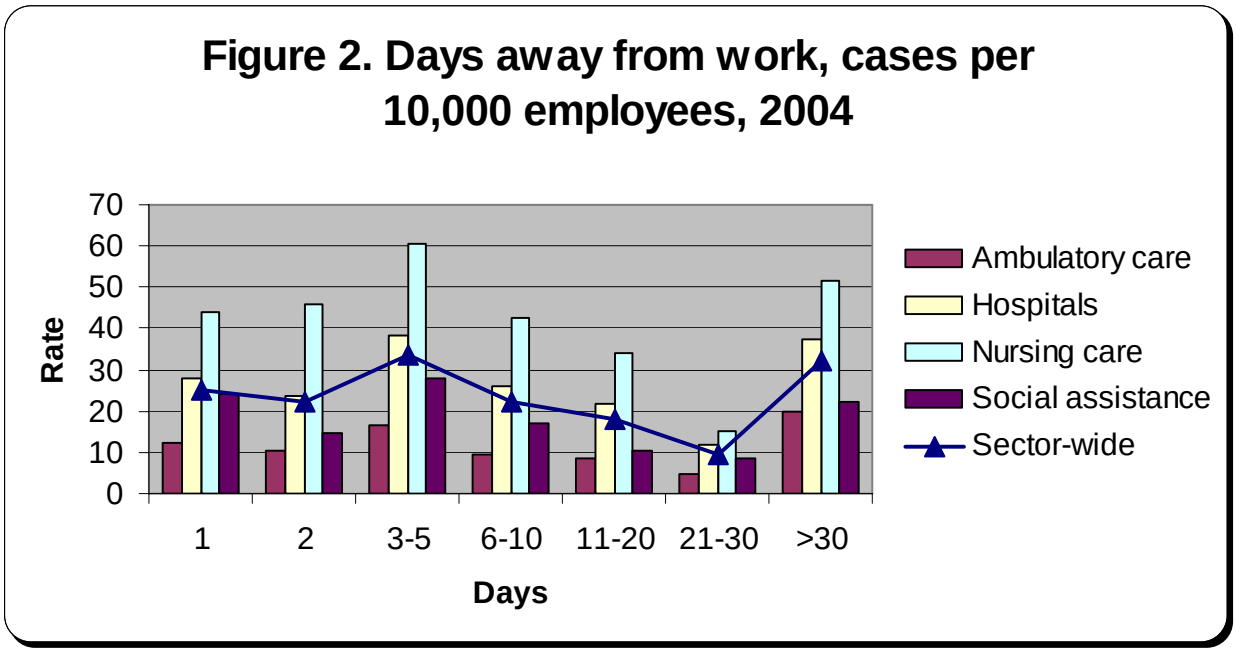
Nearly half (48%) of the 115 fatalities were from 55 transportation incidents. Most of these were on highways with 38 incidents followed by 8 aircraft incidents and seven cases of a worker being struck by a vehicle or mobile equipment.

Another 29% of the fatalities were related to assaults and violent acts, 16 of which were homicides and 13 were suicides or resulted from self-inflicted injuries. Twelve fatalities were associated with exposure to harmful substances or environments. Four fatalities were due to oxygen deficiency, while another eight related to exposures to caustic, noxious, or allergic substances half of which resulted from needlesticks.

Days Away from Work

Days away from work is a measure of severity of an occupational injury or illness; the more days away from work, the more severe the injury. As shown in Figure 2, nursing and residential care facilities consistently had higher rates of days away from work than the average for the whole health care and social assistance sector. The sector has an average of 32 cases of more than 30 days away from work because of an occupational injury or illness whereas the nursing and residential care facilities subsector experienced 51.7 cases of more than 30 days away from work. The hospitals subsector also was consistently higher than the sector average but by a smaller margin and experienced 37.4 cases of more than 30 days away from work.

Occupational back pain symptoms (without a medical diagnosis) involving days away from work for the health care and social assistance sector and all workers were, respectively, 0.65 and 0.43 injuries per 1,000 full-time workers in 2003. The incidence rate in the nursing and residential care facilities (NAICS 623) was more than 2-fold greater than the health care and social assistance sector average. Of occupational musculoskeletal system and connective tissue disease and disorders cases involving days away from work, 43% were diagnosed as tendonitis.
For occupational carpal tunnel syndrome cases involving days away from work, the home health care services (NAICS 6216) industry group had the highest incidence rate.



Conditions

Nature of Injury

The nature of injury for the health care and social assistance sector is shown in Table 2. Sprains and strains were the most frequent nonfatal injury type involving days away from work with an incidence rate within this sector. Nursing and residential care facilities had the highest injury rate for all types of nature of injury within the sector and higher than these rates for all occupations save cuts, lacerations, puncture. The injury rate for sprains and strains was nearly double the sector average, and, bruises and contusions, and soreness and pain injuries were more than double the sector average. More than half of the soreness and pain injuries were related to back pain and of the multiple injuries involved strains. These workers also had above average rates of Carpal tunnel syndrome.

Hospital workers had above average injuries related to sprains and strains, fractures, bruises and contusions, multiple injuries, and soreness and pain. More than half of the multiple injuries involved strains, and these workers had above average rates of tendonitis. Social assistance workers had above average rates of multiple injuries and cuts, lacerations, punctures. Regarding the multiple injuries, 47% involved strains and 20% involved fractures.

Source of Injury or Illness

All four subsectors had higher than average injuries related to health care patients as compared to the national average for all occupations as shown in Table 3. Workers in nursing and residential care facilities had the highest rate of these injuries followed by hospital workers, ambulatory health care services workers, and social assistance workers.

Workers in nursing and residential care facilities had the highest rate of injuries associated with chemicals, furniture and fixtures, worker motion or position, and floor and ground surfaces. They also had above average injury rates associated with containers, vehicles, and all other sources.

