

# Prevention and Management of Occupational Exposures to Human Immunodeficiency Virus (HIV)

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## Abstract

Occupational exposure to blood and other potentially infectious body fluids places health care workers at risk for acquisition of bloodborne pathogens, including the human immunodeficiency virus (HIV). Utilizing appropriate techniques, personal protective equipment, and safer “sharp” technology can minimize the risk of these exposures. When exposure does occur, immediate evaluation and initiation of post-exposure prophylaxis, when indicated, can substantially reduce the risk of transmission of HIV. In this article, the basic concepts of exposure prevention and management are reviewed.

**Key Words:** HIV, occupational exposure, needlestick injury, precautions, post-exposure prophylaxis.

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## Background

BY THE END OF 2001, 57 documented cases of occupationally acquired HIV infection among United States health care workers (HCWs) had been reported to the CDC (1). HCWs are at risk for occupational acquisition of HIV and other bloodborne pathogens (such as hepatitis B virus [HBV] and hepatitis C virus [HCV]) when there is exposure to a potentially infectious material by a route that can lead to viral transmission (2). Potentially infectious materials include: blood, any visibly bloody body fluid, semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid and amniotic fluid, and unfixed tissue. The routes of exposure that are considered to place HCWs at risk for infection include percutaneous injuries and contact of mucous membranes or nonintact skin with potentially infectious material. Direct contact with concentrated HIV virus in the laboratory setting would also be included.

Unfortunately, occupational exposures to potentially infectious materials are not uncommon among health care workers. The International Healthcare Worker Safety Center at the University of Virginia estimated that during 1996 there were a total of 786,885 percutaneous and mucocutaneous exposures to blood and other potentially infectious substances among health care workers in the U.S. (3). The majority of these exposures were the result of percutaneous injuries, the route of occupational exposure associated with the highest risk of transmission of HIV and other bloodborne pathogens. The rate of percutaneous injury (expressed as the number of injuries per 100 occupied beds per year) among HCWs in 48 health care facilities participating in the EPINet surveillance program in 2003 was found to be 26.8 in teaching hospitals and 18.7 in nonteaching hospitals (4). Although several studies have shown that rates of occupational exposures have decreased somewhat in recent years (5, 6), exposures to potentially infectious body substances remain a substantial occupational hazard for health care workers.

The average risk of HIV transmission is approximately 0.3% following percutaneous exposure to HIV-infected blood (7). All percutaneous exposures, however, do not present the same risk of transmission. A case-control study of HCWs who had percutaneous exposure to HIV-infected blood identified several factors that were independently associated with HIV seroconversion among

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the exposed HCWs (8). These factors included: deep injury, injury caused by a visibly bloody device, injury caused by a needle that had been directly in the source patient's blood vessel, and exposure to a source patient who died of the acquired immunodeficiency syndrome within two months after the exposure. This last risk factor is most likely a marker for advanced HIV disease with high-level viremia in the source patient, resulting in a higher inoculum in the exposed health care worker. As compared to percutaneous exposures, exposures of mucous membranes and nonintact skin to HIV-infected blood are associated with a lower likelihood of transmission. The average risk for mucous membrane exposures is approximately 0.09%. The risk associated with exposures of nonintact skin has not been quantified but is thought to be even lower than that associated with mucous membrane exposures (2).

### Preventing Occupational Exposures

While post-exposure antiretroviral prophylaxis (which will be discussed later) may substantially reduce the risk of transmission following an occupational exposure to HIV, it does not eliminate the risk of transmission, nor can it completely allay the anxiety that many HCWs experience following an exposure (9–11). In addition, some HCWs receiving post-exposure prophylaxis (PEP) will experience substantial, sometimes intolerable, side effects. Finally, an effective PEP regimen for exposures to hepatitis C virus has not been identified. Thus, prevention efforts must be focused not only on prevention of viral transmission once an exposure has occurred but on primary prevention of exposures as well.

