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Information Statement

Preventing the Transmission of Bloodborne Pathogens

This Information Statement was developed as an educational tool based on the opinion of the authors. It is not a product of a systematic review. Readers are encouraged to consider the information presented and reach their own conclusions.

This report provides an overview of strategies intended to reduce the risk of transmitting bloodborne pathogens in a variety of orthopaedic settings. It includes information on preventing the transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV), and discusses issues involving infected health care personnel (HCPs). Numerous documents from the United States Centers for Disease Control and Prevention (CDC) as well as other scientific publications were reviewed to arrive at this summary of recommendations for the implementation and monitoring of strategies most relevant to the orthopaedic surgeon.

The recommendations in this report are intended to supplement those of the CDC. They are not intended to supersede updates of CDC recommendations, their updates, or advances in the field. This is an attempt to bring relevant information together in a single document. Orthopaedic surgeons are encouraged to become familiar with the CDC recommendations and current updates on preventing healthcare-associated transmission of bloodborne pathogens; this information can be found on the CDC's website (www.cdc.gov). With this combined information, orthopaedic surgeons will be able to develop comprehensive strategies to deal with bloodborne pathogens tailored to their particular practice settings.

Orthopaedic surgeons, like all physicians, accept a moral and ethical responsibility to provide patient care with compassion and dignity. The orthopaedic surgeon, while making informed decisions, should take whatever precautions she or he deems necessary in order to prevent the transmission of bloodborne pathogens. This report, in addition to the recommendations of other agencies, provides a solid background upon which orthopaedic surgeons can make such decisions. The well-being of all patients and health care professionals, regardless of their bloodborne pathogen-infection-status, is of the utmost importance.

Background

Transmission of HBV, HIV, and HCV has been well-documented in health care settings. Transmission of these viruses has been reported from patient to HCP, from HCP to patient, and from patient to patient. Although all three viruses are bloodborne and share common routes of transmission, the epidemiology of transmission of each differs based on the virus involved and circumstances of the exposure. HBV is more efficiently transmitted than HCV or HIV, especially if the source is positive for hepatitis B e antigen (HBeAg), a marker for increased infectivity. In fact, when HBeAg is present, HBV is 100 times more likely than HIV to be transmitted after a percutaneous exposure to infected blood. HCV, while less infectious than HBV, is on average six

times more likely than HIV to be transmitted after a percutaneous exposure. Although much attention has focused on preventing HIV transmission, it is important for HCPs to be mindful of all of these common bloodborne pathogens. Measures for preventing transmission are common to all three of these viruses.

TRANSMISSION IN HEALTH CARE SETTINGS

Patient-to-HCP transmission of bloodborne pathogens

The risk of occupational transmission of HBV, HCV, and HIV is influenced by:

1. the prevalence of infection with bloodborne pathogen infection in the patient population
2. the nature and frequency of occupational exposures to blood or other body fluids, and
3. the risk of infection transmission after exposure.[1-3]

In general, the prevalence of infection is higher among hospitalized patients than in the general population; prevalence of one or more viruses may be higher among certain high-risk populations such as injection drug users and men who have sex with men.[4-7] Blood is the single most important source of exposure to HBV, HCV, and HIV in healthcare settings. Percutaneous exposures (e.g., needlesticks and punctures or cuts with other sharp objects) are most frequently sustained by those occupational groups that handle sharps, including surgeons, but are also sustained by others, including downstream workers such as housekeepers and those disposing of waste. The greatest risk of infection transmission is associated with percutaneous exposure to blood, followed by exposure of a mucous membrane to blood, and the least risk with exposure to nonintact skin. While delivery of the hepatitis B vaccine series offers the best protection against HBV, preventing the transmission of HBV, HCV, and HIVHIV to HCPs is accomplished by preventing exposures to blood, primarily by preventing percutaneous injuries during medical procedures. Orthopaedic surgeons and their staff should consider all patients as potentially infected with bloodborne pathogens.[8-10] Infection control recommendations must be adhered to rigorously to minimize the risk of exposure to potentially infected blood or other body fluids. Fortunately, increased awareness of the risks and improvements in devices such as the addition of retractable protection shields on catheter stylets[11] have resulted in a decrease in parenteral injuries over the past decade.[12,13] A study of medical students in Birmingham, England, has demonstrated that a consistent, ongoing effort to educate health-care professionals can greatly increase awareness of the dangers of percutaneous exposure and ways to avoid it.[14] Educational efforts must go beyond an emphasis solely on needle-stick injuries, providing mentoring and competency training to surgeons, residents, nurses, medical students, and other staff, including workers who do not have a role in the OR but handle supplies or dispose of waste.[15,16]

