

# LABORATORY BIOSAFETY

Robert E. Johnson, M.D., M.P.H., Sandra A. Larsen, Ph.D., William E. Morrill, B.S.

## **CONTENTS**

### **Risk Assessment**

- Blood Exposures
- Other Exposures

### **General Safety Principles**

- Biosafety Manual
- Universal Precautions
- Immunizations
- Laboratory Area
- Hands
- Gloves (latex)
- Laboratory Clothing
- Protective Shields
- Biological Cabinets
- Centrifuges
- Other Laboratory Equipment
- Needles, Sharp Instruments
- Glassware
- Pipettes
- Absorbent Papers
- Sterilization, Decontamination, and Disinfection
- Housekeeping
- Infective Waste
- Specimen Collection, Handling, and Processing
- Invasive Procedures

### **Management of Accidental Exposures**

- Reporting
- Advising
- Testing of Source Persons
- Postexposure Management

### **Management of Infected Health Care Workers**

### **Employers= Responsibilities in Implementing Precautions**

- Education
- Equipment and Laboratory Facility
- Practice

### **References**

## LABORATORY BIOSAFETY

The possibility or risk of exposure to infectious agents in specimens is the principal biosafety concern for health workers in the laboratory diagnosis of infection with *Treponema pallidum*. Biosafety precautions are directed primarily at the prevention of such exposures, or diminishing the risk of infection should exposures occur. Should a health worker be exposed during diagnostic procedures, the likelihood of exposure to particular infectious agents needs to be determined and the appropriate prophylactic and follow-up measures undertaken. The information in this chapter is drawn from published biosafety guidelines<sup>1-4</sup> and articles reviewing the prevention and management of exposures to blood-borne infections.<sup>5-17</sup>

### RISK ASSESSMENT

#### Blood Exposures

By far, the most common specimen collected and processed in the diagnosis of *T. pallidum* infection is blood. Although cerebral spinal fluid (CSF) is much less commonly collected for this purpose, and has received much less attention in biosafety-related studies, the hazards and the pertinent precautions and exposure management procedures are considered to be the same as those for blood specimens. The risk of infection due to an occupational exposure to blood depends upon the prevalence of blood-borne pathogens in the population supplying the blood specimens, the probability of infection given a particular type of exposure to a blood-borne pathogen, and the frequency of exposures.<sup>12,18</sup>

*T. pallidum* is present in circulating blood during primary and secondary syphilis. The minimum number (LD50) of *T. pallidum* organisms needed to infect by subcutaneous injection is 23.<sup>19</sup> The concentration of *T. pallidum* in patients' blood during early syphilis, however, has not been determined. The ability of blood inoculated with *T. pallidum* to infect animals is reduced by refrigerated storage.<sup>20,21</sup> Although multiple instances of transmission of *T. pallidum* due to transfusion of an infected donor's blood were reported prior to the introduction of penicillin for treatment of syphilis and of refrigeration for blood storage.<sup>20</sup> Subsequent reports have been rare.<sup>20,22</sup>

Infection of a health care or laboratory worker following exposure to *T. pallidum* infected blood has, apparently, not been reported.

Authoritative sources focus attention on infection with hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) as the principal concerns associated with exposure to blood.<sup>10,13,14,16,18</sup> The prevalence of these infections varies greatly among patient populations tested for *T. pallidum* infection. HBV infection is most common. HBV viremia is indicated by tests for HBV surface antigen (HBSAG) in serum. Prevalence of anti-HBsAg, from published studies of patients in hospitals and emergency rooms cited in a recent review, ranged from 0.9% to 6%.<sup>18,23-26</sup> Unlike initial HBV infection, in which only a minority of individuals continue to be viremic, initial HCV and HIV infections lead to persistent viremia in most individuals. Consequently, serum antibody to HCV and HIV are indicators of potential infectiousness. Seroprevalences of antibody to HCV in studies of patients in hospitals and emergency rooms cited in

a recent review ranged from 2% to 18%.<sup>16,25,27,28</sup> HIV prevalence ranged from 0.1% to 5.6% in patients enrolled in a national hospital surveillance system.<sup>12,29</sup> All three infections are more common among patients at increased risk for syphilis, especially patients with a history of illegal drug use. For example, seroprevalences of antibody to HCV were 10% among non-drug-using attendees at sexually transmitted diseases clinics and 60% among injection-drug users.<sup>11,17,30</sup>

While infections with HBV<sup>17,31</sup> and HIV<sup>5,14,32,33</sup> can occur with skin and mucus membrane exposures to blood, needlestick and percutaneous injury with blood-coated sharp objects are the principal sources of laboratory associated acquisition of these agents. The risk of infection following exposure to blood from an infected patient is greatest for HBV, except for exposed individuals who are immune due to prior HBV infection or vaccination. The risk is highest if the source individual is HBSAG-positive<sup>17,34-36</sup> and is positive for envelope (E) antigen. A vaccine to prevent HBV infection has been available since 1982 and is strongly recommended for health care workers with potential exposures to blood or other body fluids.<sup>34,37,38</sup> Individuals with anti-HBV antibody from vaccination or prior infection are considered to be immune to HBV infection.

The risk of HCV infection due to needlestick exposure to blood from an individual with antibody to HCV was 10% in one study,<sup>15,17,39</sup> but HCV does not appear to survive long in serum held at room temperature.<sup>17,40</sup> A vaccine is not yet available to immunize against HCV infection. Repeated infection with HCV appears to be possible in spite of detectable serum anti-HCV antibody, although the significance of reinfection is unknown.<sup>11,41,42</sup>

The risk of infection with HIV following a single needlestick exposure to blood from a patient known to be infected with HIV is approximately 0.3%.<sup>12</sup> The risks following mucous membrane or skin exposures to HIV-infected blood average approximately 0.1% and <0.1%, respectively.<sup>5,14,33,43</sup> The lower rate of transmission for HIV than for HBV or HCV probably reflects a lower concentration of HIV in the blood of infected persons. A vaccine is not available to immunize against HIV infection. The frequency and significance of repeated exposure of individuals with prior anti-HIV antibody is unknown.