Table 2. Injury Rates (per 10,000 employees) by Nature of Injury in Order of Total Injury and Illness Rates, 2004

Private Subsector	Sprains, strains	Fractures	Cuts	Bruises	Chemical burns	Multiple injuries	Soreness, pain
Nursing & residential care facilities	**156.1**	**14.3**	**7.3**	**27.4**	**2.6**	**9.8**	**36.8**
Hospitals	**106.0**	**8.9**	4.5	**18.7**	0.7	**5.9**	**15.1**
Sector-wide	*86.6*	*8.5*	*4.5*	*14.8*	*1.0*	*5.8*	*16.1*
Social assistance	55.9	7.8	**6.5**	10.6	0.9	**8.1**	13.1
Ambulatory health care services	41.2	4.9	2.0	5.8	0.4	2.4	7.7
All Occupations	59.0	10.6	12.8	12.9	0.8	5.7	11.7

Yellow indicates the transportation and warehousing average rate
Red with bold lettering indicates those average rates that exceed the sector-wide average
Orange indicates where rates for all occupations exceed the sector average

Hospital workers had the highest rate of injury associated with containers and all other sources. They also had above average injury rates associated with chemicals, furniture and fixtures, worker motion or position, and floor and ground surfaces. Social assistance workers had the highest injury rate within the sector associated with vehicles. They also had above average injury rates associated with containers, floor and ground surfaces, and all other sources.

Table 3. Injury Rates (per 10,000 employees) by Source of Injury or Illness in Order of Total Injury and Illness Rates, 2004

Subsector, private	Chemicals	Containers	Furniture	Worker motion	Floor	Vehicles	Patient	All other*
Nursing & residential care facilities	**4.3**	**11.9**	**11.0**	**33.3**	**54.3**	**9.6**	**121.7**	**37.8**
Hospitals	**3.7**	**12.4**	**10.6**	**26.2**	**33.0**	6.4	**59.4**	**121.7**
Sector-wide	*2.8*	*8.8*	*7.9*	*21.6*	*32.4*	*8.0*	*50.5*	*24.1*
Social assistance	1.6	**9.0**	5.9	17.2	**34.0**	**10.7**	13.2	**24.8**
Ambulatory health care services	1.7	3.5	4.5	12.3	18.4	7.4	16.2	15.0
All Occupations	2.0	18.1	5.0	20.5	26.3	12.5	6.4	20.4

Yellow indicates the average rate for the sector
Red with bold lettering indicates those rates that exceed the industywide average
Orange indicates where rates for all occupations exceed the sector average
*Excludes machinery, parts and materials, and handtools

Part of Body Affected

Workers in nursing and residential care facilities had the greatest rates of injuries to all parts of the body within the sector and for all occupations as shown in Table 4. The injuries to the head included above average injuries to the eye, and lower extremity-related injuries to the foot and toe were the highest in the sector. In addition, these workers in this subsector had higher than average injuries or illnesses that affect body systems.

Hospital workers had above average rates of injury to all body parts except for multiple injuries. The injuries to the head included above average injuries to the eye, and these workers had higher than average injuries or illnesses that affect body systems. Social assistance workers had above average injuries to the lower extremities and from multiple injuries. The lower extremity-related injuries to the foot and toe were above the average for the sector.

Table 4. Injury Rates (per 10,000 employees) by Part of body affected in Order of Total Injury and Illness Rates, 2004

Subsector, private	Total:	Head	Neck	Trunk	Back	Shoulder	Upper	Lower	Multiple
Nursing & residential care facilities	**294.3**	**17.3**	**5.2**	**135.0**	**94.2**	**22.3**	**43.5**	**50.5**	**38.0**
Hospitals	**186.3**	**8.3**	**4.7**	**86.3**	**61.6**	**14.9**	**29.7**	**32.8**	18.9
Sector-wide	*163.2*	*8.2*	*3.7*	*70.9*	*50.2*	*11.5*	*25.7*	*29.7*	*21.2*
Social assistance	124.2	6.8	2.8	38.2	28.2	4.7	19.9	**30.5**	**24.2**
Ambulatory health care services	81.8	3.3	2.3	32.8	23.2	4.9	14.2	14.5	12.2
All Occupations	141.3	9.1	2.4	50.2	31.7	9.2	32.6	30.2	14.2

Yellow indicates the average rate for the sector
Red with bold lettering indicates those rates that exceed the industywide average
Orange indicates where rates for all occupations exceed the sector average

Event or Exposure

Workers in nursing and residential care facilities had a high rate of overexertion injuries as shown in Table 5 with half of these injuries associated with lifting. This subsector also had the highest rate of injuries that resulted from contact with an object within the sector. These contact injuries were associated with being struck by an object, struck against an object, or caught in an object, equipment, or material, respectively, 47%, 37%, and 13% of the time. These workers also had the highest rates within the sector for injuries associated with falls from the same level, assaults and violence, exposure to harmful substances, and slips and falls.

Hospital workers had the highest rate of injury from repetitive motion as compared to the rest of the sector. They also had above average rates of injury from overexertion, falls at the same level, contact with an object or equipment, exposure to harmful substances, repetitive motion, and slips and trips. Nearly half of the overexertion injuries were associated with lifting, and 49% of the contact with object or equipment injuries was associated with being struck by an object as compared to 34% associated with being struck against an object, and 11% associated with caught in an object, equipment, or material.

Social assistance workers had the highest rate of injuries associated with transportation incidents and falls from another level. They also had a high rate of falls from the same elevation and above

average rates of contact injuries associated with being struck by an object or caught in an object, equipment, or material. Ambulatory health care services had above average rates of injuries associated with transportation incidents.

Table 5. Injury and Illness Rates (per 10,000 employees) by Event or Exposure in Order of Total Injury and Illness Rates, 2004

Subsector, private	Contact with object	Fall, lower level	Fall, same level	Slips, trips	Over-exertion	Repeti-tive motion	Harmful sub-stance	Trans-portation	Violence
Nursing & residential care facilities	**34.9**	**5.5**	**49.5**	**8.6**	**116.1**	**5.2**	**11.3**	4.9	**31.1**
Hospitals	**26.0**	4.2	**29.6**	**5.7**	**75.3**	**6.2**	**9.6**	1.7	9.6
Sector-wide	*21.1*	*4.5*	*28.8*	*5.1*	*59.4*	*4.7*	*7.6*	*4.9*	*11.2*
Social assistance	19.7	**7.5**	**29.8**	4.0	27.3	1.5	5.0	**8.6**	7.9
Ambulatory health care services	9.1	3.1	15.6	3.0	25.0	4.3	4.8	**6.2**	2.3
All Occupations	37.6	9.0	18.7	4.2	35.5	5.5	5.9	7.1	11.2

Yellow indicates the average rate for the sector
Red indicates those rates that exceed the sector-wide average
Orange indicates where rates for all occupations exceed the sector average

Illness Rates

The health care and social assistance sector had higher occupational illness rates than the average for the nation across all categories of illness as shown in Table 6. Within the sector, hospital workers were at highest risk of illnesses from skin, respiratory, and other exposures. The incidence rate of respiratory conditions was 66% higher than the sector average, and the incidence rate of skin disease and disorders was 43% higher than the sector average. Social assistance workers had a three-fold greater average rate of illness from poisonings than all other subsectors.