Hepatitis B Virus

HBV infection is a well-recognized occupational risk for HCPs.[2,3] The risk of infection is primarily related to the degree of contact with blood in the work place. The risk of transmission after a percutaneous exposure to infected blood is 30% if the source is positive for HBeAg, but is less than 6% if the source is HBeAg-negative.[3,2] The principal modes of nosocomial HBV transmission are:

1. direct percutaneous inoculation of blood or body fluids containing HBV via needle-stick or other injuries from sharp instruments,

2. direct inoculation of blood or body fluids containing HBV onto mucous membranes, cutaneous scratches, abrasions, burns or other lesions, and

3. indirect inoculation of HBV from environmental surfaces contaminated with blood or body fluids onto mucous membranes, cutaneous scratches, abrasions, burns or other lesions.

Serologic studies conducted in the United States during the 1970s demonstrated that HCPs have a prevalence of HBV infection up to 10 times higher than that in the general population.[7,17-22] Therefore, the risk of HBV transmission from patients to HCPs is significantly high. Although the risk of HBV transmission from patients to HCPs has not changed since the 1970s, the incidence of HBV infection among HCPs has declined dramatically in recent years. The incidence of infection among HCPs is now lower than that in the general population.[18-20] This decline is generally attributed to increasing numbers of HCPs receiving the hepatitis B vaccination series and improved adherence to the principles of universal precautions, leading to decreased exposure.[20-23] In addition, the use of postexposure prophylaxis with hepatitis B vaccine with or without hepatitis B immune globulin has prevented transmission of infection after exposure.[24]

Hepatitis C Virus

HCV is the most common chronic bloodborne infection in the United States.[25] Although the prevalence of HCV infection among HCPs is no greater than the general population, the risk of occupational infection from HCV has been increasingly recognized. Transmission of HCV occurs primarily through large or repeated direct percutaneous exposures to blood.[25] The risk of transmission after a percutaneous exposure to anti-HCV positive blood is 1.8%, ranging from 0-6%.[3,2,24] One study found that a history of accidental needle-stick injury was the only occupational risk factor independently associated with HCV infection.[26] Another study, from France, identified risk factors for HCV infection after occupational percutaneous exposure: deep injury and a hollow-bore needle used in an artery or vein.[27] To date, there have been no reported infections associated with intact skin exposures. However, there have been two reported cases of HCV transmission resulting from a blood splash to the conjunctiva.[28,29]

Currently, occupational HCV transmission is only preventable through prevention of blood exposure. As more information becomes available about treatment of HCV infection, prevention and treatment strategies could change.

Human Immunodeficiency Virus

The risk for HIV transmission after percutaneous exposure to infected blood is approximately 0.3% or about 3 out of 1,000 000.[1] Several factors increase the risk of infection associated with an exposure. An increased risk of seroconversion is associated with a deep injury, the injection of a large quantity of blood, an injury with a hollow needle, or injury while inserting a needle into a vein or artery.[31] The patient's stage of infection may also play a role. Since there is a higher titer of HIV in the blood of a person in the advanced stages of AIDS, there may be a greater risk of seroconversion after an exposure to the blood of a patient with advanced disease.

