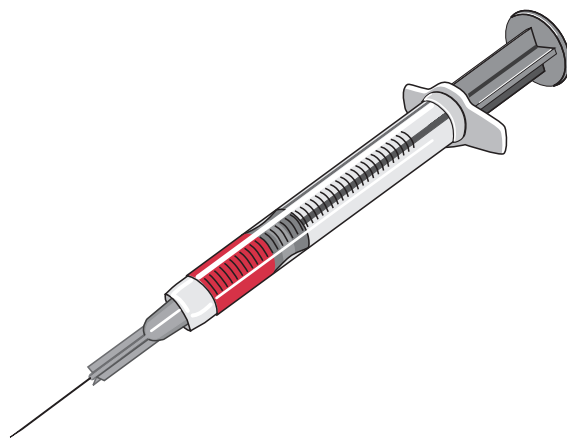




ALERT

Preventing Needlestick Injuries in Health Care Settings



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



ORDERING INFORMATION

To receive documents or more information about occupational safety and health topics, contact the National Institute for Occupational Safety and Health (NIOSH) at

NIOSH—Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998

Telephone: 1-800-35-NIOSH (1-800-356-4674)
Fax: 513-533-8573
E-mail: Pubstaff@cdc.gov

or visit the NIOSH Web site at www.cdc.gov/niosh

This document is in the public domain and may be freely copied or reprinted.

Disclaimer: Mention of any company or product does not constitute endorsement by NIOSH.

DHHS (NIOSH) Publication No. 2000-108
November 1999

Preventing Needlestick Injuries in Health Care Settings

WARNING!

Health care workers who use or may be exposed to needles are at increased risk of needlestick injury. Such injuries can lead to serious or fatal infections with bloodborne pathogens such as hepatitis B virus, hepatitis C virus, or human immunodeficiency virus (HIV).

Employers of health care workers should implement the use of improved engineering controls to reduce needlestick injuries:

- Eliminate the use of needles where safe and effective alternatives are available.
- Implement the use of devices with safety features and evaluate their use to determine which are most effective and acceptable.

Needlestick injuries can best be reduced when the use of improved engineering controls is incorporated into a comprehensive program involving workers. Employers should implement the following program elements:

- Analyze needlestick and other sharps-related injuries in your workplace to identify hazards and injury trends.

- Set priorities and strategies for prevention by examining local and national information about risk factors for needlestick injuries and successful intervention efforts.
- Ensure that health care workers are properly trained in the safe use and disposal of needles.
- Modify work practices that pose a needlestick injury hazard to make them safer.
- Promote safety awareness in the work environment.
- Establish procedures for and encourage the reporting and timely followup of *all* needlestick and other sharps-related injuries.
- Evaluate the effectiveness of prevention efforts and provide feedback on performance.

Health care workers should take the following steps to protect themselves and their fellow workers from needlestick injuries:

- Avoid the use of needles where safe and effective alternatives are available.
 - Help your employer select and evaluate devices with safety features.
 - Use devices with safety features provided by your employer.
 - Avoid recapping needles.
 - Plan for safe handling and disposal before beginning any procedure using needles.
- Dispose of used needles promptly in appropriate sharps disposal containers.
 - Report all needlestick and other sharps-related injuries promptly to ensure that you receive appropriate followup care.
 - Tell your employer about hazards from needles that you observe in your work environment.
 - Participate in bloodborne pathogen training and follow recommended infection prevention practices, including hepatitis B vaccination.

For additional information, see ***NIOSH Alert: Preventing Needlestick Injuries in Health Care Settings*** [DHHS (NIOSH) Publication No. 2000-108]. Single copies of the Alert are available from the following:

NIOSH—Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998

Telephone: 1-800-35-NIOSH (1-800-356-4674)

Fax: 513-533-8573

E-mail: pubstft@cdc.gov

Web site: www.cdc.gov/niosh

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



Preventing Needlestick Injuries in Health Care Settings

WARNING!

Health care workers who use or may be exposed to needles are at increased risk of needlestick injury. Such injuries can lead to serious or fatal infections with bloodborne pathogens such as hepatitis B virus, hepatitis C virus, or human immunodeficiency virus (HIV).

The National Institute for Occupational Safety and Health (NIOSH) requests assistance in preventing needlestick injuries among health care workers.* These injuries are caused by needles such as hypodermic needles, blood collection needles, intravenous (IV) stylets, and needles used to connect parts of IV delivery systems. These injuries may cause a number of serious and potentially fatal infections with bloodborne pathogens such as hepatitis B virus (HBV), hepatitis C virus (HCV), or human immunodeficiency virus (HIV)—the virus that causes acquired immunodeficiency syndrome (AIDS).

These injuries can be avoided by eliminating the unnecessary use of needles,

using devices with safety features, and promoting education and safe work practices for handling needles and related systems. These measures should be part of a comprehensive program to prevent the transmission of bloodborne pathogens.

This Alert provides current scientific information about the risk of needlestick injury and the transmission of bloodborne pathogens to health care workers. The document focuses on needlestick injuries as a key element in a broader effort to prevent all sharps-related injuries and associated bloodborne infections. The document describes five cases of health care workers with needlestick-related infections and presents intervention strategies for reducing these risks. Because many needleless devices and safer needle devices have been recently introduced and the field is rapidly evolving, the Alert briefly describes an approach for evaluating these devices.

*In this document, the term *health care worker* includes all workers in the health care setting who use or may be exposed to needles and other sharp devices that may contain blood or other potentially infectious materials. Health care workers include physicians, nurses, laboratory and dental personnel, pre-hospital care providers, and housekeeping, laundry, and maintenance workers.

NIOSH requests that workers, employers, manufacturers, editors of professional journals, safety and health officials, and labor unions implement the recommendations in this Alert and bring them to the attention of all health care workers who use or may be exposed to needles in the workplace.

BACKGROUND

More than 8 million health care workers in the United States work in hospitals and other health care settings. Precise national data are not available on the annual number of needlestick and other percutaneous injuries among health care workers; however, estimates indicate that 600,000 to 800,000 such injuries occur annually [Henry and Campbell 1995; EPINet 1999]. About half of these injuries go unreported [Roy and Robillard 1995; EPINet 1999; CDC 1997a; Osborn et al. 1999]. Data from the EPINet system suggest that at an average hospital, workers incur approximately 30 needlestick injuries per 100 beds per year [EPINet 1999].

Most reported needlestick injuries involve nursing staff; but laboratory staff, physicians, housekeepers, and other health care workers are also injured. Some of these injuries expose workers to blood-borne pathogens that can cause infection. The most important of these pathogens are HBV, HCV, and HIV. Infections with each of these pathogens are potentially life threatening—and preventable.

The emotional impact of a needlestick injury can be severe and long lasting, even when a serious infection is not transmitted. This impact is particularly severe when the injury involves exposure to HIV. In one study of 20 health care workers with an

HIV exposure, 11 reported acute severe distress, 7 had persistent moderate distress, and 6 quit their jobs as a result of the exposure [Henry et al. 1990]. Other stress reactions requiring counseling have also been reported [Armstrong et al. 1995]. Not knowing the infection status of the source patient can accentuate the health care worker's stress. In addition to the exposed health care worker, colleagues and family members may suffer emotionally.

HIV

Between 1985 and June 1999, cumulative totals of 55 “documented”[†] cases and 136 “possible”[‡] cases of occupational HIV transmission to U.S. health care workers were reported to the Centers for Disease Control and Prevention (CDC) [CDC 1998a]. Most involved nurses and laboratory technicians. Percutaneous injury (e.g., needlestick) was associated with 49 (89%) of the documented transmissions. Of these, 44 involved hollow-bore needles, most of which were used for blood collection or insertion of an IV catheter.