## **Other Exposures**

The collection and processing of specimens from lesions suspected to be syphilitic could potentially result in exposure to the causative agents of such lesions, such as *T. pallidum*, herpes simplex viruses and *Haemophilus ducreyi*, as well as exposure to potential pathogens unrelated etiologically to the lesion, including those described above for blood specimens. Similar exposures could result during the collection and processing of tissue specimens.

The occupational acquisition of syphilis by health care workers has occurred when gloves were not worn in handling infectious lesions or when ungloved hands came in contact with oral or genital secretions containing *T. pallidum*. Primary chancres, secondary syphilis mucous patches, and condyloma lata are infectious. The gummas of tertiary syphilis, which contain only a few *T. pallidum* organisms, are not infectious. Syphilis has been transmitted to laboratory personnel working with a concentrated suspension of *T. pallidum* obtained from an experimental rabbit orchitis.<sup>44,45</sup> However, little is known about the frequency of nonblood exposures among health care

and laboratory workers or the potential risk of infection associated with various types of exposures. Presumably, the frequency of one or more agents in specimens from individuals with disease would be relatively high. The risk of infection following exposure is presumed to be highest for percutaneous exposures with needles or sharp objects, somewhat less for exposures of nonintact skin or mucosa, and least for exposures of intact skin.

## GENERAL SAFETY PRINCIPLES

This section is an abbreviated version of the biosafety recommendations of the Centers for Disease Control and Prevention (CDC),<sup>1,2,7,9</sup> which have been adopted by the Occupational Safety and Health Association (OSHA)<sup>4</sup> and the National Committee for Clinical Laboratory Standards (NCCLS)<sup>4</sup> and included in their respective guidelines. Recommendations to prevent transmission of HIV, HBV, HCV, and other blood-borne pathogens such as *T. pallidum* are included. The following precautions expand on general laboratory safety practices that should already be in place in clinical laboratories.<sup>1,3,4,7-9,46,47</sup>

### Biosafety Manual

A safety manual which is written according to established guidelines<sup>8,46,47</sup> and which contains general information should be readily available at all times. The instructions should be easy to understand and include information such as: 1) emergency telephone numbers, 2) first aid procedures, 3) fire safety guidelines, 4) chemical hygiene, 5) handling of flammable, caustic, toxic, carcinogenic, and radioactive materials, 6) handling and storage of compressed gas cylinders, 7) use and maintenance of containment cabinets, 8) use of sterilization and decontamination equipment, 9) use of disinfectants and antiseptics, and 10) biosafety information<sup>47</sup> similar to that provided in this chapter.

### Universal Precautions

Because medical history and examination cannot reliably identify all patients with HIV or other blood-borne pathogens, all patients should be assumed to be infectious. This approach to infection control, recommended by CDC, is referred to as "universal precautions."<sup>8,9</sup> Universal precautions should be followed when workers are exposed to blood, certain other body fluids (amniotic fluid, pericardial fluid, peritoneal fluid, pleural fluid, cerebrospinal fluid, synovial fluid, semen, and vaginal secretions), or any body fluid visibly contaminated with blood.<sup>8</sup> Universal precautions<sup>3,8,9</sup> are intended to supplement rather than replace recommendations for routine infection control. The implementation of universal precautions does not eliminate the need for other category- or disease-specific isolation precautions such as those for infectious diarrhea or pulmonary tuberculosis.<sup>3,9</sup>

### Immunizations

All workers whose jobs involve participation in tasks or activities that may result in exposure to blood or other body fluids to which universal precautions apply<sup>8,9</sup> should be vaccinated with hepatitis B vaccine.

## **Laboratory Area**

Limit or RESTRICT ACCESS to the laboratory. Post biosafety hazard signs at entrances. Design the laboratory for easy cleaning. Benchtops should be impervious to spills and resistant to acid, alkaline, organic solvents, and moderate heat. Each laboratory must contain a sink for hand washing and an autoclave must be available to decontaminate infectious wastes. DO NOT EAT, DRINK, SMOKE, apply cosmetics or contact lenses, or prepare food or drink in the work area. Store food in refrigerators or cabinets designated for this purpose and located outside the work area.

Decontaminate laboratory work surfaces with an appropriate chemical germicide (1:10 dilution of bleach, 1% amphy) after a spill of blood or other body fluids, and do so routinely when work activities have been completed.

## **Hands**

Frequent and careful hand washing is one of the most effective means of preventing disease in the laboratory.<sup>48</sup> WASH HANDS thoroughly and frequently with an effective detergent (bactericidal soap). Wash hands and other skin surfaces immediately if contaminated with blood or other body fluids. Always wash hands immediately after removing gloves and before leaving the laboratory, eating, drinking, smoking, or using the bathroom. Do not touch items such as a telephones, doorknobs, laboratory equipment, or computer keyboards with contaminated hands.

## **Gloves (latex)\***

WEAR protective GLOVES at all times when working with blood, body fluid specimens, or tissue; collecting or touching blood or other body fluids; touching patient's mucous membranes, nonintact skin, lesions or lesion material; and handling items or surfaces contaminated with blood or body fluids. When gloves are visibly contaminated, remove carefully and discard; immediately wash hands and put on fresh gloves. Contaminated gloves can be a source of infection. While wearing gloves, avoid hand contact with eyes, ears, nose and mouth. REMOVE GLOVES and wash hands before handling equipment not used in processing or testing of specimens, such as the telephone or the computer keyboard. If clean items must be or are accidentally touched, use a paper towel moistened with an antibacterial solution to handle the equipment or disinfect the equipment immediately after use. Do not wash or disinfect gloves for reuse.