Although the highest risk of occupational HIV transmission is associated with percutaneous injuries, other modes of transmission are possible. In the United States, occupational transmission has been documented in 57 HCPs after exposure to blood or body fluids of patients.[32-35] Episodes of HIV transmission after non-intact skin exposure to blood have also been documented, but the risk of transmission by this route has not been precisely quantified.[1] Additionally, there is a documented but undetermined risk associated with HIV-infected body fluids other than blood. Fluids with potential for transmission in the occupational setting include cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids.[1,9]

HCP-to-patient transmission of bloodborne pathogens

Transmission of HBV, HCV, and HIV from HCP to patient has been documented.[7, 36-46] However, the risk of transmission from HCP to patient is much lower than from patient to HCP. The vast majority of HCPs infected with a bloodborne virus do not pose a risk to patients, because they do not perform activities where the conditions necessary for transmission are met. Three conditions are necessary for HCPs to pose a risk for transmitting a bloodborne virus to patients. First, the HCP must be viremic (i.e., have infectious virus circulating in the bloodstream). Second, the HCP must be injured or have a condition (e.g. weeping dermatitis) that allows direct exposure to his/her blood or

other infectious body fluids. Third, the HCP's blood or infectious body fluid must gain direct access to a patient's wound, traumatized tissue, mucous membranes, or similar portal of entry. The greatest risk of transmission of infection from HCP to patient is for HBV. HCP-to-patient transmission of HBV has primarily occurred during invasive procedures performed by HBeAg-positive HCPs.[36-38,40,41] Nonetheless, transmission of HBV from an infected provider to patient(s) has been documented for HCPs who have a mutant form of HBV that prevents expression of e antigen and generally have lower levels of viremia than those who are e antigen positive.[42] In the United Kingdom, HCPs who have this pre-core mutant are prohibited from performing invasive procedures.[43] There is a lack of consensus in the United States about similar restrictions.

Of the three bloodborne viruses, HIV carries a lowest risk of transmission from HCP to patient. Worldwide, there are only four reported instances of HIV transmission occurring from an infected HCP to a patient.[47,46,48,49] A cluster of six patients was infected by a dentist in Florida.[45] In 1997, an orthopaedic surgeon in France transmitted HIV to one of his patients during an invasive procedure.[46] A third case, where transmission is suspected, concerns an instance of HIV transmission from an infected nurse to a surgical patient in France.[48] Although there is no published explanation of the mode of transmission, HIV sequencing implicated the nurse as the source for the patient's infection. A fourth case involved transmission from an HIV-infected infected obstetrician to his patient during performance of caesarean delivery.[49] This low number of cases of HIV transmission from an HIV-infected HCP to patient indicates an extremely low risk of transmission through this mechanism.

Patient-to-patient transmission of bloodborne pathogens

Patient-to-patient transmission of bloodborne viruses has been detected in a variety of healthcare settings, both in the United States and other countries.[50-55] Such transmission occurs indirectly from patient to patient, resulting from lapses in infection control practices of caregivers. Almost all of the transmissions reported could have been prevented through adherence to recommended practices for infection control. Different mechanisms of transmission that have been implicated include improper handling of blood collection equipment, contamination of multi-dose vials, and improperly cleaned, disinfected or sterilized equipment.[55,54,53,52,51,50] For instance, HBV and HCV transmission between patients in hemodialysis centers has been attributed to the sharing of medication vials and supplies.[50,53] Additionally, transmission of HIV from one patient to another has occurred during nuclear medicine procedures where syringes were either misidentified or inadvertently reused between patients.[51]

The accumulated data show declining trends in the transmission of bloodborne viruses among patients and HCPs and increasing adoption by HCPs of strategies to prevent blood contact.[8,10,13,56] However, the rare episodes of transmission that do occur, either from infected HCPs to patients or from infected patients to other patients, demonstrate a continuing need to reinforce the prevention strategies recommended in this document.

PREVENTING TRANSMISSION OF HBV, HCV, AND HIV IN HEALTH CARE SETTINGS

Preventing transmission from patients to HCPs

Employer responsibilities

Every medical office and facility should have an occupational health plan for the prevention and treatment of exposures to bloodborne pathogens. This includes orthopaedic settings where surgeons and their staff perform procedures that put them at risk for contact with a patient's blood or other potentially infected body fluids. Furthermore, all HCPs who may be exposed to blood or other body fluids should receive the hepatitis B vaccination series. Detailed information regarding the prevention and management of exposures is published by the CDC and the Occupational Safety and Health Administration (OSHA). [8,9,24,57] Orthopaedic surgeons are encouraged to be familiar with this information.