HIV infection is a complex disease that can be associated with many symptoms. The virus attacks part of the body's immune system, eventually leading to severe infections and other complications—a condition known as AIDS. Despite current therapies

[†]Health care workers who had documented HIV after occupational exposure or had other laboratory evidence of occupational HIV infection.

[‡]Health care workers who were investigated and (1) had no identifiable behavioral or transfusion risks, (2) reported having had percutaneous or mucocutaneous occupational exposures to blood or body fluids or to laboratory solutions containing HIV, but (3) had no documented HIV seroconversion resulting from a specific occupational exposure.

that delay the progression of HIV disease, most health care workers who become infected with HIV are likely to eventually develop AIDS and die.

HBV

Information from national hepatitis surveillance is used to estimate the number of HBV infections in health care workers. In 1995, an estimated 800 health care workers became infected with HBV [CDC unpublished data]. This figure represented a 95% decline from the 17,000 new infections estimated in 1983. The decline was largely due to the widespread immunization of health care workers with the hepatitis B vaccine and the use of universal precautions and other measures required by the Occupational Safety and Health Administration (OSHA) bloodborne pathogens standard [29 CFR[§] 1910.1030].

About one-third to one-half of persons with acute HBV infection develop symptoms of hepatitis such as jaundice, fever, nausea, and abdominal pain. Most acute infections resolve, but 5% to 10% of patients develop chronic infection with HBV that carries an estimated 20% lifetime risk of dying from cirrhosis and 6% risk of dying from liver cancer [Shapiro 1995].

HCV

Hepatitis C virus infection is the most common chronic bloodborne infection in the United States, affecting approximately 4 million people [CDC 1998b]. Although the prevalence of HCV infection among health care workers is similar to that in the general population (1% to 2%) [CDC 1998b],

[§]Code of Federal Regulations. See CFR in references.

health care workers clearly have an increased occupational risk for HCV infection. In a study that evaluated risk factors for infection, a history of unintentional needlestick injury was independently associated with HCV infection [Polish et al. 1993]. The number of health care workers who have acquired HCV occupationally is not known. However, of the total acute HCV infections that have occurred annually (ranging from 100,000 in 1991 to 36,000 in 1996), 2% to 4% have been in health care workers exposed to blood in the workplace [Alter 1995, 1997; CDC unpublished data].

HCV infection often occurs with no symptoms or only mild symptoms. But unlike HBV, chronic infection develops in 75% to 85% of patients, with active liver disease developing in 70%. Of the patients with active liver disease, 10% to 20% develop cirrhosis, and 1% to 5% develop liver cancer [CDC 1998b].

RISK OF INFECTION AFTER A NEEDLESTICK INJURY

After a needlestick exposure to an infected patient, a health care worker's risk of infection depends on the pathogen involved, the immune status of the worker, the severity of the needlestick injury, and the availability and use of appropriate post-exposure prophylaxis.

HIV

To estimate the rate of HIV transmission, data were combined from more than 20 worldwide prospective studies of health care workers exposed to HIV-infected blood through a percutaneous injury. In all, 21 infections followed 6,498 exposures for an *average* transmission rate of 0.3% per

injury [Gerberding 1994; Ippolito et al. 1999]. A retrospective case-control study of health care workers who had percutaneous exposures to HIV found that the risk of HIV transmission was increased when the worker was exposed to a larger quantity of blood from the patient, as indicated by (1) a visibly bloody device, (2) a procedure that involved placing a needle in a patient's vein or artery, or (3) a deep injury [Cardo et al. 1997]. Preliminary data suggest that such high-risk needlestick injuries may have a substantially greater risk of disease transmission per injury [Bell 1997].

Post-exposure prophylaxis for HIV is recommended for health care workers occupationally exposed to HIV under certain circumstances [CDC 1998c]. Limited data suggest that such prophylaxis may considerably reduce the chance of becoming infected with HIV [Cardo et al. 1997]. However, the drugs used for HIV post-exposure prophylaxis have many adverse side effects [CDC 1998c]. Currently no vaccine exists to prevent HIV infection, and no treatment exists to cure it [CDC 1998d].

HBV

The rate of HBV transmission to susceptible health care workers ranges from 6% to 30% after a single needlestick exposure to an HBV-infected patient [CDC 1997b]. However, such exposures are a risk only for health care workers who are not immune to HBV. Health care workers who have antibodies to HBV either from pre-exposure vaccination or prior infection are not at risk. In addition, if a susceptible worker is exposed to HBV, post-exposure prophylaxis with hepatitis B immune globulin and initiation of hepatitis B vaccine is

more than 90% effective in preventing HBV infection.

HCV

Prospective studies of health care workers exposed to HCV through a needlestick or other percutaneous injury have found that the incidence of anti-HCV seroconversion (indicating infection) averages 1.8% (range, 0% to 7%) per injury [Alter 1997; CDC 1998b]. Currently no vaccine exists to prevent HCV infection, and neither immunoglobulin nor antiviral therapy is recommended as post-exposure prophylaxis [CDC 1998b]. However, recommendations for treatment of early infections are rapidly evolving. Health care workers with known exposure should be monitored for seroconversion and referred for medical follow-up if seroconversion occurs.

Summary

Although exposure to HBV poses a high risk for infection, administration of pre-exposure vaccination or post-exposure prophylaxis to workers can dramatically reduce this risk. Such is not the case with HCV and HIV. Preventing the needlestick injury is the best approach to preventing these diseases in health care workers, and it is an important part of any bloodborne pathogen prevention program in the workplace.

HOW DO NEEDLESTICK INJURIES OCCUR?

Devices Associated with Needlestick Injuries

Health care workers use many types of needles and other sharp devices to

provide patient care. However, data from hospitals participating in the CDC National Surveillance System for Hospital Health Care Workers (NaSH) and from hospitals included in the EPINet research database show that only a few needles and other sharp devices are associated with the majority of injuries [International Health Care Worker Safety Center 1997; EPINet 1999; CDC unpublished data 1999]. Of nearly 5,000 percutaneous injuries reported by hospitals participating in NaSH between June 1995 and July 1999, 62% were associated with hollow-bore needles—primarily hypodermic needles attached to disposable syringes (29%) and winged-steel (butterfly-type) needles (13%). Figure 1 shows the extent to which these and other sharp devices contributed to the burden of percutaneous injuries in NaSH hospitals. Data from hospitals participating in EPINet show a similar distribution of injuries by device type [EPINet 1999].

Activities Associated with Needlestick Injuries

Whenever a needle or other sharp device is exposed, injuries can occur. Data from NaSH show that approximately 38% of percutaneous injuries occur during use and 42% occur after use and before disposal. Causes of percutaneous injuries with hollow-bore needles are shown in Figure 2.

The circumstances leading to a needlestick injury depend partly on the type and design of the device used. For example, needle devices that must be taken apart or manipulated after use (e.g., prefilled cartridge syringes and phlebotomy needle/vacuum tube assemblies) are an obvious hazard and have been associated with increased injury rates [Jagger et al. 1988]. In

addition, needles attached to a length of flexible tubing (e.g., winged-steel needles and needles attached to IV tubing) are sometimes difficult to place in sharps containers and thus present another injury hazard. Injuries involving needles attached to IV tubing may occur when a health care worker inserts or withdraws a needle from an IV port or tries to temporarily remove the needlestick hazard by inserting the needle into a drip chamber, IV port or bag, or even bedding.

In addition to risks related to device characteristics, needlestick injuries have been related to certain work practices such as

- recapping,
- transferring a body fluid between containers, and
- failing to properly dispose of used needles in puncture-resistant sharps containers.

