The study findings were equivocal. Evaluation of the effectiveness of a comprehensive violence prevention program modeled after the OSHA healthcare and social service guidelines is currently under way in New York State.

Other Issues

Among industries at high risk of workplace violence, most rely on security personnel and some form of violence awareness training, often in the form of a "canned" video presentation. The need for both supervisor and worker violence prevention training is underrecognized. The range and quality of existing training materials has yet to be evaluated. OSHA recently developed training materials that could be a valuable resource for many industries. Evaluation of the content and delivery of such programs is needed if training is to be widespread and impact safety. Intervention studies of violence prevention efforts, in addition to training, are sorely needed.

Further Reading

Lipscomb J, Silverstein B, Slavin TJ, et al.: Perspectives on legal strategies to prevent workplace violence. *J Law Med Ethics* 30:166-72, 2002.

Duhart D: *Violence in the Workplace*, 1993-1999, U.S. Department of Justice, Office of Justice Programs, 2001.

U. S. Department of Labor, OSHA: Guidelines for preventing workplace violence for healthcare and social service workers. Washington, D.C., U. S. Department of Labor, Occupational Safety and Health Administration, 1996

Loomis D, Marshall S, Wolf S, Runyan C, Butts J. Effectiveness of safety measures recommended for prevention of workplace homicide. *JAMA*. 2002;287(8):1011-1017.

Runyan CW, Zakocs RC, Zwerling C: Administrative and behavioral interventions for workplace violence prevention. *Am J Prev Med* 18:116-27, 2000

Human Immunodeficiency Virus (HIV) Infection/Acquired Immunodeficiency Syndrome (AIDS)

ICD-10 B20-B24

Janice Huy and Bill Eschenbacher

The human immunodeficiency virus (HIV) is a lentivirus included within a subgroup of retroviruses. HIV can cause human infection of varying severity, with the most advanced form of infection referred to as acquired immunodeficiency syndrome (AIDS). The diagnosis of HIV infection is made

by sequential laboratory tests for detection of HIV antibody; a positive result on an enzyme immunoassay followed by a confirmatory test such as a Western blot or immunofluorescent antibody titer. The CDC recommends HIV testing be expanded to identify more individuals in earlier stages of infection, at which time behavioral changes could be made that would limit the transmission. A newer and more rapid screening test for HIV has been approved by the FDA and could be used in expanded testing programs.

The surveillance case definition for AIDS used by the CDC is as follows: Positive evidence for HIV infection and one of the following: (1) CD4+ T-lymphocyte count of <200 cells/L; or (2) one of the identified clinical conditions listed as part of the AIDS surveillance case definition, which include infections such as extrapulmonary coccidioidomycosis or cryptococcosis, tuberculosis, *Pneumocystis carinii* pneumonia, and histoplasmosis, as well as some noninfectious conditions, such as Kaposi's sarcoma, some forms of lymphoma, and invasive cervical cancer.

Because of its potential for transmission through a workplace exposure, HIV infection is considered, in part, an occupational illness. This entry focuses on HIV infections that occur in the workplace and the prevention of these infections.

Occurrence

As of the end of 2001, there were approximately 360,000 reported prevalent cases of AIDS in the United States, and another 160,000 reported prevalent cases of HIV infection. The actual prevalence of HIV infection would be much higher if expanded testing was performed. Through 2001, there were 462,653 people in the United States who had died from AIDS. According to the WHO, more than 40 million people have HIV infection worldwide, and more than 20 million people have died from AIDS.

Worker populations in the United States who are at increased risk for HIV infection and AIDS include health care workers, emergency response workers, public safety workers, and community workers.

At the end of 2001, there were approximately 24 000 healthcare workers in the United States who had AIDS, representing 5.1% of all AIDS cases in the nation. However, only a small fraction of these workers became infected as a result of workplace exposures. As of December 2001, there were only 57 health care workers with documented HIV seroconversion as a result of occupational exposures and only an additional 138 people with possible HIV infection from occupational exposure.

Community workers who use needles or sharp instruments (tattoo artists, body piercers, and acupuncturists) or who may encounter these devices at work (waste haulers and handlers as well as housekeepers) may be at increased risk of HIV infection through workplace exposures. The prevalence and cumulative incidence of HIV infection among these workers as a result of occupational exposure are unknown.