Comprehensive training programs for HCPs are fundamental and important tools in preventing the transmission of bloodborne pathogens. HCPs who perform procedures that put them at risk for exposure to potentially infected blood or other body fluids should be educated about the risks of bloodborne pathogen transmission. The training should include general information about bloodborne pathogens, mechanisms of transmission, methods to prevent exposure to blood and other potentially contaminated fluids, and ways to implement those methods during various procedures. Preventing patient-to-HCP transmission as well as HCP-to-patient transmission should be included in the training program.

Patient history and serological testing

A complete medical history of each patient should be taken prior to surgery whenever possible. Direct questions aimed towards gathering information on high-risk behaviors should be asked to help assess the patient's HBV, HCV, and HIV infection statuses. Increased risk of infection with bloodborne viruses is associated with a history of one or more of the following:

- injecting drug use
- high-risk sexual behaviors
- sexually transmitted diseases
- receipt of blood transfusions before 1985
- incarceration
- hepatitis.

Serological testing may be useful to determine a patient's bloodborne pathogen status, as history alone may fail to identify those infected with a bloodborne virus infection.

Theoretically, serological testing of patients may help reduce the risk of bloodborne pathogen transmission to HCP47,HCPs,[56] although observational studies have not shown lower rates of exposure when the surgeon perceived the patient to be infected with a bloodborne virus.[57-60] In September 2006, CDC published "Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings.[61] The objectives of these recommendations are to increase HIV screening of patients in health-care settings; foster earlier detection of HIV infection; identify and counsel persons with unrecognized HIV infection and link them to clinical and prevention services; and further reduce perinatal transmission of HIV in the United States. Knowledge of a patient's bloodborne pathogen status may be relevant in planning surgical procedures where effective, less invasive alternatives may be available or more techniques for health-care worker protection may be used (extra gloving, sharp protection, etc.). Furthermore, if exposure occurs, knowledge of the patient's infection status will expedite the delivery of appropriate postexposure treatment. Procedures for testing patients should follow applicable state and local laws.[62] In most states, the patient must give consent for testing. Pre- and post-test counseling should be available as appropriate. Confidentiality and protection of the patient's right to quality health care must be upheld.[8]

It is important to keep in mind that a comprehensive medical history, physical examination, and serological testing will generally identify all patients infected with HBV, HCV, or HIV. Patients in a "window" period between exposure and seroconversion may be infectious but seronegative; this is uncommon. Measures aimed at preventing exposure to blood and other body fluids should be consistently utilized during all procedures, regardless of the serologic status of the patient.

Recommendations for safety during procedures and examinations

Due to the nature of the procedures that they perform, surgical staff may have high rates of exposure to blood and other body fluids. Trauma and orthopaedic surgical procedures, in particular, have significantly higher rates of exposure than other types of surgery.[63,58-60] With this in mind, it becomes important for orthopaedic surgeons and their staff to adopt comprehensive strategies to prevent exposures to blood and other body fluids, such as use of gowns, gloves, eye protection, and

safe handling of sharp instruments. Furthermore, special measures to further reduce the risk involved in surgical procedures should be developed and implemented. Orthopaedic surgeons should consider the following:

1. Hand hygiene is the single most important procedure for preventing healthcare-associated infections.[64] Hands should be cleaned with alcohol-based hand rub if not visibly soiled or washed with either plain or antimicrobial soap before and immediately after each patient encounter. It is important to note that gloves are not a substitute for hand washing.

2. Gloves should be worn during any procedure that may result in contact with a patient's blood or other body fluids. This is particularly important for surgical staff, as frequent scrubbing may cause abrasions on the skin that pose an increased risk for transmission through skin exposure.[65] Gloves should also be worn when handling needles or other sharp instruments. It has been shown that the volume of blood transmitted by a needle-stick is reduced by 50% when the needle first passes through a glove.[66] Double gloving is recommended.[67]

3. In addition to gloves, protective eye cover (not just prescription glasses), masks, gowns and shoe covers may be worn as necessary while performing procedures, such as dressing changes or pin removals.