Past studies of needlestick injuries have shown that 10% to 25% occurred when recapping a used needle [Ruben et al. 1983; Krasinski et al. 1987; McCormick and Maki 1981; McCormick et al. 1991; Yassi and McGill 1991]. Although recapping by hand has been discouraged for some time and is prohibited under the OSHA bloodborne pathogens standard [29 CFR 1910.1030] unless no alternative exists, 5% of needlestick injuries in NaSH hospitals are still related to this practice (Figure 2). Injury may occur when a health care worker attempts to transfer blood or other body fluids from a syringe to a specimen container (such as a vacuum tube) and misses the target. Also, if used needles or other sharps are left in the work area or are discarded in a sharps container that is not puncture resistant, a needlestick injury may result.

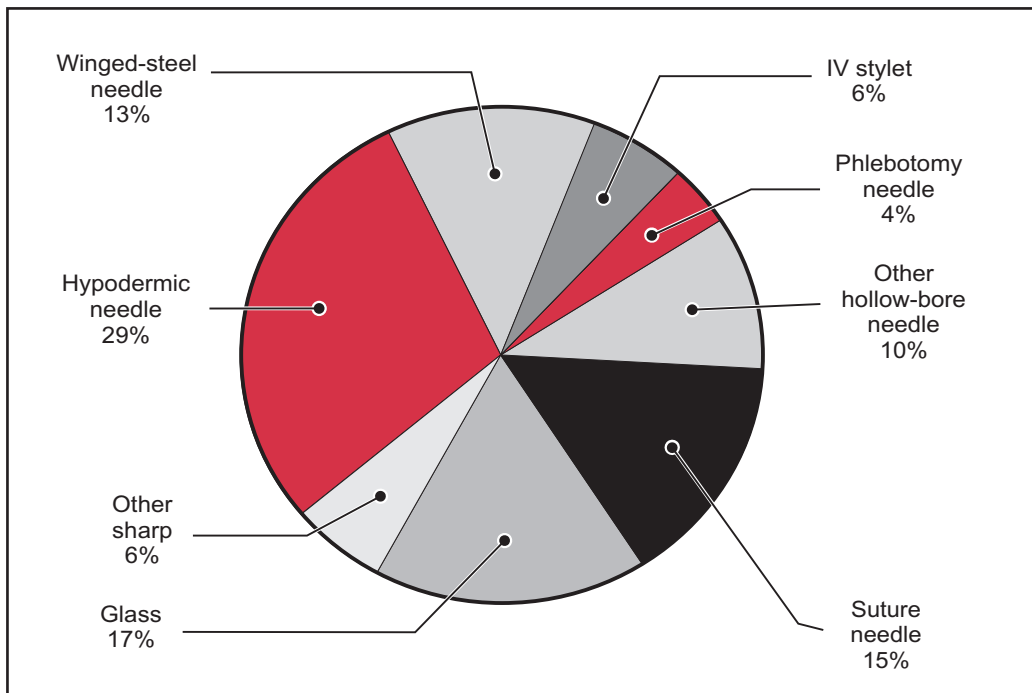


Figure 1. Hollow-bore needles and other devices associated with percutaneous injuries in NaSH hospitals, by % total percutaneous injuries (n=4,951), June 1995–July 1999. (Source: CDC [1999].)

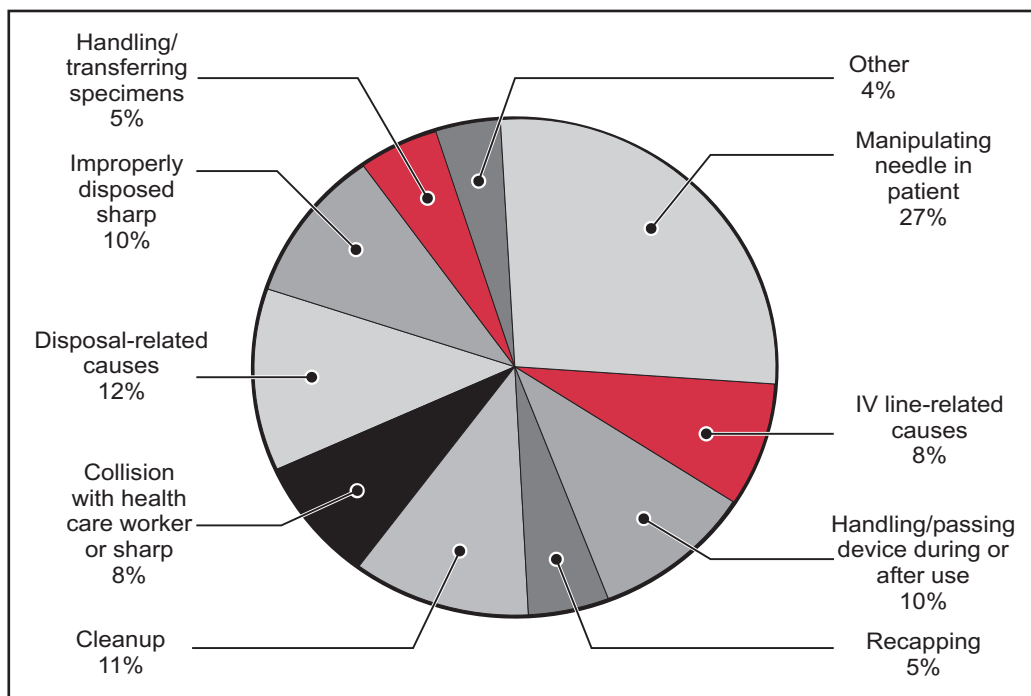


Figure 2. Causes of percutaneous injuries with hollow-bore needles in NaSH hospitals, by % total percutaneous injuries (n=3,057), June 1995–July 1999. (Source: CDC [1999].)

OSHA, FDA, AND STATE REGULATIONS**

OSHA

The current Federal standard for addressing needlestick injuries among health care workers is the OSHA bloodborne pathogens standard [29 CFR 1910.1030; 56 Fed. Reg.^{††} 64004 (1991)], which has been in effect since 1992. The standard applies to all occupational exposures to blood or other potentially infectious materials. Notable elements of this standard require the following:

- A written exposure control plan designed to eliminate or minimize worker exposure to bloodborne pathogens
- Compliance with universal precautions (an infection control principle that treats all human blood and other potentially infectious materials as infectious)
- Engineering controls and work practices to eliminate or minimize worker exposure
- Personal protective equipment (if engineering controls and work practices do not eliminate occupational exposures)
- Prohibition of bending, recapping, or removing contaminated needles and other sharps unless such an act is required by a specific procedure or has no feasible alternative

**Because of recent changes and pending legislation in the area of needlestick injury prevention, readers are urged to check with current Federal as well as State regulations.

^{††}*Federal Register*. See Fed. Reg. in references.

- Prohibition of shearing or breaking contaminated needles (OSHA defines *contaminated* as the presence or the reasonably anticipated presence of blood or other potentially infectious materials on an item or surface)
- Free hepatitis B vaccinations offered to workers with occupational exposure to bloodborne pathogens
- Worker training in appropriate engineering controls and work practices
- Post-exposure evaluation and followup, including post-exposure prophylaxis when appropriate

OSHA also intends to act to reduce the number of injuries that health care workers receive from needles and other sharp medical objects [OSHA 1999a]. First, the agency has revised the compliance directive (guidance to be used in the field) accompanying its 1992 bloodborne pathogens standard [29 CFR 1910.1030] to reflect newer and safer technologies now available and to increase the employer's responsibility to evaluate and use effective, safer technologies [OSHA 1999b]. Second, the agency has proposed a requirement in the revised recordkeeping rule that all injuries resulting from contaminated needles and sharps be recorded on OSHA logs used by employers to record injuries and illnesses. Finally, OSHA will take steps to amend its bloodborne pathogens standard by placing needlestick and sharps injuries on its regulatory agenda.