There are a number of measures that can be taken to prevent exposures to potentially infectious substances in the health care setting. These measures, which are described in the paragraphs below, include Standard Precautions (12), work practice controls, and engineering controls. Incorporation of each of these measures into the daily practice of HCWs can substantially reduce the risk of exposure.

Standard Precautions, which replaced Universal Precautions and Body Substance Isolation in the CDC's 1996 Guideline for Isolation Precautions in Hospitals (12), are designed to reduce the risk of transmission of bloodborne and other pathogens and are intended for use during the care of all patients. Standard Precautions apply to anticipated contact with blood, all body fluids, excretions, and secretions (except sweat), nonintact skin, and mucous membranes. The main features

of Standard Precautions include hand hygiene and the use of personnel protective equipment such as gloves, gowns, and face protection (i.e., mask, eye protection, face shield), when appropriate, to protect the worker from exposure to pathogens. For instance, gloves should be worn whenever contact with any of the body substances or tissues mentioned above is anticipated. Gowns should be used to protect the HCW's skin and clothing during activities that may result in direct contact with body substances, mucous membranes, or nonintact skin or creation of a spray, splash, or splatter of body substances. Face protection should be used to protect the mucous membranes of the eyes, nose, and mouth during activities in which spray, splash, or splatter of body substances may occur.

Work practice controls reduce the likelihood of exposure to potentially infectious materials by altering the manner in which a task is performed. The appropriate work practice control(s) should be included as part of the training process for all patient care activities and procedures. The Table lists some work practice controls that can reduce the risk of percutaneous injuries in the health care setting.

The term "engineering controls" refers to equipment, devices, or instruments that have been designed so that they remove or reduce the likelihood of exposure. Examples of engineering controls include sharps with engineered sharps injury protection components (e.g., self-retracting needles and lancets), needleless systems, sharps disposal containers, and blunt suture needles.

The federal government mandates that these approaches to reducing the risk of HCW exposure to HIV and other bloodborne pathogens be made available to HCWs by their employer. In order to reduce the health risk to workers whose duties place them at risk for exposure to blood or other potentially infectious materials, the Occupational Safety and Health Administration (OSHA) issued the Bloodborne Pathogens (BBP) standard in

**TABLE**  
*Examples of Work Practice Controls to Prevent  
Percutaneous Injuries*

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Avoid unnecessary use of needles and other sharps.
Do not recap needles.
Announce all sharps being introduced onto or removed from the field.
Pass sharps only in a designated area ("safe zone").
Disassemble sharp equipment by use of forceps or other device rather than by hand.
Do not hold body tissue with fingers when suturing or cutting.
Do not leave sharps on the field.
When suturing, use a needle of appropriate length for the thickness of the tissue.

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1991. The standard was subsequently revised in 2001 in response to the Needlestick Safety and Prevention Act (13). In addition to Standard Precautions, work practice controls, and engineering controls, the document outlines requirements for selection and implementation of new control technology, documentation of percutaneous injuries, and HCW training.

### **Preventing HIV Transmission after Exposure**

Despite efforts to prevent occupational exposures to potentially infectious body substances, HCW exposures to these substances continue to occur. Fortunately, a number of interventions can be taken that may reduce the risk of transmission of HIV following an exposure. The Centers for Disease Control and Prevention have provided guidelines for management of occupational exposures to HBV, HCV, and HIV (2). The guidelines for management of occupational exposures to HIV were recently updated (14).

The first step in post-exposure management is to clean the site of exposure. The site of a percutaneous injury or skin exposure should be cleaned immediately with soap and water. Mucous membranes should be flushed copiously with water (2). The exposure should then be reported using the protocol developed by the facility in which the exposure occurred, so that appropriate evaluation of the source patient and, if indicated, evaluation and treatment of the exposed HCW can occur.