Table 6. Illness Rates per 10,000 Employees in the Health Care and Social Assistance Sectors in Order of Total Illness Rates, 2003

Private Subsector	Total	Skin	Respiratory	Poisonings	Other
Hospitals	**73.4**	**13.8**	**9.8**	0.5	**49.2**
Nursing & residential care facilities	**48.0**	-	4.1	0.5	26.0
Sector-wide	*44.7*	*9.3*	*5.9*	*0.5*	*28.9*
Ambulatory health care services	25.4	3.0	4.6	0.2	17.6
Social assistance	23.5	3.0	3.1	**1.5**	15.9
All Occupations	30.7	4.9	2.2	0.4	23.2

Yellow indicates the average rate for the sector
Red with bold lettering indicates those rates that exceed the sector-wide average

Occupational infectious and parasitic diseases involving days away from work during 2003 for health care and social assistance sector had a 6.5-fold higher rate than all workers at, respectively, 1.3 and 0.2 illnesses per 10,000 full-time workers. Bacterial, viral, infectious diseases pertaining to the intestines, and other infectious and parasitic diseases accounted for, respectively, 12%, 30%, 26%, and 30% of reported cases.

Occupational mental disorders or syndromes involving days away from work during 2003 for health care and social assistance sector had a 1.6-fold higher rate than all workers at, respectively, 0.8 and 0.5 disorders per 10,000 full-time workers. Of these disabilities, 11% were due to post-traumatic anxiety and 23% were due to a neurotic reaction to stress.

3. What research is needed?

The data shown in section 2 above does not include public employees or self-employed workers, with the exception of the fatality data. The "nursing and residential care facilities" subsector has the greatest rate of injuries for private employees across the health care and social assistance sector, whereas private employees in "hospitals" have the highest rate of illnesses within the sector. The "ambulatory health care services" subsector includes the vehicular and helicopter ambulances, which may be the major contributor to the highest cause of fatalities in this sector. This measure includes public employees. "Social assistance" employees have the highest rate of transportation-related and vehicle-related injuries among private employees, and they also have a three-fold greater potential for poisonings than any other subsector.

Incident Response

An imperative for PPE research is a mandate from the Congress in which it stated, "It has been brought to the Committee's attention the need for design, testing and state-of-the-art equipment for this nation's... miners, firefighters, health care, agricultural and industrial workers... (Also) the Committee encourages NIOSH to carry out research, testing and related activities aimed at protecting workers who respond to public health needs in the event of a terrorist incident. The Committee encourages CDC to organize and implement a national PPE laboratory."

Secondary Chemical Contamination

Emergency department staff caring for patients contaminated with toxic chemicals is at risk for developing toxicity from secondary contamination. Three cases of occupational illnesses associated with organophosphate toxicity caused by exposure to a contaminated patient and underscored the importance of using PPE in acute care hospitals.[6] Health care facilities have historically been underprepared for contaminated patients presenting to their facilities, which has become an important issue for emergency preparedness for terrorist events.[7] Emergency departments are the primary provider of care to contaminated individuals, and during a hazmat accident, the victims often ignore the rules of the disaster plan by seeking out the nearest hospital for medical care, regardless of that institution's capabilities. Health care workers rushing to the aid of contaminated individuals, without taking appropriate precautions (i.e., donning PPE), potentially make themselves victims. Thus, there is a need for consistency between emergency operations at different hospitals to assure protection of health care personnel.[8]

Nosocomial and Drug Resistant Infections

Health care worker protection from nosocomial outbreaks of TB infection includes respiratory protective devices.[9] There is a need for clinical pharmacologists and all health care givers to limit the development of bacterial resistance in humans to contain the increased morbidity and mortality associated with the use of antimicrobials.[10] The cost of health care worker respiratory protection and respirator fit-testing programs outlays for respirators and education and fit-testing programs are justified by the cost of preventing nosocomial or occupational Mycobacterium TB.[11] Health care employees have been infected with hospital-based multidrug-resistant strain of

TB.[12] One-quarter of new TB cases occur in HIV-infected people, and 5.3 million workers treat AIDS patients. Work-related TB infection protection calls for respirator use in many instances.[13] Most TB infections among health care workers are work-related [14]

Health care workers bore a large burden of illness during the 2002 to 2003 severe acute respiratory syndrome (SARS) epidemic.[15] Health care workers were at high risk of acquiring SARS and accounted for a fifth of all cases globally. Risk factors for infection included poor compliance with the use of PPE especially when exposed to unsuspected SARS patients.[16] PPE were evaluated for effectiveness in protecting viral exposure, specifically related to severe acute respiratory syndrome SARS. The PPE did nor confer complete protection but did reduce the risk of exposure and the risk of secondary transmission and a milder infection.[17] Evidence from the SARS outbreaks has indicated that training programs and the availability of adequate PPE were associated with a decreased risk of infection.[18] Proper use of PPE and hand hygiene were critical to reducing transmission of SARS, especially in health care facilities. Surgical masks were shown to be effective in reducing transmission when N-95 respirators were unavailable. [19]

Surveillance

One problem in using Department of Labor data is the absence of statistics on public employees, and many health care and social assistance workers are public employees. Nonetheless, there is a need to identify and prioritize health care and social assistance technologies for PPE research with more detailed investigations. These investigations include disaggregating the high risk areas in the health care and social assistance sector by the various conditions indicated in Tables 2-6 further to gain better detail regarding the population at risk.