FDA

Under the regulations of the Food and Drug Administration (FDA) application clearance process [FDA 1995], the manufacturers of

medical devices (including needles used in patient care) must meet requirements for appropriate registration and for listing, labeling, and good manufacturing practices for design and production. The process for receiving clearance or approval to market a device requires device manufacturers to (1) demonstrate that a new device is substantially equivalent to a legally marketed device or (2) document the safety and effectiveness of the new device for patient care through a more involved premarket approval process. FDA has also released two advisories pertaining to sharps and the risk of bloodborne pathogen transmission in the health care setting [FDA 1992; FDA et al. 1999].

State Regulations

Currently, three States have adopted and more than two dozen are considering legislation to require additional regulatory actions addressing bloodborne pathogen exposures to health care workers. The recent California standard [State of California 1998] has several requirements that go beyond those currently required by OSHA. These requirements include stronger language for the use of needleless systems for certain procedures or (where needleless systems are not available) the use of needles with engineered sharps injury protection for certain procedures.

CASE REPORTS

The following case reports briefly describe the experiences of five health care workers who developed serious infections after occupational exposures to bloodborne pathogens. Their cases illustrate a number of the preventable hazardous conditions

and practices that can lead to needlestick injuries.

Case 1

A hospitalized patient with AIDS became agitated and tried to remove the intravenous (IV) catheters in his arm. Several hospital staff members struggled to restrain the patient. During the struggle, an IV infusion line was pulled, exposing the connector needle that was inserted into the access port of the IV catheter. A nurse at the scene recovered the connector needle at the end of the IV line and was attempting to reinsert it when the patient kicked her arm, pushing the needle into the hand of a second nurse. The nurse who sustained the needlestick injury tested negative for HIV that day, but she tested HIV positive several months later [American Health Consultants 1992a].

Case 2

A physician was drawing blood from a patient in an examination room of an HIV clinic. Because the room had no sharps disposal container, she recapped the needle using the one-handed technique. While the physician was sorting waste materials from lab materials, the cap fell off the phlebotomy needle, which subsequently penetrated her right index finger. The physician's baseline HIV test was negative. She began post-exposure prophylaxis with zidovudine but discontinued it after 10 days because of adverse side effects. Approximately 2 weeks after the needlestick, the physician developed flu-like symptoms consistent with HIV infection. She was found to be seropositive for HIV when tested 3 months after the needlestick exposure [American Health Consultants 1992b].

Case 3

After performing phlebotomy on a patient with AIDS, a health care worker sustained a deep needlestick injury with the used phlebotomy needle. Blood from the collection tube also spilled into the space between the wrist and cuff of the health care worker's gloves, contaminating her chapped hands. The health care worker removed the gloves and washed her hands immediately. She had a negative baseline HIV test and refused zidovudine prophylaxis. Because her patient was not known to have HCV infection and did not have clinical evidence of liver disease, the health care worker did not receive baseline testing for exposure to HCV. Eight months after the incident, the health care worker was hospitalized with acute hepatitis. She was found to be seropositive for HIV 9 months after the incident. Sixteen months after the incident, she tested positive for anti-HCV antibodies and was diagnosed with chronic HCV infection. Her clinical condition continued to deteriorate, and she died 28 months after the needlestick injury [Ridzon et al. 1997].

Case 4

During bronchoscopy to determine the cause of shortness of breath in a patient infected with HBV, a health care worker sustained a percutaneous injury with a 25-gauge needle while extracting tissue from biopsy forceps. The worker did not receive post-exposure prophylaxis with hepatitis B immune globulin or hepatitis B vaccine. Approximately 15 weeks after the needlestick injury, the worker noted fatigue, malaise, and jaundice. Later, he was

found to have abnormal liver enzymes and a positive test for hepatitis B surface antigen, consistent with acute hepatitis B infection. The patient who underwent bronchoscopy was diagnosed with *Pneumocystis carinii* pneumonia and died 8 months later after he was diagnosed with disseminated Kaposi's sarcoma and overwhelming opportunistic infection. The injured worker had an uncomplicated medical course, and his liver enzymes and his health eventually returned to normal. He later tested negative for hepatitis B surface antigen and positive for hepatitis B surface antibody, indicating recovery from his HBV infection. On followup 15 months after the needlestick injury, the worker also tested HIV negative; serum from the deceased patient was not available for antibody testing [Gerberding et al 1985].

Case 5

In 1972, a nurse sustained a needlestick injury to her finger while removing a hypodermic needle from a patient's arm. At the time of the injury, the source patient had apparent acute non-A, non-B hepatitis. The nurse developed hepatitis 6 weeks after the needlestick injury. Her liver enzymes remained elevated for nearly a year. Later examination of serum samples from the nurse and the source patient showed that both persons were infected with HCV. The initial serum sample from the nurse in 1972 was negative for anti-HCV antibody, but the sample obtained 6 weeks after the needlestick injury was seropositive. Although the nurse was clinically well at the time of the report, she remained seropositive for HCV [Seeff 1991].

USE OF IMPROVED ENGINEERING CONTROLS IN A PREVENTION STRATEGY

Comprehensive Programs to Prevent Needlestick Injuries

Safety and health issues can best be addressed in the setting of a comprehensive prevention program that considers all aspects of the work environment and that has employee involvement as well as management commitment. Implementing the use of improved engineering controls is one component of such a comprehensive program. Since many devices with needlestick prevention features are new, this section primarily addresses their use, including desirable characteristics, examples, and data supporting their effectiveness. However, other prevention strategy factors that must be addressed include modification of hazardous work practices, administrative changes to address needle hazards in the environment (e.g., prompt removal of filled sharps disposal boxes), safety education and awareness, feedback on safety improvements, and action taken on continuing problems. Several authors have noted the importance of a comprehensive approach [Krasinski et al. 1987; Hanrahan and Reutter 1997; DeJoy et al. 1995; Ramos-Gomez et al. 1997; Gershon et al. 1995]. The critical role of appropriate training has been emphasized by several recent reports of increased patient bloodstream infections associated with improper care of needleless IV systems, primarily in the home health care setting [Cookson et al. 1998; Danzig et al. 1995; Do et al. 1999; Kellerman et al. 1996]. These data emphasize the need for patient safety surveillance and thorough training as well as occupational injury surveillance when implementing the use of a new medical device.

Case Study of a Successful Comprehensive Prevention Program

The value of a comprehensive approach is illustrated by its success in a recent report by Dale et al. [1998]. Between 1993 and 1996, the phlebotomy service at a major institution decreased the needlestick injury rate among its 200 full-time phlebotomists from 1.5 to 0.2 per 10,000 venipunctures performed. In comparison, a national survey from 1990 to 1992 found a median needlestick injury rate of about 0.94 per 10,000 venipunctures [Howanitz and Schifman 1994]. A retrospective review of the events contributing to the success of the phlebotomy service included changes in worker education and work practices, the implementation of devices with safety features, and encouragement of injury reporting. These interventions as well as the implementation of CDC published guidelines and the OSHA bloodborne pathogens standard were associated with the observed steady decline in the injury rate. The authors noted that an important factor contributing to this success was a thorough understanding of the injuries that occurred among their staff.

Desirable Characteristics of Devices with Safety Features

Improved engineering controls are often among the most effective approaches to reducing occupational hazards and therefore are an important element of a needlestick prevention program. Such controls include eliminating the unnecessary use of needles and implementing devices with safety features. A number of sources have identified the desirable characteristics of safety devices [OSHA 1999c;

FDA 1992; Jagger et al. 1988; Chiarello 1995; Quebbeman and Short 1995; Pugliese 1998; Fisher 1999; ECRI 1999]. These characteristics include the following:

- The device is needleless.
- The safety feature is an integral part of the device.
- The device preferably works passively (i.e., it requires no activation by the user). If user activation is necessary, the safety feature can be engaged with a single-handed technique and allows the worker's hands to remain behind the exposed sharp.
- The user can easily tell whether the safety feature is activated.
- The safety feature cannot be deactivated and remains protective through disposal.
- The device performs reliably.
- The device is easy to use and practical.
- The device is safe and effective for patient care.