4. Proper surgical garb must be worn during any surgical procedure.[64]

    - Appropriate footwear, such as boots or surgical shoe covers, may be worn to prevent skin exposure from blood or other body fluids that may spill outside of the surgical field.
    - An appropriate surgical gown should be worn during a procedure to prevent skin exposure from seepage of blood or other body fluids.
    - Double gloves may be worn during all surgical procedures. The outer pair should be changed at least every 2 hours to prevent skin exposure from perforations that may occur in the gloves with use over time.[68] During procedures where sharp instruments and devices are used, or when bone fragments are likely to be encountered, the surgeon may consider the use of reinforced gloves that offer more protection.
    - Head covers and facemasks may also be worn during surgical procedures. Face masks should be changed if they become splattered or moist. Protective eyewear may cover the skin and mucous membranes of the eyes. In general, goggles are better than eyeglasses, but face shields offer the greatest level of protection.

5. Sharp instruments should always be handled carefully and should not be left unattended in the surgical field. The location of a returned sharp instrument should be announced if the surgical assistant is pre-occupied with another task. Recapping of needles and resheathing of scalpel blades by hand should be avoided.

6. In high-risk situations (i.e. when contamination is present), sharp instruments should not be passed from hand to hand, but on intermediate trays and should be announced when they are being passed.

7. The surgeon should periodically remind the surgical team of the importance of caution and inform them, in advance of the procedure, of aspects that place them at a higher risk. Surgeons supervising trainees should take experience into consideration when assigning roles, particularly for high-risk procedures.

8. No-touch suturing techniques should be used whenever possible. Sutures should not be tied with the suture needle in the surgeon's hand. Blunt suture needles are recommended when their use is technically feasible. Two surgeons should not suture the same wound simultaneously.

9. Special considerations apply to the safe use of numerous types of surgical equipment unique to orthopaedics. For instance, the exposed ends of all orthopaedic pins should be securely covered with plastic caps or other appropriate devices. The points of pins that have passed through soft tissue or bone should be cut off. The safe use of specialized tools (e.g. power tools) is important as well. Users need to be familiar with these tools in order to operate them properly. All tools should be inspected before and after each use to ensure that they are properly maintained. Appropriate surgical attire should be worn to prevent exposure to blood, or aerosols containing blood, resulting from the use of power tools and to reduce the likelihood of bone chips contacting the surgeon's eyes.

10. At the completion of the case, the surgeon should take care not to contaminate areas outside of the surgical field with blood. The outside layer of gloves should be changed and the dressing applied while the outer pair of gloves is clean. Next, the contaminated drapes should be removed and discarded into an appropriate biohazard container. The surgeon should then remove the surgical gown and gloves. Clean, non-sterile gloves should be used to handle any operating equipment that is not grossly contaminated. Afterwards, these gloves should be removed and the surgeon's hands washed. All contaminated clothing should be removed in a manner that avoids contact with the blood. Care must be taken not to contaminate other areas with bloody shoe covers, gloves or scrub clothes.

11. All contaminated materials resulting from a procedure should be placed in appropriate biohazard bags or containers and discarded. Instruments and other reusable equipment should be appropriately disinfected and sterilized.[8,69]

Preventing transmission from HCPs to patients

HCPs have the responsibility not only to protect themselves, but the patients as well. Although risk of transmission from a HCP to patient appears to be extremely low and differs for each pathogen, guidelines should be implemented to ensure the maximum safety of the patient. It is important that all recommendations to prevent the transmission of bloodborne pathogens are consistently followed. In general, the guidelines for preventing transmission from patients to HCPs also are effective in preventing transmission from HCPs to patients. Additionally, HCPs are encouraged to know their own HBV, HCV, and HIV infection status. Voluntary and confidential testing of HCPs for bloodborne pathogens is recommended. Preventing injuries to HCPs and subsequent blood exposure to patients offers the greatest level of protection to both HCPs and patients. HCPs who have pre-existing conditions, such as exudative lesions or weeping dermatitis, should refrain from direct patient care until the condition is resolved.[61,70] The affected HCP also should refrain from handling patient-care equipment and devices used to perform invasive procedures. If a member of a surgical team sustains an injury during a procedure, the instrument responsible for the injury should be removed from the surgical field without being reused on the patient until appropriately re-sterilized. Additionally, any disposable items that come into contact with a HCP's blood should be removed from the surgical field and discarded into an appropriate container.