Causes

Transmission of HIV occurs as a result of contact with infected blood, and can occur through any of three routes: (1) parenteral exposure to infected blood or blood products, such as by intravenous injection using a needle contaminated with HIV; (2) heterosexual or homosexual contact with an HIV-infected person; or (3) perinatally, from an HIV-infected mother to her infant. Although HIV has been isolated from a number of body fluids, only blood, semen, vaginal secretions, and breast milk have been implicated in its transmission. There is no evidence of its transmission through food, insects, or casual contact. It is presumed that HIV-infected people are able to transmit the virus at any time after infection has begun. Transmission risk is increased as the viral load of the HIV-infected person increases.

Occupational risk of infection results from worker exposure to infected blood or blood products, or to body fluids or tissue contaminated with infected blood. This exposure can occur via percutaneous injury, splashes to mucous membranes, and exposure of non-intact skin. In the occupational setting, the vast majority of infection cases are due to percutaneous injuries, through puncture with a needle or other sharp instrument or by a cut injury. In a retrospective case-control study, the risk of HIV transmission to an exposed health care worker appeared to be increased with a deep percutaneous injury, an injury involving a device that had been in an artery or vein, and a hollowed bore needle. Terminal illness of the source patient was also associated with a higher risk of transmission, possibly reflecting a higher viral load. The estimated average risk of HIV infection after a needlestick or cut exposure to HIV-infected blood is about 1 in 300. In addition to percutaneous injuries, there have been documented cases of HIV infection resulting from mucous membrane and/or skin exposure.

Regarding the risk of an HIV-infected health care worker possibly infecting patients, there has been only one identified incident, in which an HIV-infected dentist transmitted the infection to six patients. Other investigations, involving over 22,000 patients of 63 HIV-infected physicians and dentists, have identified no other cases of transmission from healthcare workers to patients. Recommended guidelines for the management of healthcare workers infected with HIV, including any work restrictions, have been published by the Society for Healthcare Epidemiology of America.

Pathophysiology

Like all viruses, HIV can only reproduce inside cells. Using an enzyme called reverse transcriptase, the virus converts viral RNA into DNA, and then incorporates that DNA into the host cell's genome. Once HIV enters the body, it infects a large number of CD4+ cells and replicates rapidly. During this initial or acute phase, the blood contains a great many viral particles, the greatest viral load during the course of infection for that individual. The virus then spreads throughout the body, involving many tissues, including lymphoid tissues or

organs. These lymphoid structures include the lymph nodes and spleen.

Within 4 weeks after exposure to the virus, as many as 70% of HIV-infected individuals will experience flu-like symptoms. The patient's immune response to the initial infection is through CD8+ cells and B-cell antibodies. As a result, the viral load is reduced. However, because of many mutations, some of the virus escapes the body's response to the infection. At the same time, the cells involved in controlling the infection (so-called killer T cells) may become depleted or dysfunctional. As a result, the virus will hide within certain cells and serve as a reservoir for future worsening of the infection.

The median time between initial HIV infection, to worsening of the infection ultimately to AIDS, can take 10-12 years in the absence of anti-retroviral therapy. But there is wide variation in the progression of the disease in any one individual. Approximately 10% of infected patients will progress to AIDS within the first 3 years, while up to 5% of individuals will have stable CD4+ counts and have no symptoms, even after being infected for 12 years or longer. Factors such as age, genetic differences, level of virus virulence, and co-infection with other infectious agents will influence the rate and severity of disease progression.

The major immune effect of HIV infection is the disabling and destruction of CD4+ T cells or helper lymphocytes. These cells are involved in the body's protection against other infectious agents, and their loss results in increased susceptibility for the HIV-infected individual to acquire these other infectious agents, leading to severe life-threatening diseases. A healthy, uninfected person usually has 800 to 1200 CD4+ T cells per microliter of blood. During HIV infection, these numbers will decline. When the count for CD4+ T cells falls to less than 200 cells per liter, the person becomes highly vulnerable to opportunistic infections and certain cancers that are associated with AIDS.

Prevention

Many occupations have the potential for exposure to blood and body fluids that may be contaminated with HIV or other bloodborne pathogens, such as hepatitis B virus (HBV) or hepatitis C virus (HCV). Preventive measures are designed to minimize or eliminate contact with blood and body fluids that are contaminated with the virus.