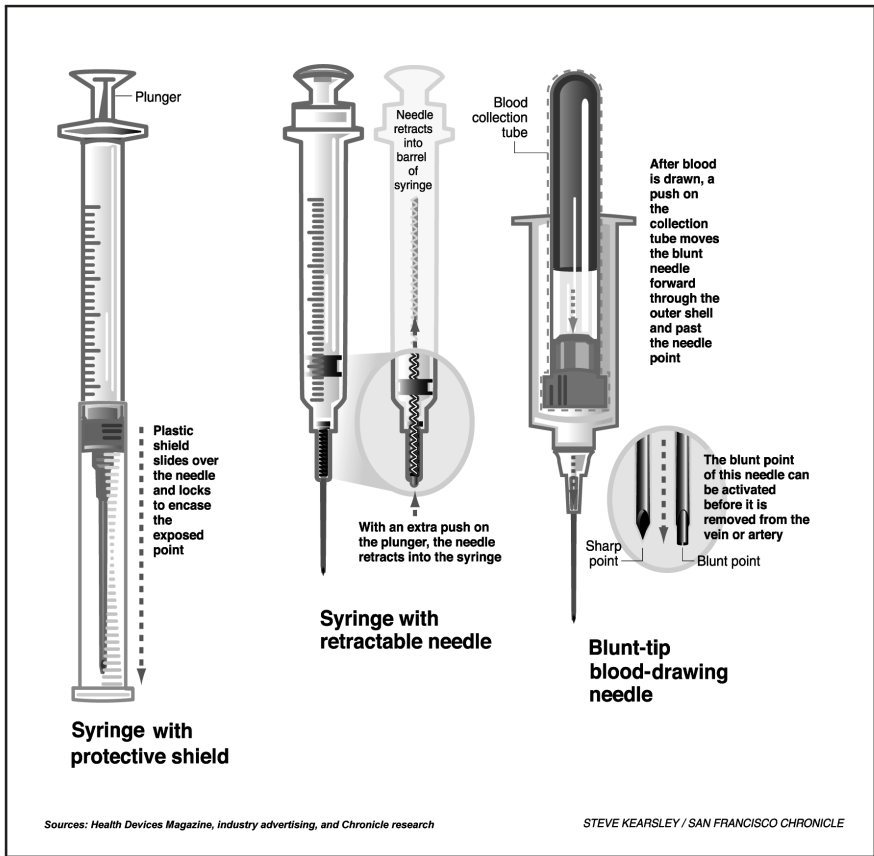
Although each of these characteristics is desirable, some are not feasible, applicable or available for certain health care situations. For example, needles will always be necessary where alternatives for skin penetration are not available. Also, a safety feature that requires activation by the user might be preferable to one that is passive in some cases. Each device must be considered on its own merit and ultimately on its ability to reduce workplace

injuries. The desirable characteristics listed here should thus serve only as a guideline for device design and selection.

Examples of Safety Device Designs

Figure 3 shows examples of syringes with safety features. These and other examples of safety device designs are listed as follows:

- Needleless connectors for IV delivery systems (e.g., blunt cannula for use with prepierced ports and valved connectors that accept tapered or luer ends of IV tubing)
- Protected needle IV connectors (e.g., the IV connector needle is permanently recessed in a rigid plastic housing that fits over IV ports)
- Needles that retract into a syringe or vacuum tube holder
- Hinged or sliding shields attached to phlebotomy needles, winged-steel needles, and blood gas needles
- Protective encasements to receive an IV stylet as it is withdrawn from the catheter
- Sliding needle shields attached to disposable syringes and vacuum tube holders
- Self-blunting phlebotomy and winged-steel needles (a blunt cannula seated inside the phlebotomy needle is advanced beyond the needle tip before the needle is withdrawn from the vein—see Figure 3)
- Retractable finger/heel-stick lancets



©The San Francisco Chronicle. Reprinted with permission.

Figure 3. Three examples of syringes with safety features. (These drawings are presented for educational purposes and do not imply endorsement of a particular product by NIOSH.)

Evidence of Effectiveness

Accumulating evidence indicates that devices with safety features reduce needlestick injuries:

- Needleless or protected-needle IV systems decreased needlestick injuries related to IV connectors by 62% to 88% [Gartner 1992; Yassi et al. 1995; Lawrence et al. 1997].
- Phlebotomy injuries were reduced by 76% with a self-blunting needle, 66% with a hinged needle shield, and 23% with a sliding-shield, winged-steel (butterfly-type) needle [CDC 1997a].
- Phlebotomy injuries were reduced by 82% with a needle shield, but a recapping device had minimal impact [Billiet et al. 1991].

- Safer IV catheters that encase the needle after use reduced needlestick injuries related to IV insertion by 83% in three hospitals [Jagger 1996].

Other studies also document substantial reductions in needlestick injuries with the proper use of needleless systems or newer safety needle devices used in a comprehensive program to prevent needlestick injuries [NCCC and DVA 1997; Zafar et al. 1997].

Although the focus in this section is on needle devices with safety features, sharps disposal containers are also important engineering controls to consider in a comprehensive needlestick injury prevention program. NIOSH [1998] recently reviewed the proper location, use, and benefits of sharps disposal containers.

As illustrated by the examples listed here, many devices with safety features decrease the frequency of needlestick injuries, but for many reasons they do not completely eliminate the risk. In some cases, the safety feature cannot be activated until after the needle is removed from the patient. Or the needle may be inadvertently dislodged during a procedure, thereby exposing the unprotected sharp. Some health care workers fail to activate the safety feature, or the safety feature may fail. With some devices, users can bypass safety features. For example, even with some needleless IV delivery systems, a needle can be used to connect parts of the system. Understanding the factors that influence the safety of a device and promoting practices that will maximize prevention effectiveness are therefore important components in prevention planning.

CONCLUSIONS

Needlestick injuries are an important and continuing cause of exposure to serious and fatal diseases among health care workers. Greater collaborative efforts by all stakeholders are needed to prevent needlestick injuries and the tragic consequences that can result. Such efforts are best accomplished through a comprehensive program that addresses institutional, behavioral, and device-related factors that contribute to the occurrence of needlestick injuries in health care workers. Critical to this effort are the elimination of needle-bearing devices where safe and effective alternatives are available and the development, evaluation, and use of needle devices with safety features.

RECOMMENDATIONS

Selecting and Evaluating Needle Devices with Safety Features

An increasing number and variety of needle devices with safety features are now available, but many of these devices have had only limited use in the workplace. Thus health care organizations and workers may find it difficult to select appropriate devices. Although these devices are designed to enhance the safety of health care workers, they should be evaluated to ensure that

- the safety feature works effectively and reliably,
- the device is acceptable to the health care worker, and
- the device does not adversely affect patient care.

As employers implement the use of needle devices with safety features, they can use several guidelines to select and evaluate these products. These guidelines are derived partly from publications and other resources offering plans, evaluation forms, and related information in this new area [Chiarello 1995; Fisher 1999; SEIU 1998; EPINet 1999; Pugliese and Salahuddin 1999]. While health care settings are implementing the use of needle devices with safety features, they should seek help from the appropriate professional organizations, trade groups, and manufacturers in obtaining information about devices and procedures suitable for specific settings (e.g. dental offices). Other information sources are listed in later sections of the Alert (see *References, Additional Information, and Suggested Readings*). In addition, OSHA received nearly 400 responses to its recent public request for information about preventing occupational exposure to bloodborne pathogens from percutaneous injuries [63 Fed. Reg. 48250 (1998); OSHA 1999c]. This information includes numerous reports about the successful implementation of needlestick injury prevention programs, and it may be useful to medical institutions as they establish injury tracking systems, prevention approaches, and the use of safer devices.