\*Personnel who have dermatitis or other lesions on the hands, arms, neck, and face, and who may touch potentially infectious material, should cover the lesions with a water-impermeable occlusive dressing.<sup>3</sup> Personnel with allergies to latex should use glove liners or gloves recommended by their dermatologist. Under certain circumstances, a person may be temporarily assigned to a nonrisk area.<sup>3</sup>

## **Laboratory Clothing**

WEAR a LABORATORY COAT, gown, or uniform with long sleeves when collecting or working with specimens. Protective garments should be fluid-resistant; disposable laboratory coats made of polyethylene-coated, spunbonded polypropylene are suitable. Discard garment if protective coating is punctured or if coat is soiled with caustic or carcinogenic chemicals or infectious body fluids or tissue. Spot-clean or totally disinfect nondisposable protective clothing that becomes contaminated. Remove protective clothing before leaving the laboratory and leave clothing in the laboratory or place in a designated receptacle for decontamination.

### **Protective Shields**

WEAR masks and protective eyewear or FACE SHIELDS during procedures that are likely to generate droplets of blood plasma, serum, or aerosols of other infectious material. For example, when stoppers are removed from vacuum type blood collection tubes outside a biological safety cabinet, wear a mask and protective eyewear or face shields. Cover the stopper with an absorbent paper or cloth and gently twist the stopper to remove it from the tube. Dispose of protective papers by placing into discard containers to be decontaminated. Contact lenses provide no protection and may hinder decontamination of the eyes.

### **Biological Cabinets**

For routine procedures, such as histologic and pathology studies, microbiologic culturing or the rotation of specimens for nontreponemal tests, a biological safety cabinet is not necessary. However, use biological safety cabinets (Class I or II) when the potential for creating infectious aerosols or splashes exists, or high concentrations of infectious agents are present. These include activities such as blending, sonicating, vortexing, and other vigorous mixing. Clean and disinfect cabinets after every use or when spills occur.

### **Centrifuges**

Aerosol production during centrifugation can contribute to the spread of some infectious diseases. Cap tubes to be centrifuged or place in centrifuge safety cups with lids. Operate the centrifuge with the top closed and do not open until the rotor has stopped.

If possible, locate laboratory centrifuges away from other laboratory work areas. Position microfuges, serofuges, and other tabletop centrifuges so that their air exhaust vents are directed away from laboratory personnel. Instruct each centrifuge operator in proper operating procedures. Clean centrifuges daily (and whenever contamination may have occurred) with germicidal solution containing 5,000 ppm available chlorine such as 0.525% sodium hypochlorite [1:10 dilution of 5.25% NaOCl (household bleach)].<sup>49</sup>

Broken tubes in centrifuges may be the most common hazard in the clinical laboratory. Remove unbroken tubes carefully and disinfect the outside of the tubes. Soak the centrifuge carrier that contains the broken tube in a chemical germicide or disinfectant soap, place the carrier in fresh germicide and rinse. Remove broken tubes carefully with forceps and place in a discard container.

Follow specific instructions for disinfection of the inside of the centrifuge issued by the centrifuge manufacturer. After a spill or breakage, disinfect the inside of the centrifuge.

### **Other Laboratory Equipment**

Disinfect scientific equipment such as freezers, centrifuges, rotators, and filters with chemical germicides before sending for repair or when contaminated. Some instruments should be cleaned with disinfectant soaps before exposing to chemical germicides or autoclaving.

### **Needles, Sharp Instruments**

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. To prevent needlestick injuries, **DO NOT RECAP NEEDLES**, purposely **BEND OR BREAK** by hand, remove from disposable syringes, or otherwise manipulate by hand. After they have been used, place disposable syringes and needles, scalpel blades, and other sharp items in puncture-resistant containers (Sharps containers) for disposal; the puncture-resistant containers should be located as close as practical to the work area. Place large-bore reusable needles in a puncture-resistant container containing detergent and disinfectant for transport to the reprocessing area. Immediately report needle sticks or other injuries from sharp instruments to the supervisor and other appropriate persons as outlined in your safety manual.

### **Glassware**

Decontaminate all laboratory glassware suspected or known to contain infectious material, preferably in an autoclave, before it is washed, discarded, or recycled. Use separate receptacles for recyclable and disposable items. Items that are being collected for autoclaving should be soaked in disinfectant.

Discard broken or chipped glassware. **DO NOT HANDLE BROKEN GLASSWARE WITH BARE HANDS**. Place broken glassware in puncture-resistant containers and, if the item was contaminated, autoclave before disposal.

Do not attempt to remove rubber stoppers or tubing on glassware by force. Replace, if necessary, with a new unit.

### **Pipettes**

Use mechanical (safety) pipetting devices for manipulation of all reagents, specimens, and other liquids in the laboratory. Do not mouth-pipette. After use, carefully lay pipettes in a horizontal container of disinfectant. Aerosols may be produced by dropping pipettes in vertical containers. Do not allow pipettes to protrude from bottles, flasks, beakers, or test tubes. Automated (robotic) pipettors with disposable tips may be used, but must be disinfected after use.

## Absorbent Papers

Use disposable, absorbent paper covers in the work area to protect the work bench and personnel from spills. Collect paper towels or absorbent material used to clean up spills, wipe work areas, open containers, or protect work areas into discard containers, and autoclave or dispose of according to institutional policies.