The Centers for Disease Control and Prevention (CDC) developed the National Surveillance System for Health Care Workers (NaSH) and collaborates with health care facilities to systematically collect information important to prevent occupational exposures and infections among health care workers. In addition, police investigations are a source of data regarding acts of violence.

PPE interventions can be identified by conducting case studies of investigation reports by OSHA and by NIOSH in their Health Hazard Evaluations (HHE's) and Fatality Assessment and Control Evaluation (FACE) Programs. Regarding ambulance-related injuries, National Transportation Safety Board,[20] Federal Aviation Administration, [21] and National Highway Transportation Safety Administration investigation reports are also resources available for identifying PPE needs. The Department of Defense has the potential for providing important surveillance information on most aspects for protecting workers against hazards for institutional medial care.

OSHA provides a rich source of recorded injuries that could be prevented with the use of PPE or failures in the use of PPE. Many investigations have been conducted at hospitals, which have been cited for lack of proper PPE, e.g., OSHA Inspection No. 125250449.

An example of an HHE is an investigation of the potential for airborne transmission of diseases, especially TB and chickenpox within health department clinics. At the time of the request, no health effects had been reported by employees.[22]

The NIOSH FACE program investigates occupational fatalities, many of which could be prevented by the use of functional PPE. As an example, an emergency medical technician died when the ambulance on which she was working struck a support column for an elevated train track. The victim had been riding unrestrained in the patient compartment while attending to a patient during a non-emergency medical transport.[23]

Needlestick Injuries

A descriptive epidemiological analysis of needlestick injuries in Navy medical personnel found that hospital corpsmen was the most common affected work group (57%), and fingers were the most commonly reported anatomical location (77%) for needle sticks.[24] Needlestick injuries among health care workers are a recognized health hazard, with 400,000 needlesticks occurring annually among the 4 million health care workers in the United States. Nurses are at high risk of needlestick injury from syringes and i.v. equipment relative to the other health care workers. The focus of these studies has been on hospital sites and may not be generalizable to other health care settings such as nursing homes, home health care sites, clinics, and emergency response units.[25]

Hemodialysis health care workers are twice as likely to sustain a high-risk needlestick injury as health care workers in all other settings and are at a high risk of exposure to bloodborne pathogens. The dialysis patient population has a higher incidence of hepatitis C than the general population (8.4% compared to 1.8%) and the incidence of human immunodeficiency virus (HIV) has increased tenfold from 1985 to 2000.[26] In 1999, an estimated 590,000 health care worker needlesticks were reported each year in the United States.[27] In the United States, needlestick injuries potentially associated with infections such as HIV or hepatitis B and C decreased from an estimated one million exposures per year in 1996 to 385,000 per year in 2000. This decline reportedly resulted from compliance with the OSHA Bloodborne Pathogens Standard with decreasing needlestick and sharps injuries, which is partly attributable to the use of gloves and personal protective gear as part of universal precautions.[28]

Acts of Violence

Caregivers have experienced frequent verbal and physical assaults from nursing home residents for many years. [29] Health care workers are particularly vulnerable to workplace violence because of the nature of their jobs dealing with clients, many of whom are emotionally disturbed.[30] High rates of physical assaults among nurses and certified nursing assistants working in long-term psychiatric care facilities were documented in which an overall rate of assaults (67.3 per 100 person-years) associated with contact with combative residents were high. A higher risk of assault was found among women and higher risks of assault were observed among full-time employees compared to per diem or pool agency workers. [31] Nurses in psychiatric facilities experience high risks of assault.[32] OSHA developed advisory guidelines (OSHA 3148) that are the agency's recommendations for reducing workplace violence, specifically in the health care and social assistance work environments.[33] Implementation of the OSHA Vi*olence Prevention Guidelines for Health Care and Social Service Workers and for Late-Night Retail Establishments* is a high priority to unions.[34] Health care workers have faced the risk of job-related violence, and PPE is needed as part of an effective health care violence evaluation and mitigation program.[35]

Ambulance Crashes

Air transport of patients has been associated with disproportionate increases in crashes and deaths especially with postcrash fire.[36] The helicopter air ambulance community has a crash about once a month, and a fifth of these crashes involve weather.[37] Army aeromedical helicopter crash rates are comparable with published civilian mishap rates.[38] Air medical crews continue to be exposed to situations that can bring about severe personal injury or death. Helmets have been shown to decrease morbidity and mortality from head injury, the most common form of injury in a helicopter crash. Flame-retardant clothing may likewise improve the outcome of an in-flight or post-crash fire and should include gloves. Consideration should be given to the appropriate undergarments, and protective footwear can also decrease injuries to air medical crews.[39]

Ground ambulance crashes are one of many hazards faced by EMS personnel, but no complete national count of these crashes exists.[40] Restrained ambulance occupants involved in a crash are significantly less likely to be killed or seriously injured than unrestrained occupants. Ambulance rear occupants are significantly more likely to be killed than front-seat occupants. Ambulance occupants traveling for a non-emergency are more likely to be killed or severely injured than occupants traveling for an emergency. Unrestrained ambulance occupants, occupants riding in the patient compartment, and especially unrestrained occupants riding in the patient compartment are at substantially increased risk of injury and death when involved in a crash. Ambulance crewmembers riding in the back and firefighters in any seating position should be restrained.[41]

Complex Circumstances

Health care has moved from the traditional hospital setting into ambulatory, home, and other noninstitutional settings, thus increasing the complexity of worker protection measures. Research is needed into providing necessary PPE fro protecting these workers from such hazards as multiple-drug resistant TB and the spread of HIV and other blood-borne pathogens.[42] Employees need protection when handling chemicals, in lifting, and when giving medications, but a change requires a focus on safety, not just occupational safety or patient safety.[43] Health care workers are potentially exposed to infectious diseases such as measles, mumps, rubella, varicella, and hepatitis B as well as bloodborne pathogens including HIV, hepatitis B, and hepatitis C. Depending upon their circumstances, they are also exposed to lasers, radiation, formaldehyde, ethylene oxide, hazardous drugs, anesthetic gases, and TB.[44] The nursing workforce is aging at an unprecedented rate. In one study, almost a quarter of older registered nurses experienced a job-related injury within the past 5 years, and more than a third experienced job-related health problems. Nurses with higher job demands and those employed in hospital settings were more likely to have an injury.[45]