The major elements of a process for selecting and evaluating needle devices with safety features are listed here briefly:

1. Form a multidisciplinary team that includes workers to (1) develop, implement, and evaluate a plan to reduce needlestick injuries in the institution and (2) evaluate needle devices with safety features.
2. Identify priorities based on assessments of how needlestick injuries are occurring, patterns of device use in the institution, and local and national data on injury and disease transmission trends. Give the highest priority to needle devices with safety features that will have the greatest impact on preventing occupational infection (e.g., hollow-bore needles used in veins and arteries).
3. When selecting a safer device, identify its intended scope of use in the health care facility and any special technique or design factors that will influence its safety, efficiency, and user acceptability. Seek published, Internet, or other sources of data on the safety and overall performance of the device.
4. Conduct a product evaluation, making sure that the participants represent the scope of eventual product users. The following steps will contribute to a successful product evaluation:
 - Train health care workers in the correct use of the new device.
 - Establish clear criteria and measures to evaluate the device with regard to both health care worker safety and patient care. (Safety feature evaluation forms are available from the references cited earlier.)
 - Conduct onsite followup to obtain informal feedback, identify problems, and provide additional guidance.
5. Monitor the use of a new device after it is implemented to determine the need for additional training, solicit informal feedback on health care worker experience with the device (e.g., using a suggestion box), and identify possible adverse effects of the device on patient care.

Ongoing review of current devices and options will be necessary. As with any evolving technology, the process will be dynamic, and with experience, improved devices with safety features will emerge.

Recommendations for Employers

To protect health care workers from needlestick injuries, employers must provide a safe working environment that includes safer needle devices and effective safety programs. Many types of needle devices are associated with needlestick injuries, and these injuries can occur in many ways. Thus a combination of prevention strategies must be considered. Employers should take the following steps to implement a program for reducing needlestick injuries and to involve workers in this effort.

1. Employers of health care workers should implement the use of improved engineering controls to reduce needlestick injuries:

- *Eliminate the use of needle devices where safe and effective alternatives are available.* The most obvious example of unnecessary needle use is the use of exposed needles to access or connect parts of an IV delivery system. For nearly a decade, needleless IV delivery systems and protected needles have been available to remove or isolate this hazard. Examine information about your own institution to identify other unnecessary needle use.
- *Implement the use of needle devices with safety features and evaluate their use to determine which are*

most effective and acceptable. Many devices are now available with safety features that isolate an exposed needle after use. An evaluation approach and references are provided in this document.

2. Needlestick injury reduction can best be accomplished when the use of improved engineering controls is incorporated into a comprehensive program involving workers:

- *Analyze needlestick and other sharps-related injuries in your workplace to identify hazards and injury trends.* Data from injury reporting should be compiled and assessed to identify (1) where, how, with what devices, and when injuries are occurring and (2) the groups of health care workers being injured.
- *Set priorities and prevention strategies by examining local and national information about risk factors for needlestick injuries and successful intervention efforts.* Procedures and devices that have contributed to disease transmission (e.g., devices used to access a vein or artery) should receive the highest priority for intervention. Look to local and national resources for information about the types of devices and work practices that have been successful in reducing injuries.
- *Ensure that health care workers are properly trained in the safe use and disposal of needles.* Health care workers and students in the health professions should be trained to use needle devices properly and to maximize their personal protection throughout the handling of these

devices. As safer devices are introduced, worker training is essential to ensure proper use [Ihrig et al. 1997].

- *Modify work practices that pose a needlestick injury hazard to make them safer.* Hazards that can be eliminated by modifying work practices include injuries due to recapping, failing to dispose of a needle device properly, passing or transferring such a device, and transferring blood or body fluids from a device into a specimen container. Also, specimen collection can be coordinated to reduce the number of times needles are used on a patient, thereby reducing both worker risk and patient discomfort. In some cases, the use of devices with safety features will reduce or eliminate these risks. In all cases, involving health care workers will help identify and resolve safety issues. Employers should thus review current procedures for reporting and addressing hazards related to needles and other sharps.
- *Promote safety awareness in the work environment.* Many needlestick injuries result from unexpected circumstances such as sudden movement by a patient or collision with a coworker or needle device. Health care workers should be trained to be constantly alert to the injury potential when an exposed needle or other sharp device is being used. A number of job-related factors influence the adoption of safety behaviors by health care workers [Dejoy et al. 1995; Murphy et al. 1996; Gershon et al. 1995]. These workers often place patient needs before their personal safety. They are less likely to

perform a safety measure they perceive to interfere with patient care or to require added steps. Therefore, employers must address both the hazards that contribute to needlestick injuries and the institutional barriers and attitudes that affect safe work practices [Hanrahan and Reutter 1997].

- *Establish procedures for and encourage the reporting and timely followup of **all** needlestick and other sharps-related injuries.* Reporting of needlestick injuries is essential to (1) ensure that all health care workers receive appropriate post-exposure medical management and (2) provide a record for assessing needlestick hazards in the work environment.
- *Evaluate the effectiveness of prevention efforts and provide feedback on performance.* Employers need to ensure that health care workers are adopting the recommended prevention strategies and that the changes they make have the desired effect. Thus they should provide a forum to assess worker perceptions, evaluate compliance, and identify problems.

Recommendations for Workers

To protect themselves and their coworkers, health care workers should be aware of the hazards posed by needlestick injuries and should use safety devices and improved work practices as follows:

1. Avoid the use of needles where safe and effective alternatives are available.
2. Help your employer select and evaluate devices with safety features.

3. Use devices with safety features provided by your employer.
 4. Avoid recapping needles.
 5. Plan safe handling and disposal before beginning any procedure using needles.
 6. Dispose of used needle devices promptly in appropriate sharps disposal containers.
 7. Report all needlestick and other sharps-related injuries promptly to ensure that you receive appropriate followup care.
 8. Tell your employer about hazards from needles that you observe in your work environment.
 9. Participate in bloodborne pathogen training and follow recommended infection prevention practices, including hepatitis B vaccination.
- San Francisco General Hospital's Trauma Foundation, Training for Development of Innovative Control Technology (TDICT) Project: www.tdict.org (or call 412-821-8209)
 - OSHA Web page: www.osha.gov; for needlestick information, www.osha-slc.gov/SLTC/needlestick/index.html (or call the OSHA Publications Office at 202-693-1888)
 - CDC Web page: www.cdc.gov; for hepatitis information, www.cdc.gov/ncidod/diseases/hepatitis/index.htm; for hospital infections, www.cdc.gov/ncidod/hip/default.htm; and for HIV information, www.cdc.gov/nchstp/hiv_aids/dhap.htm
 - FDA medical device safety alerts: www.fda.gov/cdrh/safety.html

ADDITIONAL INFORMATION

For additional information about needlestick injuries, call 1-800-35-NIOSH (1-800-356-4674); or visit the NIOSH Web site at www.cdc.gov/niosh

The following Web sites provide additional information about needlestick injuries and safer needle devices:

- University of Virginia's International Health Care Workers Safety Center and its EPINet needlestick injury data collection system: www.med.virginia.edu/~epinet (or call 804-982-0702)

ACKNOWLEDGMENTS

Principal contributors to this Alert were Thomas K. Hodous, M.D.; Linda A. Chiarello, R.N., M.S.; Scott D. Deitchman, M.D., M.P.H.; Ann N. Do, M.D.; Anne C. Hamilton; Janice M. Huy, M.S.; E. Lynn Jenkins, M.A.; Andrew M. Maxfield, Ph.D.; Edward L. Petsonk, M.D.; Raymond C. Sinclair, Ph.D.; and Angela M. Weber, M.S.