The OSHA Bloodborne Pathogen (BBP) Standard was promulgated in 1991 to provide worker protection from exposure to blood and other potentially infectious material. In 2000, the Needlestick Safety and Prevention Act was signed into law, mandating specific revisions to the OSHA standard that clarified the need for employers to (a) select safer needle devices as they become available and (b) involve employees in identifying and choosing the devices. The Act also requires employers to maintain a log of injuries from contaminated sharps. Many employers mistakenly believe that the BBP Standard is limited to healthcare settings; however, it applies to all covered

workplaces where occupational exposures to blood and other potentially infectious material may be reasonably anticipated.

A comprehensive prevention program should consider all aspects of the work environment, and should include employee involvement as well as management commitment. Implementing the use of improved engineering controls, such as safer sharps devices, is one component of such a comprehensive program. Other prevention strategies that should be addressed include modification of hazardous work practices (such as no recapping of needles), administrative changes to address needle hazards in the environment (such as prompt removal of filled sharps disposal boxes), use of personal protective equipment (such as gloves and eye protection), and worker education and awareness.

Improving engineering controls is often the most effective approach to reducing occupational exposures. An example of such an engineering control includes sharp devices that have integrated safety features. Ideal characteristics are reliability and ease of activation and use, which make them safe and effective during patient care and which remain active through the disposal process. Elimination of unnecessary needles also effectively reduces occupational exposures.

Strategies to prevent exposure to blood and body fluids by modifying hazardous work practices and using personal protective equipment are covered by universal precautions. In 1987, the CDC published a set of precautions designed to prevent transmission of bloodborne pathogens when providing first aid or health care. Under universal precautions, all blood and certain body fluids are considered potentially infectious for bloodborne pathogens, and certain precautions should be used in situations where there is potential for exposure to blood. The specific provisions of universal precautions include:

1. Workers should use appropriate barrier precautions to prevent skin and mucous membrane exposure. Protective equipment includes gloves, masks and protective eyewear or face shields, and gowns or aprons. Gloves should be changed after contact with each person.
2. Hands and other skin surfaces should be washed immediately (or as soon as safety permits) if contaminated with blood or body fluids. Hands should be washed immediately after gloves are removed.
3. All workers should take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices during procedures, when cleaning used instruments, during disposal of used needles, and when handling sharp instruments after procedures. Needles should not be recapped by hand, purposely bent or broken by hand, removed from disposable syringes, or otherwise manipulated by hand. Sharp items should be placed in puncture-resistant containers for disposal.

4. Mouthpieces, resuscitation bags, or other ventilation devices should be available for use in areas where the need for resuscitation is predictable.
5. Healthcare workers who have exudative lesions or weeping dermatitis should refrain from all direct patient care, and from handling patient-care equipment, until the condition resolves.
6. Pregnant healthcare workers are not known to be at any greater risk of contracting HIV infection than health care workers who are not pregnant; however, if a health care worker develops HIV infection during pregnancy, the infant is at risk of infection resulting from perinatal transmission. Because of this risk, pregnant healthcare workers should be especially familiar with,and should strictly adhere to precautions in order to minimize the risk of HIV transmission.

The CDC has published precautions for dentistry, autopsy or morticians' services, dialysis, and laboratory personnel. The CDC has also addressed environmental considerations, sterilization and disinfection, housekeeping and clean-up issues, laundry, and handling of infective waste. Facilities involved in producing large volumes of HIV or highly concentrated virus are subject to much more stringent biosafety regulations. Individuals working in such facilities should be acutely aware of the attendant guidelines for such activities.

Precautions for community workers are not as clearly defined as for healthcare workers. Lessons learned from health care exposures may provide guidance in the community setting. Interventions may include improving reporting of exposures, implementing more effective engineering and work practice controls, and providing more effective education. Examples of such preventive measures include the following:

1. Acupuncturists, body piercers, and tattoo artists should be aware of, and use, available sharps devices that have engineered safety features, and follow universal precautions and standard infection control procedures.
2. To prevent needlestick injuries among waste haulers and handlers, housekeepers, janitorial service workers, and other service employees, primary consideration should be given to eliminating used syringes and other sharps from the municipal waste stream, and using engineering controls to isolate contaminated material. This may include locating sharps containers in public areas, such as in hotel rooms, restaurants, public restroom facilities, and airplanes.
3. Police and other public safety workers who may encounter used needles while performing searches or restraining suspects may want to consider using puncture-resistant flexible gloves.