Musculoskeletal Disorders

Work-related injuries are becoming increasingly prevalent in hospital settings impacting professionals including nurses, physicians, and household cleaning employees and are at-risk for musculoskeletal injuries.[46] Back injuries among nurses force them to leave the bedside and are due to patient transfers, which present clear risk for both the patient and the nurse.[47] Costs of occupational injury and illness in the health services industry are high and varied across occupation and disease. The most costly injured body parts are back, shoulder, knee, wrist, and neck.[48] Back strain is common among health care workers.[49] High rates of acute injuries associated with resident lifting among nurses and certified nursing assistants working in long-

term psychiatric care facilities were documented in which an overall rate of injuries (55.6 per 100 person years) was high. In addition, weekend shifts were found to have a higher rate of injuries.[50] Nursing aides and orderlies ranked second of all occupations in the number of occupational injuries and illness involving lost days at work. The majority of these injuries were associated with moving, lifting, or assisting patients and residents in health care settings and inpatient rehabilitation facilities.[51]

Changes in the health care and social assistance sector show an increasing prevalence of overweight, Asian, and Hispanic, workers. This diverse workforce needs to be represented in PPE research. The Civilian Anthropometric and European Surface Anthropometric Resource (CAESAR) has profiled of 2,400 people. However, research in Peru collected data for 30 nurses and compared it to these cells and found that no anthropometric data point matched any of the CAESAR data. [52]

Radiation-Induced Cancer

Workers, especially surgeons, subject to routine radiation dosimetric assessment in hospitals have an increased cancer risk because of potential radiation exposure.[53] There is a wide range of radiation hazards related to medical imaging (x-rays, nuclear scans utilizing radioactive isotopes) and radiation oncology, which utilizes ionizing radiation from a variety of sources to treat a range of malignant tumors. These sources include radioactive material such as isotopes of radium, cobalt and strontium, and linear accelerators emitting short wave length gamma waves. [54]

PPE Technology Assessments

A need exists to identify research gaps while iteratively analyzing technologies so that critical PPE needs with a standards perspective can be filled via research agendas for existing as well as specific new technologies. OSHA has not established specific standards for personal protective clothing resistance against biological agents.

OSHA's Bloodborne Pathogen Standard requires appropriate PPE to be used to prevent blood or other potentially infectious materials from passing through to, or contacting the employees' work or street clothes, undergarments, skin, eyes, mouth, or other mucous membranes, unless engineering controls and work practices have eliminated occupational exposure. For example, laboratory coats or gowns with long sleeves shall be used for procedures in which exposure of the forearm to blood or other potentially infectious materials is reasonably anticipated to occur. A gown which is frequently ripped or falls apart under normal use would not be considered "appropriate PPE".

PPE in health settings depend upon traditional approached, but in patient care, special PPE is needed to protect against body fluids and infectious agents spread tactily, via splashes, or through the air. Gowns have been used to minimize the risk of disease acquisition by health care providers in health care facilities, and drapes have been used during invasive procedures to maintain the sterility of environmental surfaces, equipment, and patients. Scientific studies have produced mixed results of their efficacy.[55] A study evaluated six gown types used in hospitals (one disposable cover or isolation gown, three disposable operating room gowns, and new and

washed reusable operating room gowns) to protect against bacteria contaminated blood strike-through. Different types of gowns varied in efficacy.[56] PPE used by the nursing staff in colonoscopy clinics included goggles, splash-proof gown, face mask, shoe covers, and latex gloves and compliance in their use varied greatly.[57] Findings in dental settings emphasized the need for further educational campaigns in practical infection control measures based upon universal precautions. Proper use of eyewear and masks was in better compliance with PPE guidelines than was compliance for glove handling and hand care.[58] A strong correlation was found between the availability of PPE and infection control (IC) practices. Those employees who perceived a high level of management support for safety were more than twice as likely to adhere to recommended IC practices. IC practices were significantly more likely to be followed if PPE was always readily available.[59]

Burns due to steam sterilizing are a potential hazard, and lasers used in operating theaters require PPE to prevent retinal burns to the eyes. [60]

4. Who are our partners?

PPE Manufacturing Industry

The International Safety Equipment Association represents the safety equipment manufacturing industry and promotes and the increased use and awareness of PPE. Members of the association include companies that design, manufacture and supply safety equipment that is used in hazardous work environments. It also drafts national and international safety equipment performance standards, provides a forum for discussing industry issues such as non-proprietary technologies and e-commerce, and represents the industry's interests before governmental agencies. The Best's Safety & Security Directory also provides a large compilation of PPE manufacturing and distribution companies,[61] which is a source for potential collaboration in specialty areas.

The Emergency Care Research Institute is a nonprofit organization with a mission to promote the highest standards of safety, quality, and cost-effectiveness in health care to benefit patient care through research, publishing, education and consulting. The industry that manufactures health care apparel and PPE is an important economic sector that needs to be organized. Many of these products are imported from countries such as China and Pakistan. Other associations representing the PPE manufacturing and distribution industry that supports the health care and social assistance sector include the American Apparel and Footwear Association, the Association for Healthcare Resource Materials Management, the Advanced Medical Technology Association, and the Health Industry Distributors Association.

Professional and Standard-setting Organizations

Professional organizations also provide viable partners in PPE research. These include the, American Conference of Governmental Industrial Hygienists, American Industrial Hygiene Association, and American Society of Safety Engineers. Standard-setting organizations include the American National Standards Institute, American Society of Testing Materials, European Committee for Standardization, International Organization for Standardization, Association for Professionals in Infection Control and Epidemiology, Inc., National Fire Protection Association,

and Standards Council of Canada. Several PPE standards that apply to health care and social assessment sector workers are listed in Appendix 2.

Health Care and Social Assistance Trade Organizations and Unions

Many unions or associations represent workers in the health care and social assessment sector, as can be seen in Table 6. Opportunities exist in working with the unions in training their members and apprentices through their training programs.