Please direct comments, questions, or requests for additional information to the following:

Director, Division of Safety Research
National Institute for Occupational Safety and Health
1095 Willowdale Road
Morgantown, WV 26505

Telephone, 304-285-5894; or call 1-800-35-NIOSH (1-800-356-4674).

We greatly appreciate your assistance in protecting the health of U.S. workers.



Linda Rosenstock, M.D., M.P.H.
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control
and Prevention

REFERENCES

- Alter MJ [1995]. Epidemiology of hepatitis C in the west. *Semin Liver Dis* 15(1):5-14.
- Alter MJ [1997]. The epidemiology of acute and chronic hepatitis C. *Clin Liver Dis* 1(3):559-569.
- American Health Consultants [1992a]. Court awards \$5.37 million to occupationally infected nurse. *AIDS Alert* Oct:149-152.
- American Health Consultants [1992b]. Occupationally infected doctor says exposure was preventable. *AIDS Alert* Aug:118-119.
- Armstrong K, Gorden R, Santorella G [1995]. Occupational exposure of health care workers (HCWs) to human immunodeficiency virus (HIV): stress reactions and counseling interventions. *Soc Work Health Care* 21(3):61-80.
- Bell DM [1997]. Occupational risk of human immunodeficiency virus infection in healthcare workers: an overview. *Am J Med* 102 (Suppl 5B):9-15.
- Billiet LS, Parker CR, Tanley PC, Wallas CH [1991]. Needlestick injury rate reduction during phlebotomy; a comparative study of two safety devices. *Lab Med* 22(2):122-123.
- Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, Heptonstall J, Ippolito G, Lot F, McKibben PS, Bell DM, CDC Needlestick Surveillance Group [1997]. A case-control study of HIV seroconversion in health care workers after percutaneous exposure. *New Engl J Med* 337(21):1485-1490.
- CDC (Centers for Disease Control and Prevention) [1997a]. Evaluation of safety devices for preventing percutaneous injuries among health-care workers during phlebotomy procedures—Minneapolis-St.Paul, New York City, and San Francisco, 1993-1995. *MMWR* 46(2):21-25.
- CDC (Centers for Disease Control and Prevention) [1997b]. Immunization of health care workers: recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee (HICPAC). *MMWR* 46(RR-18):1-42.
- CDC (Centers for Disease Control and Prevention) [1998a]. U.S. HIV and AIDS cases reported through December 1998. *HIV/AIDS Surveillance Report* 10(2):26.
- CDC (Centers for Disease Control and Prevention) [1998b]. Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. *MMWR* 47(RR-19):1-39.
- CDC (Centers for Disease Control and Prevention) [1998c]. Public Health Service guidelines for the management of health

care worker exposures to HIV and recommendations for postexposure prophylaxis. *MMWR* 47(RR-7).

CDC (Centers for Disease Control and Prevention) [1998d]. Guidelines for the use of antiretroviral agents in HIV-infected adults and adolescents. *MMWR* 47(RR-5).

Chiarello LA [1995]. Selection of needlestick prevention devices: a conceptual framework for approaching product evaluation. *Am J Infect Control* 23(6):386-395.

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Cookson ST, Ihrig M, O'Mara EM, Denny M, Volk H, Banerjee SN, Hartstein AI, Jarvis WR [1998]. Increased bloodstream infection rates in surgical patients associated with variation from recommended use and care following implementation of a needleless device. *Infect Control Hosp Epidemiol* 19(1):23-27.

Dale JC, Pruett SK, Maker MD [1998]. Accidental needlestick in the Phlebotomy Service of the Department of Laboratory Medicine and Pathology at Mayo Clinic Rochester. *Mayo Clin Proc* 73(7):611-615.

Danzig LE, Short LJ, Collins K, Mahoney M, Sepe S, Bland L, Jarvis WR [1995]. Bloodstream infections associated with a needleless intravenous infusion system in patients receiving home infusion therapy. *JAMA* 273(23):1862-1864.

DeJoy DM, Murphy LR, Gershon RM [1995]. The influence of employee, job/task, and organizational factors on adherence to universal precautions among nurses. *Int J Ind Ergonomics* 16:43-55.

Do AN, Ray BJ, Banerjee SN, Illian AF, Barnett BJ, Pham MH, Hendricks KA, Jarvis WR [1999]. Bloodstream infection associated with needleless device use and the importance of infection-control practices in the home health care setting. *J Infect Dis* 179:442-448.

ECRI [1999]. Needlestick-prevention devices. *Health Devices* 28(10):381-407.

EPINet [1999]. Exposure prevention information network data reports. University of Virginia: International Health Care Worker Safety Center.

FDA [1992]. FDA safety alert: needlestick and other risks from hypodermic needles on secondary I.V. administration sets—piggyback and intermittent I.V. Rockville, MD: Food and Drug Administration.

FDA [1995]. FDA supplementary guidance on the content of premarket notification [510 (K)] submissions for medical devices with sharps injury prevention features. Rockville, MD: Food and Drug Administration.

FDA, NIOSH, OSHA [1999]. Glass capillary tubes: joint safety advisory about potential risks. Rockville, MD: Food and Drug Administration.

[www.cdc.gov/niosh/capssa9.html]. Date accessed: May 28, 1999.

56 Fed. Reg. 64004 [1991]. Occupational Safety and Health Administration: final rule on occupational exposure to bloodborne pathogens.

63 Fed. Reg. 48250 [1998]. Occupational Safety and Health Administration: final rule on occupational exposure to bloodborne pathogens: request for information, Docket No. H370A.

Fisher J [1999]. Training for development of innovative control technology project. San Francisco, CA: San Francisco General Hospital.

Gartner K [1992]. Impact of a needleless intravenous system in a university hospital. *Am J Infect Control* 20:75–79.

Gerberding JL [1994]. Incidence and prevalence of human immunodeficiency virus, hepatitis B virus, hepatitis C virus, and cytomegalovirus among health care personnel at risk for blood exposure: final report from a longitudinal study. *J Infect Dis* 170(6):1410–1417.

Gerberding JL, Hopewell PC, Kaminsky LS, Sande MA [1985]. Transmission of hepatitis B without transmission of AIDS by accidental needlestick. *N Engl J Med* 312(1):56.

Gershon RM, Vlahov D, Felknor SA, Vesley D, Johnson PC, Delclos GL, Murphy LR [1995]. Compliance with universal precautions among health care workers at three regional hospitals. *Am J Infect Control* 23(4):225–236.

Hanrahan A, Reutter L [1997]. A critical review of the literature on sharps injuries: epidemiology, management of exposures and prevention. *J Adv Nurs* 25:144–154.

Henry K, Campbell S [1995]. Needlestick/sharps injuries and HIV exposures among health care workers: national estimates based on a survey of U.S. hospitals. *Minn Med* 78:1765–1768.

Henry K, Campbell S, Jackson B, Balfour H, Rhame F, Sannerud K, Pollack S, Sninsky J, Kwok S [1990]. Long-term follow-up of health care workers with work-site exposure to human immunodeficiency

virus [letter to the editor]. *JAMA* 263(13):1765–1766.

Howanitz PJ, Schiffman RB [1994]. Phlebotomists' safety practices: a College of American Pathologists Q-Probes study of 683 institutions. *Arch Pathol Lab Med* 118:957–962.

Ihrig M, Cookson ST, Campbell K, Hartstein AI, Jarvis WR [1997]. Evaluation of the acceptability of a needleless vascular-access system by nurses. *Am J Infect Control* 25(5):434–438.