## Sterilization, Decontamination, and Disinfection<sup>49</sup>

Standard sterilization and disinfection procedures for patient-care equipment currently recommended for use<sup>48-50</sup> in a variety of health care settings are adequate to sterilize or disinfect instruments, devices, or other items contaminated with blood or other body fluids from persons infected with blood-borne pathogens including HIV.<sup>51,52</sup> Studies have shown that HIV is inactivated rapidly after being exposed to commonly used chemical germicides at concentrations that are much lower than used in practice.<sup>53-56</sup>

Information on specific label claims of commercial germicides can be obtained by writing to the Disinfectants Branch, Office of Pesticides, Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460.

## Decontamination of Spills<sup>3,9</sup>

The following procedure is recommended for decontaminating spills of blood, body fluids, or other infectious materials.

1. Wear gloves and a gown. Heavyweight, puncture-resistant utility gloves such as those used for housecleaning and dishwashing are recommended.

If the spill contains broken glass or other objects, these should be removed and discarded without contact with the hands. Rigid sheets of cardboard used as a Apusher@ and Areceiver@ may be used to handle such objects and discarded with the objects into an appropriate biohazard container.

2. Absorb the spill.\*

Since most disinfectants are less active, or even ineffective, in the presence of high concentrations of protein that are found in blood and serum, the bulk of the spilled liquid should be absorbed with paper towels prior to disinfection.

\* With large spills of cultured or concentrated infectious agents, the contaminated area should be flooded with a liquid germicide before cleaning. The intent is to dilute the spilled material, lyse red blood cells, and further remove proteins from the contaminated area.

3. Disinfect the spill site using an appropriate intermediate to high-level hospital disinfectant, such as a 10% dilution of household bleach. Flood the spill site or wipe down the spill site with disposable towels soaked in disinfectant to make the site glistening wet. The disinfectant should be allowed to remain on the spill site for the period of time recommended by the manufacturer.
4. Absorb the disinfectant solution with disposable material or alternatively, allow the disinfectant to dry.
5. Rinse the spill site with water to remove any noxious chemical or odors.
6. Place all disposable materials used to decontaminate the spill into a biohazard container. Handle the material in the same manner as other infectious waste.

### **Housekeeping**

Environmental surfaces such as walls and floors are not associated with the transmission of HIV, HBV, or syphilis infections to patients or health care workers. Therefore, extraordinary attempts to disinfect or sterilize these environmental surfaces are not necessary. However, surfaces should be cleaned routinely. In addition, an insect and rodent control program should be in effect, including screens for windows that open to the outside.

### **Infective Waste<sup>9,57</sup>**

The most practical approach to the management of infective waste is to identify the wastes that may cause infection during handling and disposal and for which some special precautions seem prudent. Take special precautions with microbiology laboratory waste, pathology waste, and blood specimens or blood products. Although any item that has been in contact with blood, exudates, or secretions may be potentially infective, it is not usually considered practical or necessary to treat all such waste as infective.<sup>48,51</sup> Infective waste, in general, should be either incinerated or autoclaved before disposal in a sanitary landfill. Bulk blood, suctioned fluids, excretions, and secretions may be carefully poured down a designated generator sink drain connected directly to a sanitary sewer.<sup>17</sup> If permission has been obtained from the local sewer authority, sanitary sewers also may be used to dispose of other infectious wastes capable of being ground and flushed into the sewer.

### **Specimen Collection, Handling, and Processing**

For specific details see chapter 3.

### **Invasive Procedures<sup>9</sup>**

The collection of specimens for darkfield microscopy or the direct fluorescent antibody test for *T. pallidum* (DFA-TP) may, in some instances, be considered an invasive procedure, according to the following definition.

An invasive procedure may be defined as surgical entry into tissues, cavities, or organs: (1) in an operating or delivery room, emergency department, or outpatient setting, including physicians' offices; (2) a vaginal or cesarean delivery or other invasive obstetric procedure during which bleeding may occur; or (3) the manipulation, cutting, or removal of any oral or perioral tissues, during which bleeding occurs or may occur.

All health care workers who participate in invasive procedures must routinely use appropriate barrier precautions to prevent skin and mucous membrane contact with the blood and other body fluids of all patients. Gloves and surgical masks must be worn for all invasive procedures. Protective eyewear or face shields should be worn for procedures that commonly result in the generation of droplets, the splashing of blood or other body fluids, or the generation of bone chips. Gowns or aprons made of materials that provide an effective barrier should be worn during invasive procedures that are likely to result in the splashing of blood or other body fluids.

All health care workers should wear gloves and gowns when handling a placenta or an infant until blood and amniotic fluid have been removed from the infant's skin and should wear gloves during postdelivery care of the umbilical cord.

## **MANAGEMENT OF ACCIDENTAL EXPOSURES<sup>5,7,11</sup>**

### **Reporting**

Immediately report all laboratory accidents, including spills, to the supervisor. The supervisor provides, as appropriate, access to medical evaluation, surveillance, and treatment. The laboratory supervisor maintains written records of each overt exposure to infectious material and provides a written incident report to the Safety Officer at the time of the accident.

### **Advising**

Advise the health care worker to report and seek medical evaluation for any acute febrile illness that occurs within 12 weeks after the exposure.