Management of infected HCPs

There is considerable debate concerning the management of HCPs infected with HBV, HCV, or HIV. In 1991, the CDC issued guidelines for HCPs infected with HBV or HIV9.[36] The CDC's guidelines were established on the premise that the risk for transmission of HBV and HIV to patients is greatest during certain definable "exposure-prone" procedures. Exposure-prone procedures include "palpation of a needle tip in a body cavity or the simultaneous presence of a HCP's fingers and a

needle or other sharp object in a poorly visualized or highly confined anatomic site."[36] HCPs who are positive for HIV or HBeAg should not perform exposure-prone procedures, as defined above, unless they have obtained expert counsel regarding the circumstances under which they may perform such procedures. Furthermore, HCPs should inform patients of their infection status before conducting exposure-prone procedures.

Data accumulated since 1991 has shown that the overall risk of bloodborne pathogen transmission from HCPs to patients is very low.[37-40] Studies have shown that there is a greater risk associated with HBV than with HCV or HIV. Policies regarding infected HCPs should focus on virus-specific recommendations that take the relative risk of transmission associated with each virus into account.

Due to the high levels of viremia associated with HBeAg positivity, standard infection control practices may not be effective for preventing transmission of HBV from an HBeAg-positive HCP.[8,9] HBeAg-positive HCPs who perform invasive procedures should seek expert advice to determine under what circumstances they may continue to perform such procedures.[36] However, HBeAg-positive HCPs should not be restricted from performing non-invasive procedures.

Currently, CDC has no recommendations that restrict professional activities of HCPs infected with HCV. Specific factors related to HCV transmission from infected HCPs to patients are unknown.[3] HCPs infected with HCV should always follow strict aseptic technique and vigorously adhere to universal precautions. HCV-infected HCPs should seek medical evaluation and treatment to prevent chronic liver disease. Specific recommendations for the prevention of HCV transmission from infected HCPs may be developed as more is learned about the virus and its associated risks.

In accordance with the CDC guidelines, HIV-infected HCPs should not perform exposure-prone procedures until they have sought counsel from an expert panel and been advised under what circumstances they may perform such procedures.[36]

Preventing transmission from patient to patient

In order to provide maximum protection to all patients, health care institutions and medical offices should require consistent adherence to standard infection control practices. Disposable equipment should not be reused between patients. Instruments and other reusable equipment used in performing any procedure should be reprocessed, which includes cleaning and disinfection or sterilization as appropriate. Medical devices that enter normally sterile areas of the body should be sterilized before being used on a patient. Equipment and devices that touch intact mucosal membranes but do not penetrate the body's surface should be sterilized or undergo high-level disinfection. Equipment or devices that only touch intact skin need only be cleaned with a detergent as indicated by the manufacturer.[69] Furthermore, since HBV can remain infective in dry blood for up to one week[2], the health care environment should be kept clean and disinfected for the safety of both patients and HCPs.

Additional areas of risk for patients

Blood Transfusions

A potential for HBV, HCV, and HIV transmission exists whenever allogenic blood is used in surgery.[71,72] Currently, the Food and Drug Administration requires that all donations of whole blood, plasma, and other transfusable components be subjected to serological testing for HBsAg, HCV antibody as well as antibodies to HIV.[73] Although the development of improved screening tests has greatly reduced the risk of transmission, it is recommended that the use of transfused blood in orthopaedic surgery be limited whenever possible. The residual risk of HBV transmission is between 1 in 200,000 to 1 in 500,000 units of blood transfused and for HICV and HIV between 1 and 2 in 1,000,000.[72] The option to use autologous blood should be made available, and utilized, when it is medically feasible. Additionally, cell-savers should be utilized when their use is medically appropriate.