### **Source Patient Evaluation**

At the end of 2003, there were an estimated 925,000–1,185,000 persons living in the United States who were infected with the human immunodeficiency virus (HIV) (15). Approximately one-quarter of these individuals were unaware of their HIV infection. The source patient's HIV infection status is invaluable in determining the risk of the exposure to the affected HCW and in determining whether post-exposure prophylaxis (PEP) should be recommended to the HCW. Source patient interviews and HIV testing are key components in the occupational BBP exposure program because, as mentioned above, many persons infected with HIV are unaware of their infection status and others may not routinely disclose their HIV infection status.

Standard HIV testing methods, such as enzyme immunoassays (EIA), are not routinely available around the clock. Thus, the HIV infection status of the source patient has frequently been unknown at the time when initial post-exposure management decisions must be made. Given the evidence that

HIV PEP is more effective when initiated early after the exposure (as discussed below), many HCWs have initially been prescribed PEP with discontinuation of therapy if the source patient was subsequently found to be HIV-negative. The development of a new generation of HIV diagnostic techniques that can be performed around the clock, that can provide results within one to two hours, and that have sensitivity and specificity similar to that of EIA has the potential advantages of reducing the number of courses of HIV PEP initiated (16, 17), reducing the number of HIV PEP doses ingested (9) decreasing HCW anxiety and side effects of antiretroviral PEP therapy, and decreasing the cost of HIV PEP for occupational exposures (9).

Unfortunately, the source patient's HIV serological status will not be immediately available for all occupational exposures and may never be available in at least a small proportion of exposures. One situation in which this occurs is that of an exposure that involves an unknown source patient. Proper handling and discarding of sharps, prompt cleaning of blood and other body fluid spills, and labeling of specimens of blood and other potentially infectious body substances will minimize the risk of such exposures. A second situation in which the source patient's HIV status remains unknown is that in which there is an inability to obtain consent for HIV testing from the source patient. In the United States, the requirement for informed consent from the source patient in occupational exposures varies from state to state. In situations in which the HIV status of the source patient is unknown at the time of initial evaluation of the exposed HCW, the decision to initiate HIV PEP must be made taking into account all other data available (e.g., type and severity of exposure, prevalence of HIV in the local community, and patient-specific risk factors for HIV infection).

### **Post-exposure Prophylaxis**

Although data regarding the efficacy of PEP following occupational exposures to HIV are limited, there is evidence that administration of one or more antiretroviral agents to the exposed HCW can substantially reduce the risk of HIV transmission. In a case-control study of health care workers with percutaneous exposures to HIV, logistic-regression analysis found that HCWs who became infected following an exposure were significantly less likely to have taken zidovudine after the exposure than were those who did not become infected (OR 0.19,  $p=0.003$ ) (8). Based on this study, PEP is generally considered to reduce the risk of transmission by approximately 80%. Whether current

prophylaxis regimens which involve administration of at least two antiretroviral medications, as opposed to the monotherapy that was typically prescribed during the period of the study, offer additional protective benefits has not been specifically evaluated in the setting of occupational exposures.

Given the limited amount of specific data regarding post-exposure prophylaxis for occupational exposures, data from other settings may help to inform decisions and recommendations regarding occupational exposures to HIV. For instance, administration of zidovudine within 48 hours of birth to infants of HIV-infected mothers significantly reduced the risk of infant infection (18). Animal models may also provide useful information regarding both the efficacy of PEP and the optimal timing and duration of therapy. Animal models of simian immunodeficiency virus infection following intravenous inoculation have found tenofovir (a nucleotide reverse transcriptase inhibitor) to be protective when administered within 24 hours of exposure and continued for 28 days following exposure (19, 20). The effectiveness of tenofovir was reduced if administration was delayed until 48 or 72 hours after exposure or if the duration of therapy was reduced to 3 or 10 days. These findings highlight the importance of immediate reporting of exposures and rapid institution of antiretroviral therapy when indicated.

The decision to initiate post-exposure prophylaxis is based on an assessment of the level of risk associated with each exposure. This assessment should take into account all available information, including the type and severity of the exposure, the source patient's HIV status and/or risk factors for HIV infection, and the prevalence of HIV in the local population (if source patient's HIV status is unknown) (14). Based on available data, when HIV PEP is indicated, it should be initiated as soon as possible after the exposure (e.g., within two hours) and continued for 4 weeks.