### **Testing of Source Persons**

When an exposure has occurred, a blood sample from the source person (after consent is obtained) should be tested for HBsAg and antibody to HIV and HCV.<sup>6,14</sup> Local laws regarding consent for testing source individuals should be followed. Policies should be available for testing source individuals in situations in which consent cannot be obtained (e.g., an unconscious patient). Testing of the source individual should be done at a location where appropriate pretest counseling is available; posttest counseling and referral for treatment should also be provided. It is extremely important that all persons who seek consultation for any HIV-related concerns receive counseling as outlined in the APublic Health Service Guidelines for Counseling and Antibody Testing to Prevent HIV Infection and AIDS.<sup>58</sup>

## Postexposure Management

### Hepatitis B

Public Health Service (PHS) recommendations for the administration of hepatitis B prophylaxis,<sup>6,14</sup> which are summarized in Table 2:1, depend upon the HBsAg status of the exposed person. The original document should be reviewed for additional details.<sup>6</sup>

**TABLE 2:1. Recommendations for hepatitis B prophylaxis following percutaneous exposure**

Exposed person	Treatment when source is found to be		Unknown or not tested
	HBsAg positive	HBsAg negative	
<b>Unvaccinated</b>	Administer HBIg x 1 and initiate hepatitis B vaccination	Initiate hepatitis B vaccination	Initiate hepatitis B vaccination
<b>Previously vaccinated</b>			
Known responder	Test exposed person for anti-HBs 1. If adequate, no treatment required 2. If inadequate, administer hepatitis B vaccine booster dose	No treatment	No treatment
Known non-responder	HBIg x 2 or HBIg x 1, plus 1 dose of hepatitis B vaccine	No treatment	If known high-risk source, may treat as if source were HBSAG positive
Response unknown	Test exposed person for anti-HB 1. If inadequate, HBIg x 1, plus hepatitis B vaccine booster dose 2. If adequate, no treatment	No treatment	Test exposed person for anti-HBs 1. If inadequate, hepatitis B vaccine booster dose 2. If adequate, no treatment

\*Hepatitis B immune globulin (HBIg) dose 0.06 ml/kg intramuscularly.

†Adequate anti-HBs is  $\geq 10$  milli-international units.

Exposed workers not previously infected and managed according to the recommended prophylaxis are at low risk for infection. These workers pose minimal risk to patients, household contacts, and sexual partners and should be counseled accordingly.<sup>14</sup>

## HIV

For any exposure to a source individual who has acquired immunodeficiency syndrome (AIDS), who is positive for HIV infection, or who refuses testing, the worker should be counseled regarding the risk of infection and evaluated clinically and serologically for evidence of HIV infection as soon as possible after the exposure.<sup>9</sup>

Based on results of a case-control study that demonstrated reduced risk of HIV infection following postexposure prophylaxis with zidovudine, the PHS provisionally recommends prophylaxis after occupational exposure to HIV.<sup>5,59</sup> Prophylaxis is likely to be most efficacious if administered within 1-2 hours postexposure. Source-patient risk factors must be considered if the source patient's HIV infection status is unknown. Since the average risk of HIV infection following occupational exposures is relatively low, the decision to initiate a particular regimen for prophylaxis should be made after also considering the degree of risk associated with the particular type of exposure; e.g., amount of blood and percutaneous versus mucous membrane or skin exposures. If the source individual is seronegative, baseline testing of the exposed worker with follow-up testing at 12 weeks may be performed if desired by the worker or recommended by the health care provider.

Table 2:2 summarizes the recommendations for postexposure prophylaxis, which include multiple-drug regimens. The original document should be reviewed for additional details.<sup>5</sup>

The worker should be advised to report and seek medical evaluation for any acute febrile illness that occurs within 12 weeks after the exposure. Such an illness, particularly one characterized by fever, rash, or lymphadenopathy, may be indicative of recent HIV infection. Following the initial test at the time of exposure, seronegative workers should be retested 6 weeks, 12 weeks, and 6 months after exposure to determine whether transmission has occurred. During this follow-up period (especially the first 6-12 weeks after exposure when most infected persons are expected to seroconvert), exposed workers should follow PHS recommendations for preventing the transmission of HIV.<sup>58</sup> These include refraining from donating blood and using appropriate protection during sexual intercourse.<sup>51</sup> During all phases of follow-up, it is vital that worker confidentiality be protected.

**TABLE 2:2. Provisional Public Health Service recommendations for chemoprophylaxis after occupational exposure to HIV, by type of exposure and source material -- 1996**

Type of exposure	Source material*	Antiretroviral prophylaxis <sup>†</sup>	Antiretroviral regimen <sup>‡</sup>
Percutaneous	Blood& Highest risk	Recommended	ZDV plus 3TC plus IDV

	Increased risk	Recommended	ZDV plus 3TC, $\pm$ IDV**
	No increased risk	Offer	ZDV plus 3TC
	Fluid containing visible blood, other potentially infectious fluid <sup>HH</sup> , or tissue	Offer	ZDV plus 3TC
	Other body fluid (e.g., urine)	Do not offer	
Mucous membrane	Blood	Offer	ZDV plus 3TC, $\pm$ IDV**
	Fluid containing visible blood, other potentially infectious fluid <sup>HH</sup> , or tissue	Offer	ZDV, $\pm$ 3TC
	Other body fluid (e.g., urine)	Do not offer	
Skin, increased risk <sup>"</sup>	Blood	Offer	ZDV plus 3TC, IDV**
	Fluid containing visible blood, other potentially infectious fluid <sup>HH</sup> , or tissue	Offer	ZDV, $\pm$ 3TC
	Other body fluid (e.g., urine)	Do not offer	

\* Any exposure to concentrated HIV (e.g., in a research laboratory or production facility) is treated as percutaneous exposure to blood with highest risk.

† *Recommend* -- Postexposure prophylaxis (PEP) should be offered to the exposed worker with counseling (see text). *Offer* -- PEP should be offered to the exposed worker with counseling (see text). *Not offer* -- PEP should not be offered because these are not occupational exposures to HIV.<sup>60</sup>

‡ Regimens: zidovudine (ZDV), 200 mg three times a day; lamivudine (3TC), 150 mg two times a day; indinavir (IDV), 800 mg three times a day (if IDV is not available, saquinavir may be used, 600 mg three times a day). Prophylaxis is given for 4 weeks. For full prescribing information, see package inserts.