Bone and Soft-Tissue Transplants

The use of bone and soft tissue grafts from human donors (allografts) has expanded dramatically in recent years. Well over a million allografts have been performed in the USA.[78] Bone grafts may be obtained from either the patients themselves (autografts), or from deceased or living donors (allografts). Although the use of autografts does not pose a risk for viral transmission in itself, blood loss from obtaining the autograft could make a blood transfusion necessary. A blood transfusion is more likely to transmit a viral disease than a bone allograft. It has been established that HBV, HCV and HIV can be transmitted through musculoskeletal allografts.[74-76] However, the possibility of transplanting bone allografts from an infected donor is remote, provided there is a combination of rigorous donor screening and serologic testing.[77-80] The FDA Current Good Tissue Practice and Final Guidance Document state that screening and testing must indicate that the donor is free of risk factors for, and clinical evidence of infection due to a relevant communicable disease agent or disease. Eligible donors must also be free from communicable disease risks associated with xenotransplantation, and the results of donor testing for relevant communicable disease agents or disease are negative or nonreactive.[73] Once a donor is approved, the tissues may undergo additional processing. This could involve everything from simple cleaning (large structural allografts) to major modifications and secondary sterilization (machined spine fusion grafts). The American Association of Tissue Banks (AATB) has set standards for donor selection, and allograft procurement and preparation.[78] Orthopaedic surgeons using allografts should be familiar with these standards and obtain musculoskeletal allografts only from tissue banks accredited by the AATB.

Allografts can be obtained from either deceased or living donors. For deceased donor specimens, a complete social and medical history (including autopsy records if autopsy accomplished) should be obtained to the fullest extent possible. The information obtained should be evaluated for evidence of high-risk behavior and HBV, HCV or HIV infection. Serologic testing for HBsAg, HCV antibody, HIV antibody, (including Nucleic Acid Test (NAT) for HIV and NAT HCV) and syphilis should be performed, as well as multiple microbiologic cultures of the allograft.[73] If this information is unacceptable or cannot be obtained, the tissue must be discarded.[78]

In the case of living donors, donor screening should include a comprehensive social and medical history, physical examination, and serologic testing for HBsAg, HCV antibody, and HIV antibody (including NAT HIV and NAT HCV). Living donors should be interviewed to identify risks associated with HIV infection. Additionally, the donor should sign a patient informed consent statement.[73] The graft should be quarantined during this time and utilized only if the follow-up test results are negative. The CDC recommends HIV testing only for recipients of solid organ transplants; the recipients of bone or tissue allografts do not need to be tested for HIV, provided the tissue came from appropriately screened donors.[79]

Managing Exposures to Bloodborne Pathogens

Incidents of percutaneous, mucous membrane, or non-intact skin exposures to blood or other potentially infected fluids should be reported immediately to a person designated by the health care institution as being responsible for the management of occupational exposures to blood. Relevant information that should be documented includes the activity in which the HCP was engaged in at the time of the incident, the extent to which safe workplace practices and protective equipment were used, a description of the exposure source, and details of the exposure such as mode, volume and type of fluid involved, as well as the severity of the exposure.[24] As consistent with applicable law, both the source patient and exposed HCP should be tested for HBsAg, HCV antibody, and HIV antibody.[62] The organization should have policies in place for the testing of source individuals in cases where consent cannot be obtained (e.g. when the patient is unconscious). If the source cannot be identified, decisions regarding appropriate follow-up should be individualized. Follow-up testing after an exposure to a source of unknown infection status might be performed (after baseline) at 6 months after the exposure (unless the exposure is being treated as one to an infected source). Serologic testing should be available to all HCPs who are concerned that they may have been

infected with HIV.[19.24] CDC recommends that follow-up testing should be conducted at 6 weeks, 3 months, and 6 months after exposure to a known HIV-positive source.[24] Extended HIV follow-up (e.g., for 12 months) is recommended for HCP who become infected with HCV following exposure to a source co-infected with HIV and HCV. Appropriate pre- and post-test counseling should be provided. The confidentiality of all medical data and the identities of the individuals involved should be protected during all phases of medical management and counseling.

If a patient is exposed to the potentially infected blood or body fluid of a HCP, the exposed patient should be immediately informed of the incident. The same procedures detailed above for management of HCP exposures should be followed for both the source HCP and the exposed patient.

CDC recommendations concerning exposure to potentially contaminated blood vary with each type of bloodborne pathogen and the source's infection status.[24,56] Additionally, depending on the circumstances of the exposure, different protocols may be recommended. Antiretroviral postexposure prophylaxis (PEP), as discussed below, may play an important role in preventing infection after exposures to infected blood or other body fluids.[56,24] Treatment decisions for exposed HCPs or patients should always be made in consultation with experts in antiretroviral therapy.