Several trade organizations are potential partners for occupational safety and health in the health care and social assessment sector. These organizations include the American Health Quality Association, American Hospital Association, American Health Care Association, Institute for the Future of Aging Services, International Association of Homes and Services for the Ageing, Center for Aging Services Technologies, American Association of Homes and Services for the Aging, National Association of Community Health Centers, and National Association of Rural Health Clinics.

Table 6. List of Unions and Associations that Represent Health Care and Social Assistance Workers

Service Employees International Union
Drug, Hospital, and Health Care Employees Union
American Federation of Teachers Health care
United Food and Commercial Workers International Union
United Nurses Association
California Nurses Association
National Nurses Organizing Committee
American Nurses Association
American Medical Association
National Medical Association
Society for Social Work Leadership in Health Care
United American Nurses
American Federation of State, County and Municipal Employees
American Federation of Government Employees
National Association of Social Workers
Latino Social Workers Organization
Association of Oncology Social Work
National Association of Black Social Workers
Association of Pediatric Oncology Social Workers
Association of Occupational Health Professionals in Health care
Visiting Nurse Associations of America

Governmental Agencies

OSHA has been and will continue to be a principle partner in protecting health care and social assistance workers from occupational hazards. The Health Resources and Services Administration and the Agency for Health care Research and Quality within the DHHS are potential partners in applying PPE in migrant health care. [62] In addition, the health care provided by the Department of Defense and Department of Veteran's Affairs also offer opportunities for partnerships regarding protecting their workers from occupational hazards. The U.S. Department of Justice's National Institute of Justice is a potential partner regarding the protection against violent acts at the workplace.

CDC provides guidelines for certain PPE regarding clinical exposures, e.g., masks, protective eyewear, protective apparel, gloves. The Food and Drug Administration (FDA) regulates the manufacture and sale of PPE used in health care settings. Surgical masks, surgical N-95 respirators, medical gloves, and surgical gowns are all medical devices. FDA ensures that manufacturers use reliable methods for manufacturing and packaging the products and evaluates

the manufacturer's new product applications. Once FDA has cleared the products, it maintains databases of those products and their manufacturers.

5. How can we make a difference?

Emergency Preparedness

The attacks of September 11, 2001 have demonstrated the need for improved PPE ensembles, guidelines, and effective delivery systems of equipment. There is also a need for quick access to expert information regarding complex emergencies.[63] A broad range of exposures are possible including chemical, physical, and biological hazards, which can challenge the workers as first responders before hazards have been identified. Communications are an important adjunct to the PPE ensemble as well.

First Decade NORA Priorities

An original NORA priority addressed PPE. That priority addressed chemical protective clothing, noise, respirators, and eye safety. NIOSH's Protective Clothing Program is aimed at protecting the skin from various health hazards that may be encountered in the workplace or during a terrorist attack. The program has evolved over the years to incorporate a broad range of studies of how chemicals seep through barrier materials, leak through small holes, or change the barrier material to reduce its protection. Latex gloves have proved effective in preventing the transmission of many infectious diseases to health care workers. But for some workers, exposures to latex may result in allergic reactions. Reports of such reactions have increased in recent years—especially among health care workers. Thus, the unintended consequences of PPE need to be considered.

Respirators protect the user in two basic ways. The first is by the removal of contaminants from the air. Respirators of this type include particulate respirators, which filter out airborne particles; and "gas masks" which filter out chemicals and gases. Other respirators protect by supplying clean respirable air from another source. Respirators that fall into this category include airline respirators, which use compressed air from a remote source; and self-contained breathing apparatus, which include their own air supply

Personal protective eyewear, such as goggles, face shields, safety glasses, or full face respirators must also be used when an eye hazard exists. The eye protection chosen for specific work situations depends upon the nature and extent of the hazard, the circumstances of exposure, other protective equipment used, and personal vision needs. Eye protection should be fit to an individual or adjustable to provide appropriate coverage. It should be comfortable and allow for sufficient peripheral vision. Selection of protective eyewear appropriate for a given task should be made based on a hazard assessment of each activity, including regulatory requirements when applicable.

Regarding musculoskeletal disorders, NIOSH has concluded that there was insufficient evidence to recommend the use of back belts as a back injury prevention measure.[64, 65] Recently completed research found that belt use reduced spine bending in laboratory trials.[66] However, elastic support back belt use among retail material-handlers was not associated with reduced back injuries or back pain.

Forums

A variety of PPE needs exist across the health care and social assistance sector, and a variety of private and public organizations has a stake in the protection that PPE presents. A series of workshops or conferences around specific concerns would help guide the research agenda for PPE. Topics include those identified previously in section 3 regarding incident responses, surveillance, a variety of complex circumstances, and PPE technology assessments. The PPE manufacturing industry is an important partner in these forums.

Training

Training to respond to emergencies requires planning and evaluation. PPE is critical is part of this response. Common emergencies include fires, medical emergencies, HazMat releases, special rescues (e.g., confined space), workplace violence, bomb threats, external emergencies, weather, and power failure.[67] Safety signs have been found to be ineffective in encouraging the donning of PPE.[68] An example of a need is to understand the differences between primary and secondary clothing. Primary clothing is used when the exposure is significant, e.g., radiant heat and flame. Secondary protective clothing is designed for continuous wear.[69] Training is critical for the protection of medical response personnel in the event of fires, medical emergencies, terrorist acts, and numerous other emergencies that include hazards that responders face and the personal protective technology needed to contend with those hazards.[70]

Research Plan

In addition to the above assessment, an important aspect of this *Research Plan* is to provide a framework for future U.S. Government planning efforts that is consistent with *The National Security Strategy* and the *National Strategy for Homeland Security*. It recognizes that preparing for and responding to emergencies cannot be viewed as a purely federal responsibility, and that the nation must have a system of plans at all levels of government and in all sectors outside of government that can be integrated to address the threat of emergencies whether small or catastrophic. It is guided by the following principles:

• Engineering control or inherently safer systems should be used to negate the need for PPE. PPE should only be used as a "last line of defense" when engineering control systems or hazard elimination are not feasible.
• Employers should have credible preparedness plans to respond to PPE needs within their workplaces. Individual workers should be prepared for the use of PPE and be trained in the use of PPE for their particular working conditions.
• The private sector should play an integral role in PPE research and development and should be part of the national deployment of PPE technologies.
• Partnerships will be leveraged to address the threat of uncontrolled hazards, especially the threat of terrorist attacks.
• Three criteria are important in assessing the need for PPE research:
  ► Frequency of the occupational safety and health problem.
  ► Severity of the occupational safety and health problem.
  ► The preventability of the problem with PPE.