International Health Care Worker Safety Center [1997]. Uniform needlestick and sharp-object injury report 1996, 65 hospitals. *Adv Exposure Prev* 3(2):15–16.

Ippolito G, Puro V, Heptonstall J, Jagger J, De Carli G, Petrosillo N [1999]. Occupational human immunodeficiency virus infection in health care workers: worldwide cases through September 1997. *Clin Infect Dis* 28:365–383.

Jagger J [1996]. Reducing occupational exposure to bloodborne pathogens: where do we stand a decade later? *Infect Control Hosp Epidemiol* 17(9):573–575.

Jagger J, Hunt EH, Brand-Elnagger J, Pearson RD [1988]. Rates of needle-stick injury caused by various devices in a university hospital. *N Engl J Med* 319(5):284–288.

Kellerman S, Shay DK, Howard J, Goes C, Feusner J, Rosenberg J, Vugia DJ, Jarvis WR [1996]. Bloodstream infections in home infusion patients: the influence of race and needleless intravascular access devices. *J Pediatr* 129(5):711–717.

Krasinski K, LaCouture R, Holzman RS [1987]. Effect of changing needle disposal systems on needle puncture injuries. *Infect Control* 8(2):59–62.

Lawrence LW, Delclos GL, Felkner SA, Johnson PC, Frankowski RF, Cooper SP, Davidson A [1997]. The effectiveness of a needleless intravenous connection system: an assessment by injury rate and user satisfaction. *Infect Control Hosp Epidemiol* 18(3):175–182.

McCormick RD, Maki DG [1981]. Epidemiology of needle-stick injuries in hospital personnel. *Am J Med* 70:928–932.

McCormick RD, Meisch MG, Ircink FG, Maki DG [1991]. Epidemiology of hospital sharps injuries: a 14-year prospective study in the pre-AIDS and AIDS eras. *Am J Med* 91(Suppl 3B):301S–307S.

Murphy LR, Gershon RM, Dejoy D [1996]. Stress and occupational exposure to HIV/AIDS. In: Cooper CL, ed. *Handbook of stress, medicine, and health*. Boca Raton, FL: CRC Press, pp. 177–190.

NCCC, DVA [1997]. Needle stick prevention in the Department of Veterans Affairs; 1996 follow-up survey results. Milwaukee, WI: National Center for Cost Containment and Department of Veterans Affairs.

NIOSH [1998]. Selecting, evaluating, and using sharps disposal containers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 97–111.

Osborn EHS, Papadakis MA, Gerberding JL [1999]. Occupational exposures to body

fluids among medical students. A seven-year longitudinal study. *Ann Intern Med* 130(1):45–51.

OSHA [1999a]. National news release: Labor Secretary announces plans to combat needlestick injuries among healthcare workers. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, USDL 99–145.

OSHA [1999b]. OSHA Directives 2-2.44D—Enforcement procedures for the occupational exposure to bloodborne pathogens. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. [www.osha-slc.gov/OshDoc/Directive_data/CPL_2-2_44D.html]. Date accessed: November 11, 1999.

OSHA [1999c]. Record summary of the request for information on occupational exposure to bloodborne pathogens due to percutaneous injury. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. [www.osha-slc.gov/html/ndlreport052099.html]. Date accessed: August 9, 1999.

Polish LB, Tong MJ, Co RL, Coleman PJ, Alter MJ [1993]. Risk factors for hepatitis C virus infection among health care personnel in a community hospital. *Am J Infect Control* 21(4):196–200.

Pugliese G, ed. [1998]. Using safer needle devices: the time is now. Report of the National Committee on Safer Needle Devices. Arlington, TX: Johnson & Johnson Medical.

Pugliese G, Salahuddin M, eds. [1999]. Sharps injury prevention program: a step-by-step guide. Chicago, IL: American Hospital Association.

Quebbeman EJ, Short LJ [1995]. How to select and evaluate new products on the market. *Surg Clin North Am* 75(6):1159–1165.

Ramos-Gomez F, Ellison J, Greenspan D, Bird W, Lowe S, Gerberding JL [1997]. Accidental exposures to blood and body fluids among health care workers in dental teaching clinics: a prospective study. *J Am Dent Assoc* 128:1253–1261.

Ridzon R, Gallagher K, Ciesielski C, Mast EE, Ginsberg MB, Robertson BJ, Luo C, DeMaria A Jr. [1997]. Simultaneous transmission of human immunodeficiency virus and hepatitis C virus from a needle-stick injury. *N Engl J Med* 336(13):919–922.

Roy E, Robillard P [1995]. Underreporting of accidental exposures to blood and other body fluids in health care settings = an alarming situation (abstract). *Adv Exposure Prev* 1(4):11.

Ruben FL, Norden CW, Rockwell K, Hruska E [1983]. Epidemiology of accidental needle-puncture wounds in hospital workers. *Am J Med Sci* 286(1):26–30.

Seeff LB [1991]. Hepatitis C from a needle-stick injury. *Ann Intern Med* 115(5):411.

SEIU [1998]. SEIU's guide to preventing needlestick injuries. 3rd ed. Washington, DC: Service Employees International Union.

Shapiro CN [1995]. Occupational risk of infection with hepatitis B and hepatitis C virus. *Surg Clin North Am* 75(6):1047–1056.

State of California [1998]. California proposed emergency standard: 5193; bloodborne pathogens. Sacramento, CA. [www.dir.ca.gov/DIR/OS&H/OSHSB/bloodborne.html]. Date accessed: December 21, 1998.

Yassi A, McGill M [1991]. Determinants of blood and body fluid exposure in a large teaching hospital: hazards of the intermittent intravenous procedure. *Am J Infect Control* 19(3):129–135.

Yassi A, McGill ML, Khokhar JB [1995]. Efficacy and cost-effectiveness of a needleless intravenous access system. *Am J Infect Control* 23(2):57–64.

Zafar AB, Butler RC, Podgorny JM, Mennonna PA, Gaydos LA, Sandiford JA [1997]. Effect of a comprehensive program to reduce needlestick injuries. *Infect Control Hosp Epidemiol* 18(10):712–715.

SUGGESTED READINGS

Association for Professionals in Infection Control and Epidemiology, Inc. [1998]. APIC position paper: prevention of device-mediated bloodborne infections to health care workers. *Am J Infect Control* 26: 578–580.

Charney W (ed.) [1994]. *Essentials of modern hospital safety*. Vol. 3. Ann Arbor, MI: CRC Press.

Cone JE, Hagadone K, Boyd A [1999]. The epidemiology of sharps injuries. In: *The epidemic of health care worker injury: an epidemiology*. Charney and Fragala, eds. New York, NY: CRC Press.

ECRI [1998]. Needlestick-prevention devices. *Health Devices* 27:183–232.

OSHA [1997]. *Safer needle devices: protecting health care workers*. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, Directorate of Technical Support.

OSHA [1999]. How to prevent needlestick injuries: answers to some important questions. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

OSHA [1996]. Occupational exposure to bloodborne pathogens. Washington, DC:

U.S. Department of Labor, Occupational Safety and Health Administration, OSHA, #3127 (Revised).

Porta C, Handelman E, McGovern P [1999]. Needlestick injuries among health care workers: a literature review. *Am Assoc Occup Health Nur J* 47(6):237–244.

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

OFFICIAL BUSINESS
Penalty for private use \$300

FIRST CLASS
Postage and
Fees paid
PHS CDC
Permit No.
G-284



To receive NIOSH documents or more information about occupational safety and health topics, contact NIOSH at

1-800-35-NIOSH (1-800-356-4674)

Fax: (513) 533-8573

E-mail: pubstaff@cdc.gov

or visit the NIOSH Web site at: www.cdc.gov/niosh

DHHS (NIOSH) Publication No. 2000-108