& *Highest risk* -- BOTH larger volume of blood (e.g., deep injury with large diameter hollow needle previously in source patient's vein or artery, especially involving an injection of source-patient's blood) AND blood containing a high titer of HIV (e.g., source with acute retroviral illness or end-stage AIDS; viral load measurement may be considered, but its use in relation to PEP has not been evaluated). *Increased risk* -- EITHER exposure to larger volume of blood OR blood with a high titer of HIV. *No increased risk* -- NEITHER exposure to larger volume of blood NOR blood with a high titer of HIV (e.g., solid suture needle injury from source patient with asymptomatic HIV infection).

\*\* Possible toxicity of additional drug may not be warranted (see text).

<sup>HH</sup> Includes semen; vaginal secretions; cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids.

<sup>"</sup> For skin, risk is increased for exposures involving a high titer of HIV, prolonged contact, an extensive area, or an area in which skin integrity is visibly compromised. For skin exposures without increased risk, the risk for drug toxicity outweighs the benefit of PEP.

## Hepatitis C

The PHS has not published recommendations for the management of occupational exposure to HCV. No postexposure prophylactic therapy has been demonstrated to be effective. Nevertheless, since HCV infection in most individuals progresses to chronic hepatitis, an effort should be made to document infection by testing the exposed worker for antibody to HCV at the time of exposure and, if seronegative, 6 - 9 months after exposure.<sup>14</sup> Exposed workers should be informed that secondary transmission, e.g., through sexual contact, has been reported. The risk of secondary transmission through occupational, family, or sexual contacts appears to be sufficiently low that no special precautions are necessary.<sup>14</sup> Since HCV was first identified in 1989, new information is likely to emerge relatively rapidly. As with HIV infection, health care providers and laboratories should make especial effort to maintain current information on this subject.

## Syphilis

Syphilis may be acquired by clinicians who, not wearing gloves, accidentally touch infectious lesions, such as primary syphilis chancres or secondary syphilis condyloma lata or mucous patches. Laboratorians working with high *T. pallidum* concentrates from a rabbit orchitis may acquire syphilis when these concentrates touch skin breaks or mucous membranes or if the concentrates are accidentally injected by a needlestick. A syphilis serologic test should be performed to exclude preexisting syphilis, and exposed persons should also receive prophylactic penicillin; 2.4 million units benzathine penicillin G, intramuscularly (IM).

Needlestick transmission of syphilis from an untreated patient's blood to a health care worker has not been adequately documented in the literature and remains only a theoretical possibility. A health care worker who experiences such a needlestick should have a baseline syphilis serology and a repeat serology performed in 12 weeks, or sooner if a lesion develops at the needlestick site. The possibility of needlestick transmitted syphilis is greatest if the source person is in the septicemic primary or secondary syphilis stages; in this circumstance the health care worker can either be followed clinically and serologically for 12 weeks or receive prophylactic penicillin (benzathine penicillin 2.4 mu, IM) treatment.

## **MANAGEMENT OF INFECTED HEALTH CARE WORKERS**

Health care workers with impaired immune systems resulting from HIV infection or other causes are at increased risk for serious complications of infectious disease. Of particular concern is the risk of severe infection following exposure to patients with infectious diseases, e.g., measles, varicella, that are easily transmitted if appropriate precautions are not taken. Counsel health care workers with impaired immune systems about the potential risks associated with taking care of patients with a transmissible infection. Advise employees to continue following existing recommendations for infection control to minimize risk of exposure to other infectious agents.<sup>57,61</sup>

## **EMPLOYERS' RESPONSIBILITIES IN IMPLEMENTING PRECAUTIONS<sup>47,62,63</sup>**

Employers' responsibilities include the development of safety procedures and training programs based on anticipated problems and present or potential hazards that may endanger personnel. However, employees must share the responsibility for their own safety and the safety of their coworkers once employers have established guidelines.<sup>47</sup>

## **Education**

Provide initial orientation and continuing education and training for all health care workers, including students and trainees, on the epidemiology, modes of transmission, and prevention of HIV and other blood-borne infections, and the need for routine use of universal blood and body-fluid precautions for all patients. Extend safety education to all who handle or may become exposed to potential laboratory hazards including clerical, maintenance, and housekeeping staff. Continuing education efforts may be provided in conjunction with professional associations and labor organizations.

## **Equipment and Laboratory Facility**

Provide the laboratory space, equipment, and supplies necessary to minimize the risk of infection with blood-borne pathogens. At a minimum, design laboratories for easy cleaning with work benches made from, or coated with, water-impervious, heat- and chemical-resistant material. Provide a sink and eyewash station for each laboratory. Provide ventilation and climate control systems that prevent airflow from laboratories into nonlaboratory areas.

## **Practice**

Implement safety policies and procedures. Establish a safety committee or appoint a safety officer to review and update guidelines, review accident reports, perform inspections, and discuss safety issues. Monitor employees' adherence to recommended safety precautions. When monitoring reveals a failure to follow recommended precautions, provide counseling, education, or retraining and, if necessary, consider appropriate disciplinary action.

## **REFERENCES**

1. Centers for Disease Control. Agent summary statement for human immunodeficiency virus and report on laboratory acquired infection with human immunodeficiency virus. *MMWR* 1988; 37(S4):1-22.
2. Centers for Disease Control. Acquired immunodeficiency syndrome (AIDS): Precautions for clinical and laboratory staffs. *MMWR* 1982; 31:577-80.
3. National Committee for Clinical Laboratory Standards. Tentative guideline. NCCLS document M29-52. Protection of laboratory workers from infectious disease transmitted by blood, body fluid and tissue. 1991; Villanova, PA
4. Docet No. 13-370. Occupational Safety and Health Administration. Occupational Safety and Health Administration proposed standard for occupational exposure to HBV and HIV. *Federal Register* 1987;52(November 25):45438.