Immediate treatment

If blood or other fluids contaminate a HCP's skin, the contaminated area should be washed immediately with soap and water. If it is not possible to leave the area to clean the contaminated site (e.g. during surgery), circulating personnel should clean the surgical team member's contaminated area of skin. If the skin is cut or punctured, care must be taken not to expose the patient to the HCP's blood, gloves should be removed and the wound washed with soap and water. Exposed mucous membranes should be flushed with water.[24,56] Serological testing and the initial risk assessment should be conducted as outlined above and postexposure treatment administered as necessary.

Postexposure Prophylaxis

Hepatitis B Virus

After an exposure to HBV, appropriate immunoprophylactic treatment can generally prevent infection. The mainstay of postexposure immunoprophylaxis is the hepatitis B vaccine. The addition of a single dose of hepatitis B immune globulin (HBIG) is also recommended, if it can be given within seven days of exposure.[24] However, it is preferable to give the HBIG within 24 hours of the exposure. If the exposed individual has previously been vaccinated with the hepatitis B vaccine, postexposure blood tests should ensure that the individual's HBV antibody levels are appropriate.

Hepatitis C Virus

Currently there is no postexposure prophylaxis available for HCV. A HCP who may have been exposed to HCV should be tested and monitored for evidence of seroconversion so that treatment for chronic liver disease can be initiated as soon as possible. Studies indicate that interferon treatment begun early in the course of HCV infection is associated with a higher rate of resolved infection.[24,25,81,82] However, no data exist indicating that treatment begun during the acute phase of infection is more effective than treatment begun early during the course of chronic HCV infection. Interferon is currently FDA approved only for treatment of chronic HCV infection. The combination of interferon + ribavirin has been shown to be more effective than interferon alone in the treatment of chronic HCV infection, and is FDA approved for this indication.[10] This drug combination may prove to be a promising treatment early in the course of HCV infection. Determination of the most effective treatments will require further evaluation with well-designed research protocols.

Human Immunodeficiency Virus

In June 1996 the U.S. Public Health Service (PHS) first published recommendations for PEP after certain occupational exposures to HIV.[83] The PHS recommends that PEP be used for exposures that pose a risk of HIV infection, but is not justified for exposures that do not pose a known risk. Exposures that pose a high risk include those involving a deep injury, visible blood on the device that caused the injury, injury from a needle that was placed in a source patient's vein or artery, or an exposure from a source patient who died of AIDS within 60 days after exposure (indicating a high titer of HIV present in the blood).[31] The PHS recommendations for PEP*, updated in 2005,[56] include either a two-drug basic regimen, consisting of drug combinations such as zidovudine (AZT) and lamivudine (3TC), or lamivudine and tenofovir, or an enhanced regimen, which is the basic regimen with the addition of two or more drugs, generally a protease inhibitor alone or a "boosted" protease inhibitor, such as lopinavir/ritonavir for higher-risk exposures. PEP should be started promptly, preferably within a few hours of exposure, and given for four weeks, if tolerated. Decisions about postexposure treatment should be individualized if the source patient's HIV status is unknown.

Conclusion

Although current data indicate that the risk of transmitting a bloodborne pathogen in a health care setting is low, some risk is unavoidable. The danger can be greatly reduced by following the accepted recommendations of the CDC, PHS, and other agencies. The orthopaedic surgeon should be familiar with these established guidelines. This report provides emphasis on those areas of exposure prevention and treatment most pertinent to the orthopaedic setting. Adherence to the recommendations in this report, and familiarity with other accepted guidelines will help protect the orthopaedic surgeon, surgical staff, and patients from nosocomial HBV, HCV, and HIV infections. The importance of providing the best quality health care to patients, in a safe environment for HCPs, should be the goal of every medical office and health care facility.

These recommendations may be modified periodically as new information becomes available in this rapidly developing field.

*The use of antiretroviral agents as postexposure prophylaxis following occupational exposure to HIV is not "cleared for marketing" by the FDA.

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