Four pillars of the *Research Plan* are described below:

Pillar 1. Surveillance

Occupational health surveillance can be viewed as the tracking of occupational injuries, illnesses, hazards, and exposures. Occupational surveillance data are used to guide efforts to improve worker safety and health, and to monitor trends and progress over time. This effort will analyze and interpret existing data, undertakes data collection efforts to fill gaps in surveillance data, provides support to state agencies to conduct occupational surveillance and associated prevention efforts, and works with Federal, State, and private sector partners to improve occupational health surveillance.

Goal: To set priorities for further surveillance and research.

Priorities under this goal include:

■ ***Investigate high risk subsectors and populations for injuries and illnesses that can be prevented with PPE.***

■ ***This surveillance effort involves the review and monitoring of HHEs, FACE, and OSHA inspection reports regarding health care and social assistance to identify severe injuries and illnesses that PPE could prevent and PPE failures to protect workers.***

■ ***The emergence of new technologies need to be evaluated for both potential hazards as well as use in PPE.***

Pillar 2. Standardization and Certification

NIOSH is developing appropriate standards and test procedures for PPE used to protect workers in hazardous environments that includes the validation of performance-based PPE specifications including shelf life. Concepts, standards (when fully developed), and other documents will be posted when they become available. This development work involves international collaboration in PPE standards as well as with partners from government and industry.

Goal: To establish voluntary standards or 42 CFR certification programs for PPE.

Goal: To facilitate voluntary standards for PPE to protect workers in circumstances that engineering controls have been ineffective or that pose hazards from new types of emergencies.

Priorities under this goal include:

■ Literature search and data gathering, laboratory and field studies, development of performance based PPE based specifications, and validation of performance based specification and standards.

■ Product development and evaluation including materials evaluations, filter/cartridge evaluations, garment and respiratory protection design evaluations, and laboratory and field study evaluations.

Pillar 3. Product Development and Evaluation

PPE such as respirators and protective clothing can be used to isolate workers from the hazard. PPE must not only be effective, but also practical for use in the workplace. In addition to field

surveys of chemical or biologic protective clothing performance, studies need to examine ways to detect when chemicals or biological contaminants intrusion into the clothing, and how to effectively remove chemicals or sterilize biological agents from protective clothing after it has been contaminated. PPE research includes literature searches and data gathering, laboratory and field studies, and materials, shelf-life and design evaluations.

Goal: To incorporate advanced protective technologies into fully-integrated, intelligent, and reliable ensembles.

Goal: To collaborate with partners in the development of PPE to protect workers from high risk, frequency and/or severity hazards.

Priorities under this goal include:

■ ***Continuation of ongoing research, e.g., respirators, protective clothing, eye protection.***

■ ***Investigation and evaluation of PPE emerging into the marketplace, e.g., splash resistant garments, extra-skeletal braces, personal detection monitors.***

■ ***Investigation of test methods for PPE effectiveness for different anthropomorphic characteristics.***

Pillar 4. Education, Training, and Feedback

The purpose of training and training-related research is to understand and act on the multiple factors influencing occupational education and training effectiveness. NIOSH evaluates the impact of training programs and their components by investigating theoretical models gleaned from health promotion, psychology, learning and educational perspectives, the role of attitudes, beliefs, behavioral intentions, and other characteristics of the individual that affect learning and transfer of learning into action, barriers affecting adoption of health and safety behaviors promoted by training, and environmental influences on occupational safety and health training.

Goal: To improve and implement PPE training programs, guidelines, and products for optimum use and acceptance by workers.

Appendix 1: Health Care and Social Assistance Subsector Descriptions

62 Health Care and Social Assistance

The Health Care and Social Assistance sector establishments provides services for individuals that includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided in this sector are delivered by trained professionals. All industries in the sector share the process of labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by their practitioners.

621 Ambulatory Health Care Services

Industries in the Ambulatory Health Care Services subsector provide health care services directly or indirectly to ambulatory patients and do not usually provide inpatient services. Health practitioners in this subsector provide outpatient services, with the facilities and equipment not usually being the most significant part of the production process.

622 Hospitals

Industries in the Hospitals subsector provide medical, diagnostic, and treatment services that include physician, nursing, and other health services to inpatients and the specialized accommodation services required by inpatients. Hospitals may also provide outpatient services as a secondary activity. Establishments in the Hospitals subsector provide inpatient health services, many of which can only be provided using the specialized facilities and equipment that form a significant and integral part of the production process.

623 Nursing and Residential Care Facilities

Industries in the Nursing and Residential Care Facilities subsector provide residential care combined with either nursing, supervisory, or other types of care as required by the residents. In this subsector, the facilities are a significant part of the production process and the care provided is a mix of health and social services with the health services being largely some level of nursing services.

624 Social Assistance

Industries in the Social Assistance subsector provide a wide variety of social assistance services directly to their clients. These services do not include residential or accommodation services, except on a short stay basis.