5. Centers for Disease Control and Prevention. Provisional Public Health Service recommendations for chemoprophylaxis after occupational exposure to HIV. *MMWR* 1996; 45:468-72.
6. Centers for Disease Control and Prevention. Hepatitis B virus: A comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination. Recommendations of the Immunization Practice Advisory Committee (ACIP). *MMWR* 1991; 40(RR-13):1-16.
7. Centers for Disease Control. Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers. *MMWR* 1989; 38(5-6):1-37.
8. Centers for Disease Control. Update: Universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other blood borne pathogens in health-care settings. *MMWR* 1988; 37:377-88.
9. Centers for Disease Control. Recommendations for prevention of HIV transmission in health-care settings. *MMWR* 1987; 36(S25):1-18.
10. NIH Consensus Development Panel on Infectious Disease Testing for Blood Transfusion. Infectious disease testing for blood transfusions. *JAMA* 1995; 274:1374-9.
11. Alter HJ. Blood. To C or not to C: These are the questions. *J Amer Soc Hematol* 1995; 85:1681-95.
12. Chamberland ME, Ciesielski CA, Howard RJ, Fry DE, Bell DM. Occupational risk of infection with human immunodeficiency virus. *Surgical Clin N Amer* 1995; 75:1057-70.
13. Doebbeling BN, Wenzel RP. Nosocomial viral hepatitis and infections transmitted by blood and blood products. In: Mandell GL, Bennett JE, Dolin R, editors. *Principles and practices of infectious diseases*. 4th ed. New York: Churchill Livingstone, 1994:2616-32.
14. Gerberding JL. Management of occupational exposures to blood-borne viruses. *N Eng J Med* 1995; 332:444-51.
15. Henderson DK. Postexposure prophylaxis for occupational exposures to hepatitis B, hepatitis C, and human immunodeficiency virus. *Surgical Clin N Amer* 1995; 75:1175-86.
16. Lanphear BP. Trends and patterns in the transmission of bloodborne pathogens to health care workers. *Epidemiol Rev* 1994; 16:437-50.
17. Shapiro CN. Occupational risk of infection with hepatitis B and hepatitis C virus. *Surgical Clin N Amer* 1995; 75:1047-56.
18. Short LJ, Bell DM. Risk of occupational infection with blood-borne pathogens in operating and delivery room settings. *Amer J Infect Control* 1993; 21:343-50.
19. Magnuson HJ, Thomas EW, Olansky S, Kaplan BL, DeMello L, Cutler JC. Inoculation syphilis in human volunteers. *Med* 1956; 35:33-82.
20. De Schryver A, Meheus A. Syphilis and blood transfusion: A global perspective. *Transfusion* 1990; 30:844-7.
21. van der Sluis JJ, ten Kate FJW, Vuzevski VD, Kothe FC, Aelbers GMN, van Eijk RVW. Transfusion syphilis, survival of *Treponema pallidum* in stored donorblood. II. Dose dependence of experimentally determined survival times. *Vox Sang* 1985; 49:390-9.
22. Risseuw-Appel IM, Kothe FC. Transfusion syphilis: A case report. *Sex Transm Dis* 1983; 10:200-1.

23. Gordon FM, Gilbert C, Hawley HP, Willoughby A. Prevalence of human immunodeficiency virus and hepatitis B virus in unselected hospital admissions: Implications for mandatory testing and universal precautions. *J Infect Dis* 1990; 161:14-7.
24. Handsfield HH, Cummings MJ, Swenson PD. Prevalence of antibody to human immunodeficiency virus and hepatitis B surface antigen in blood samples submitted to a hospital laboratory. *JAMA* 1987; 258:3395-7.
25. Kelen GD, Green GB, Purcell RH, et al. Hepatitis B and hepatitis C in emergency department patients. *N Eng J Med* 1992; 326:1399-404.
26. Mahoney JP, Richman AV, Teague PO. Admission screening for hepatitis B surface antigen in a university hospital. *Southern Med J* 1978; 71:624-8; 637.
27. Lanphear BP, Linnemann CCJ, Cannon CG, et al. Hepatitis C virus infection in health care workers: Risk of exposure and infection. *Infect Cont Hosp Epidemiol* 1994; 15:745-50.
28. Louie M, Low DE, Feinman SV, et al. Prevalence of bloodborne infective agents among people admitted to a Canadian hospital. *Can Med Assoc J* 1992; 146:1331-4.
29. Centers for Disease Control and Prevention. Update: Acquired Immunodeficiency Syndrome -- United States 1992. Atlanta, U.S. Department of Health and Human Services, Public Health Service, Publication HIV/NCID. *MMWR* 1993;42(28):547-51,557.
30. Thomas DL, Cannon RO, Shapiro CN, et al. Hepatitis C, hepatitis B and human immunodeficiency virus infections among non-intravenous drug-using patients attending clinics for sexually transmitted diseases. *J Infect Dis* 1994;169:990.
31. Scott RM, Snitbhan D, Bancroft WH, et al. Experimental transmission of hepatitis B virus by semen and saliva. *J Infect Dis* 1980;142:67.
32. Fahey BJ, Koziol DE, Banks SM, Henderson DK. Frequency of nonparenteral occupational exposures to blood and body fluids before and after universal precautions training. *Am J Med* 1991;90:145-53.
33. Ippolito G, Puro V, De Carli G, Italian Study Group on Occupational Risk of HIV Infection. The risk of occupational human immunodeficiency virus infection in health care workers. *Arch Intern Med* 1993;153:1451-8.
34. Centers for Disease Control. Recommendations for protection against viral hepatitis. *MMWR* 1985;34:313-24,329-35.
35. Grady GF, Lee VA, Prince AM, et al. Hepatitis B immune globulin for accidental exposures among medical personnel: Final report of a multicenter controlled trial. *J Infect Dis* 1978;138:625.
36. Seeff LB, Wright EC, Zimmerman HJ, et al. Type B hepatitis after needle-stick exposures: Prevention with hepatitis B immune globulin: Final report of the Veterans Administration Cooperative Study. *Ann Internal Med* 1978;88:285.
37. Centers for Disease Control. Update on hepatitis B prevention. *MMWR* 1987;36:353-60,366.
38. Centers for Disease Control. Inactivated hepatitis virus vaccine. *MMWR* 1982;26:317-22,327-8.
39. Mitsui T, Iwano K, Masuko K, et al. Hepatitis C virus infection in medical personnel after needlestick accident. *Hepatology* 1992;16:1109.