When the decision is made to initiate HIV PEP, issues that must be considered during regimen selection include: efficacy of the antiretroviral agent(s), the likelihood that the strain to which the HCW was exposed will be susceptible to various antiretroviral agents, pill burden, and tolerability. HIV PEP regimens typically consist of two or three antiretroviral medications. Current CDC guidelines include recommendations for the use of a two-drug regimen for lower risk exposures and a three-drug regimen for higher risk exposures (14). Other agencies, such as the New York State Department of Health AIDS Institute, have recommended a three-drug regimen for all occupational exposures (21). A detailed discussion of HIV PEP regimen selection is

beyond the scope of this article, but abundant resources, such as the CDC guidelines (14), exist for those with additional interest.

When post-exposure prophylaxis is being considered, consultation with an expert is recommended. For those without access to a local expert, an excellent resource is the National Clinician's Post-Exposure Prophylaxis Hotline ([PEpline], 1-888-448-4911), which is operated by the University of California, San Francisco, and provides 24-hour expert consultation to health care professionals managing occupational exposures to bloodborne pathogens. Other agencies, such as state and local health departments and HIV treatment centers, also provide 24-hour consultation services. Individuals involved in the evaluation and management of HCWs with occupational exposures to potentially infectious substances should be familiar with locally available resources.

Unfortunately, the potential benefits of HIV PEP often come with substantial side effects. Drug interactions are common with antiretroviral medications, particularly protease inhibitors, and thus must be considered when selecting a prophylaxis regimen. Side effects are also quite common among recipients of HIV PEP, with reported rates of up to 75% or higher (22–25). The frequency of side effects and the type of side effects experienced are somewhat dependent on the number and class of agent(s) and the specific medication(s) prescribed. Gastrointestinal complaints such as nausea, vomiting, abdominal pain, and diarrhea are among the most commonly reported. Other common complaints include fatigue and headache. More than just a nuisance, these side effects can present a significant barrier to adherence to the prophylaxis regimen. In fact, up to one-quarter of individuals prescribed HIV PEP discontinue therapy due to side effects (23, 24). Extensive counseling, thoughtful selection of antiretroviral prophylaxis regimens, aggressive identification and treatment of prophylaxis-related side effects, and, when necessary, substitution of the offending medication may reduce the frequency of discontinuation.

### **Counseling and Follow-up of the Exposed HCW**

Counseling the exposed HCW is a critical component of any evaluation of an occupational exposure to potentially infectious substances. Topics that should be included in the discussion are: the risk of acquisition of each of the bloodborne pathogens, side effects of any treatments initiated, measures that can reduce the risk of secondary transmission (e.g., abstinence or use of condoms), signs and

symptoms of acute HIV infection, and recommendations for follow-up evaluation and testing.

The exposed HCW should have serial testing for HIV antibodies performed for at least 6 months following an occupational exposure. Testing is recommended at the time of the exposure and again at 6 weeks, 12 weeks, and 6 months after the exposure. Follow-up should be extended to 12 months if the HCW acquires HCV through exposure to a source patient co-infected with HIV and HCV (14).

### Conclusion

Exposure to blood and other potentially infectious body substances is a relatively common occupational hazard for health care workers. These exposures place HCWs at risk for infection with bloodborne pathogens, such as HIV, and often cause the exposed worker substantial emotional and/or psychological stress. In order to reduce these risks, all health care employers should develop comprehensive exposure control programs that include measures to prevent exposures and reduce the likelihood of viral transmission when an exposure does occur. Some of the key components of these programs include HCW education and training, provision of necessary personal protective equipment and safer sharp devices, source patient testing, and a method by which post-exposure prophylaxis can be initiated rapidly when indicated. HCWs can further contribute to their own safety and the safety of their colleagues by performing duties in a manner that minimizes the risk of exposure, appropriately using safer sharps technology, and promptly reporting any exposures that may occur.

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