Appendix 2: Applicable standards and standards setting organizations

U.S. Department of Human Services
Pandemic Influenza Planning,
Supplement 4 Infection Control

1. Personal protective equipment
    a. PPE for standard and droplet precautions
        Masks (surgical or procedure)
        Gloves
        Gowns
        Goggles or face shield
    b. PPE for special circumstances
        PPE for aerosol-generating procedures
        PPE for managing pandemic influenza with increased transmissibility
        Precautions for early stages of a pandemic
    c. Caring for patients with pandemic influenza

NIOSH
42 CFR Part 84 – Approval of respiratory protective devices

FDA
21 CFR Part 801 – Labeling
21 CFR Part 803 – Medical Device Reporting
21 CFR Part 807 – Establishment Registration and Medical Device Listing
21 CFR Part 812 – Investigational Device Exemption
21 CFR Part 814 – Premarket Approval
21 CFR Part 820 – Quality System Regulation/Good Manufacturing Practices

U.S. Department of Labor (DOL)
Occupational Safety and Health Administration
29 CFR 1910 – Occupational Safety and Health Standards
1926.65 App. B, Part IV – General Description and Discussion of the Levels of Protection and Protective Gear
1910.95 – Hearing Protection
1910.120 – HAZWOPER
Subpart I – Personal Protective Equipment
1910.132 – General requirements
1910.133 – Eye and face protection
1910.134 – Respiratory protection
1910.135 – Head protection
1919.137 – Electrical protective devices
1910.136 – Foot protection
1910.138 – Hand protection
1910.1030 – Bloodborne Pathogens Standard
1910.1032 – Training
1910.146 App F – Rescue Team or Rescue Service Evaluation Criteria
1910.1450 – Occupational exposure to hazardous chemicals in laboratories

U.S. Department of Homeland Security

NIOSH Chemical, Biological, Radiological and Nuclear (CBRN) Standard for Open-Circuit Self-Contained Breathing Apparatus (SCBA)
NIOSH Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Full Facepiece Air Purifying Respirator
NIOSH Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Air-Purifying Escape Respirator and CBRN Self-Contained Escape Respirator
NFPA 1951: Standard on Protective Ensemble for USAR Operations, 2001 Edition
NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, 2002 edition
NFPA 1991: Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies, 2000 Edition
NFPA 1994: Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents, 2001 Edition
NFPA 1999: Standard on Protective Clothing for Emergency Medical Operations, 2003 Edition

American National Standards Institute

ANSI Z88.7-2001, Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters
ANSI Z88.10-2001, Respirator Fit Testing Methods
ANSI Z 88.2-1969, Standard Practice for Respirator Protection
ANSI Z41.1-1991, Protective Footwear
ANSI S12.6-1997, Methods for Measuring the Real-Ear Attenuation of Hearing Protectors
ANSI Z87.1-2003, Standard for Occupational and Educational Eye and Face Protection Devices
ANSI Z359.1-1992, Safety Requirements for Personal Fall Arrest Systems, Sub-Systems and Components
ANSI Z89.1, Safety Requirements for Industrial Head Protection
ANSI Z89.2, Safety Requirements for Industrial Protective Helmets for Electrical Workers
ANSI J6.6-1971, Rubber Insulating Gloves
ANSI/ASSE Z359.1 Safety Requirements for Personal Fall Arrest Systems

American Society for Testing Materials

ASTM F23 Protective Clothing

International Organization for Standardization

ISO 13.280 Radiation protection including protection against radio-frequency radiation
ISO 13.340.01 Protective equipment in general
ISO 13.340.10 Protective clothing, including flameproof clothing
ISO 13.340.20 Head protective equipment, including helmets, eye-protectors, hearing protectors, ear muffs, teeth protectors and hoods.
ISO 13.340.30 Respiratory protective devices
ISO 13.340.60 Protection against falling and slipping, including safety ropes, harnesses and fall arrestors
ISO 4007:1977 Personal eye-protectors, Vocabulary
ISO 4849:1981 Personal eye-protectors, Specifications
ISO 4851:1979 Personal eye-protectors, Ultra-violet filters, Utilization and transmittance requirements
ISO 4852:1978 Personal eye-protectors, Infra-red filters, Utilization and transmittance requirements
ISO 4854:1981 Personal eye-protectors, Optical test methods

ISO 4855:1981 Personal eye-protectors, Non-optical test methods
ISO 4856:1982 Personal eye-protectors, Synoptic tables of requirements for oculars and eye-protectors
ISO 4869-1:1990 Acoustics, Hearing protectors, Part 1: Subjective method for the measurement of sound attenuation
ISO 4869-2:1994 Acoustics, Hearing protectors, Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn
ISO/TR 4869-3:1989 Acoustics, Hearing protectors, Part 3: Simplified method for the measurement of insertion loss of ear-muff type protectors for quality inspection purposes
ISO/TR 4869-4:1998 Acoustics, Hearing protectors, Part 4: Measurement of effective sound pressure levels for level-dependent sound-restoration ear-muffs
ISO 6161:1981Personal eye-protectors, Filters and eye-protectors against laser radiation
ISO 8194:1987Radiation protection, Clothing for protection against radioactive contamination, Design, selection, testing and use
ISO/CD 2801 Clothing for protection against heat and flame -- General recommendations for selection, care and use of protective clothing
ISO/FDIS 11612 Protective clothing -- Clothing to protect against heat and flame
ISO/DIS 16602.3 Protective clothing for protection against chemicals -- Classification, labeling and performance requirements
ISO/CD 17491-1 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 1: Determination of resistance to outward leakage of gases (internal pressure test)
ISO/CD 17491-2 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 2: Determination of resistance to inward leakage of aerosols and gases (inward leakage test)
ISO/AWI 17491-3 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 3: Determination of resistance to penetration by a jet of liquid (jet test)
ISO/AWI 17491-4 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 4: Determination of resistance to penetration by a spray of liquid (spray test)
ISO/AWI TR 26061 Guidelines on the selection, use, care and maintenance of protective clothing
ISO-7250:1996 Basic human body measurements for technological design
Joint Commission on Accreditation of Healthcare Organizations
Standard EC 1.4
American Conference of Governmental Industrial Hygienists
Guidelines for Selection of Chemical Protective Clothing, 1987
National Fire Protection Association
NFPA 1999 EMS Standards

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[3] http://www.osha.gov/SLTC/nursinghome/index.html

[4] Fatality data are from BLS Census of Fatal Occupational Injuries (CFOI) special research file. Data exclude information for New York City and are preliminary. Employment data are from BLS Current Population Survey monthly microdata files. Fatality totals include all workers regardless of age. Workers under the age of 16 and active duty military were not included in the rate calculations to maintain consistency with the employment data. Rates were calculated by NIOSH and may differ from previously published BLS CFOI rates.

[5] Fatality data are from the BLS Occupational and Safety and Health (OSH)/Census of Fatal Occupational Injuries (CFOI) 2003 Profiles and Charts. Employment data for 2003 are based on estimates derived from BLS Current Population Survey (CPS) monthly microdata files.

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