40. Cuypers HTM, Bresters D, Winkel IN, et al. Storage conditions of blood samples and primer selection affect yield of cDNA polymerase chain reaction products of hepatitis C virus. *J Clin Microbiol* 1992;30:3320.
41. Farci P, Alter HJ, Govindarajan S, Wong DC, Engle R, Lesniewski RR, et al. Lack of protective immunity against reinfection with hepatitis C virus. *Science* 1992;258:135.
42. Lai ME, Mazzoleni AP, Argioli F, De Virgili S, Balestrieri A, Purcell RH, et al. Hepatitis C virus in multiple episodes of acute hepatitis in polytransfused thalassaemic children. *Lancet* 1994;343:388.
43. Henderson DK, Fahey BJ, Willy M, et al. Risk for occupational transmission of human immunodeficiency virus type 1 (HIV-1) associated with clinical exposure: a prospective evaluation. *Ann Intern Med* 1990;113:740-6.
44. Fitzgerald JJ, Johnson RC, Smith M. Accidental laboratory infection with *Treponema pallidum*, Nichols strain. *J Amer Vener Dis Assoc* 1976;3:76-8.
45. Pike RM. Laboratory-associated infections: Summary and analysis of 3921 cases. *HiTh Lab Sci* 1976;13:105-14.
46. College of American Pathologists 1996 Commission on Laboratory Accreditation. 1996 Inspection Checklist 1: Laboratory General. Northfield, IL. College of American Pathologists. 1996.
47. Strain BA, Gröschel DH. Laboratory safety and infectious waste management. In: Murray PR, Baron EJ, Pfaller MA, Tenover FC, Tenover FC, Tenover FC, Yolken RH, editors. *Manual of Clinical Microbiology*. 6th ed. Washington, DC: American Society for Microbiology, 1995:75-85.
48. Garner JS, Favero MS. Guideline for handwashing and hospital environmental control. 1985; HHS Publication No. 99-1117. Atlanta, GA. Public Health Service, Centers for Disease Control.
49. Marsik FJ, Denys GA. Sterilization, decontamination, and disinfection procedures for the microbiology laboratory. In: Murray PR, Baron EJ, Pfaller MA, Tenover FC, Tenover FC, Yolken RH, editors. *Manual of Clinical Microbiology*. 6th ed. Washington, DC: American Society for Microbiology, 1995:86-98.
50. Favero MS. Sterilization, disinfection and antisepsis in the hospital. In: Lennette EH, Balows A, Hausler WJJ, Shadomy HD, editors. *Manual of Clinical Microbiology*. 4th ed. Washington, DC: American Society for Microbiology, 1985:129-37.
51. Centers for Disease Control. Human T-lymphotropic virus type III/lymphadenopathy-associated virus: Agent summary statement. *MMWR* 1986; 35:540-2,549.
52. Favero MS. Dialysis-associated diseases and their control. In: Bennett JV, Brachman PS, editors. *Hospital Infections*. Boston, MA: Little, Brown and Company, 1985:267-84.
53. Martin LS, McDougal JS, Loskowski SL. Disinfection and inactivation of the human T-lymphotropic virus type III/lymphadenopathy-associated virus. *J Infect Dis* 1985;152:400-3.
54. McDougal JS, Martin LS, Cort SP, Mozen M, Heldebrant CM, Evatt BL. Thermal inactivation of the acquired immunodeficiency syndrome virus III/lymphadenopathy-associated virus, with special reference to antihemophilic factor. *J Clin Invest* 1985;76:875-7.

55. Spire B, Barre-Sinoussi F, Dormont D, Montagnier L, Chermann JC. Inactivation of lymphadenopathy-associated virus by heat, gamma rays and ultraviolet light. *Lancet* 1985;1:188-9.
56. Spire B, Montagnier L, Barre-Sinoussi F, Chermann JC. Inactivation of lymphadenopathy associated virus by chemical disinfectants. *Lancet* 1984;2:899-901.
57. Environmental Protection Agency. EPA guide for infectious waste management. 1986; Washington, DC: U.S. Environmental Protection Agency. EPA/530-SW-86-014.
58. Centers for Disease Control. Public Health Service guidelines for counseling and antibody testing to prevent HIV infection and AIDS. *MMWR* 1987;36:509-15.
59. Centers for Disease Control and Prevention. Case-control study of HIV seroconversion in health-care workers after percutaneous exposure to HIV-infected blood -- France, United Kingdom, and United States, January 1988-August 1994. *MMWR* 1995;44:929-33.
60. Centers for Disease Control. Public Health Service statement on management of occupational exposure to human immunodeficiency virus, including considerations regarding zidovudine postexposure use. *MMWR* 1990;39(RR-1):1-14.
61. Garner JS, Simmons BP. Guidelines for isolation precautions in hospitals. *Infect Cont* 1983;4:245-325.
62. US Department of Labor USD. Joint advisory notice: Protection against occupational exposure to hepatitis B virus (HBV) and human immunodeficiency virus (HIV). *Federal Register* 1987;52:41818-24.
63. Williams WW. Guideline for infection control in hospital personnel. *Infect Cont* 1983;4:326-49.