Worker education is an important aspect of prevention, and is required under the OSHA BBP Standard. Employees should be educated about the hazards associated with blood and potentially infectious materials, and the protective measures they should take in order to minimize their risk of exposure. Training should be tailored to the type of work being performed by the employees.

Managing exposures to contaminated blood and body fluids requires a concerted effort among the employer, the employee, and the healthcare provider. The employer must be aware of, and follow, applicable laws and regulations, which includes providing access for employees to prompt evaluation and management after sustaining an occupational exposure to blood or other potentially infectious material. Employees should report all exposure incidents to their employer and follow the established protocols for evaluation. Healthcare providers who evaluate exposed workers should be aware of the most recent guidelines published by the CDC that address the management of occupational exposures to HIV, HBV, and HCV. The guidelines apply to both health care and community worker exposures.

Medical management of occupational exposures to blood is complex and rapidly changing, as new medications are approved and drug resistance increases. Recommendations exist for the risk assessment of workers with occupational exposure to blood and other potentially infectious materials. These include determining the likelihood that the exposure will result in an infection, assessing risk factors for the source patient, testing the source patient when possible, and determining whether preventive therapy with anti-retroviral agents should be recommended. Expert consultation is available to medical providers who are managing occupational exposures, through the National HIV/AIDS Clinical Consultation Center. This toll-free telephone consultation service provides up-to-date HIV, HBV, and HCV clinical information and individualized, expert case consultation.

Further Reading

AIDS/TB Committee of the Society for Healthcare Epidemiology of America (SHEA). Management of health care workers infected with hepatitis B virus, hepatitis C virus, human immunodeficiency virus, or other bloodborne pathogens. *Infection Control and Hospital Epidemiology* 1997; 18: 349-363.

Centers for Disease Control and Prevention. 1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. *MMWR* 1992; 41 (No. RR-17).

Centers for Disease Control and Prevention. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. *MMWR* 2001; 50(No. RR-11): 7.

Centers for Disease Control and Prevention. Recommendations for prevention of HIV transmission in healthcare settings. *MMWR* 1987; 36 (Suppl .no. 2S).

Huy JM, Ross CS, Boudreau AY, et al. Occupational blood-borne pathogen exposures among community workers. *Clinical Occupational and Environmental Medicine*

2002; 2: 537-556.
National Institute for Occupational Safety and Health. NIOSH Alert: Preventing Needlestick Injuries in Health Care Settings (DHHS [NIOSH] Publication No. 2000-108). Washington, DC: NIOSH, 1999.
National HIV/AIDS Clinical Consultation Center. [2003]. World Wide Web [URL=http://www.ucsf.edu/hivcntr/]. Date accessed: May 10, 2003.
Occupational Safety and Health Administration. *Occupational Exposure to Bloodborne Pathogens* (29 CFR 1910.1030). 1992.
Occupational Safety and Health Administration. *Occupational Exposures to Bloodborne Pathogens; Needlesticks and Other Sharps Injuries; Final Rule.* (29 Federal Register 1910)

Hyperbaric Injury

ICD-10 T70.9

James L. Weeks

Hyperbaric injuries and diseases result from exposure to increased atmospheric pressure. Such pressure occurs during underwater diving, in pressurized underground or underwater caissons, or therapeutically in clinical hyperbaric chambers. Increased atmospheric pressure is used in caissons, sewers, and other tunnel work to purge ground water from the worksite. Diving exposures may include commercial oil field construction, repair work at sea, underwater salvage, oceanographic investigation, scientific research, and some military operations.

Disorders include barotrauma, inert gas narcosis (commonly referred to as "nitrogen narcosis" or, in the United Kingdom, "the narks") or high-pressure nerve syndrome (during very deep diving), and decompression sickness ("the bends" or caisson worker's disease). Noise-induced hearing loss and hypothermia are also associated with work under increased pressure or underwater.

Barotrauma is traumatic tissue damage resulting either from bodily compression or from decompression. Tissue itself, like water, is relatively incompressible and resistant to injury. Air, however, is highly compressible. Thus barotrauma occurs along the boundaries of air-containing structures. The external ear canal, middle ear space, lungs, and sinuses as well as potential spaces, such as dental fillings or intestines, may all be adversely affected by changes in pressure, resulting in loss of hearing, pain, and other forms of traumatic injury.

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Cover photographs by Earl Dotter illustrate airborne, ergonomic, safety, and physical hazards at work, all of which are preventable.

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