PEDIATRIC EMERGENCY MEDICINE REPORTS

Practical, Evidence-Based Reviews in Pediatric Emergency Care

May 2021 VOL. 26, NO. 5

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Bloodborne Pathogens

In the acute care setting, clinicians may be confronted with a child who has had a nonoccupational blood and/or body fluid exposure. Being prepared with a focused approach and the ability to identify the multiple factors that may adjust the risk of contracting bloodborne pathogens is valuable in such exposures. The authors provide a focused approach to nonoccupational blood and/or body fluid exposure, as well as a discussion of each of the bloodborne pathogens.

— Ann M. Dietrich, MD, FAAP, FACEP, Editor

Case Study

A previously healthy 2-year-old boy presents to the emergency department with his mother. Earlier that day, the boy and his mother visited a playground. While the mother was talking to a friend, the boy suddenly started crying, exclaiming, "Owie," and pointing at his hand. The mother discovered that he had found a discarded syringe in the bushes and was apparently playing with it when he poked himself in the palm of his right hand. The mother immediately washed her son's hands. She placed the syringe in a water bottle and brought it with her to the emergency department. The needle is a 30-gauge insulin needle with no visible blood in the hub or on the needle. It is dry and crusted with dirt, apparently having been discarded many days or weeks ago. The boy is happy and well-appearing on examination. You see a very small puncture mark in the thenar eminence of the right hand.

Introduction

Nonoccupational blood and body fluid exposures are common concerns in the pediatric emergency department. Such incidents naturally are concerning to parents and providers for potential transmission of bloodborne pathogens like human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). These exposures may arise from the discovery of used or discarded needles in the community, in which case the serostatus of the potential source for the pathogens mentioned earlier typically is unknown. However, many nonoccupational blood and body fluid exposures also may occur between household members with known or unknown history of bloodborne pathogens. This may occur because of family members with medical conditions requiring regular needle use, like insulin-controlled diabetes mellitus, or it may be a consideration when faced with household intravenous drug use. Other situations, such as human bites and other injuries, may present unexpected challenges to the pediatric emergency medicine provider.

This review will discuss a focused approach to nonoccupational blood and body fluid exposures will be discussed. It will identify multiple factors that may adjust the risk of contracting bloodborne pathogens in such

EXECUTIVE SUMMARY

- The source of the blood or body fluid potentially is the most important factor providers must consider in exposure situations. Sources with known and uncontrolled infections from bloodborne pathogens constitute the highest risk of possible transmission and nearly always require postexposure prophylaxis (if available) with the guidance of an infectious disease specialist.
- The surfaces that were exposed should be considered carefully and stratified by risk, such as intact skin (lowest risk), mucous membranes, conjunctivae, and penetrating injuries to underlying tissues and capillary beds (highest risk).
- In all situations, regardless of risk level, initial wound care remains the same. All needlestick and other penetrating injuries should be washed appropriately with soap and water as soon as possible. Bleeding should be controlled. Sutures should be used for lacerations according to typical emergency wound care.
- Observational studies, case reports, and a systematic review broadly confirm that environmental needlesticks are extremely low risk for bloodborne pathogen transmission.
- For a potential human immunodeficiency virus exposure, if the source is unknown, but the needle is larger in bore and blood was visible on or in the needle prior to the injury, baseline testing is indicated and an infectious disease specialist should be contacted immediately. If no blood was visible on the needle, many infectious disease physicians will err on the side of recommending baseline serologic testing anyway.
- In environmental needlestick injuries, the hepatitis B status of any previous users of the needle or sharp often is unknown. In this setting, given the low risk of transmission, the fully immunized patient requires no further treatment. The unimmunized patient should receive the first dose of the hepatitis B vaccine within 24 hours and then continue a normal vaccine schedule, as recommended by the Centers for Disease Control and Prevention. Partially immunized patients should simply continue the normal vaccine series.
- If a community-associated exposure is caused by a needle or sharp used by a known hepatitis B-surface-antigen-positive source, the epidemiologic risk for transmission is much higher. In this setting, unimmunized patients should receive both hepatitis B immune globulin and the first hepatitis B vaccine within 24 hours of the exposure event, administered in different limbs. Partially immunized patients should still receive hepatitis B immune globulin within 24 hours of injury, but thereafter should continue with the standard vaccine schedule. Fully immunized patients should only receive a single booster dose of the hepatitis B vaccine within 24 hours of injury.
- Although most exposures (such as environmental needlesticks) likely will be extremely low risk, high-risk exposures from known hepatitis C virus (HCV)-positive individuals still are possible. In these situations, there is, unfortunately, no medication or immunoglobulin preparation approved for postexposure prophylaxis for HCV. After obtaining an appropriate history and baseline testing, providers should explain the risk and natural history of hepatitis C infection. Follow-up testing should be arranged. HCV ribonucleic acid may be detected by polymerase chain reaction four to six weeks after exposure, but ultimately ruling out infection is performed best by later serological testing.

exposures, followed by a discussion on each of the bloodborne pathogens of greatest concern (HIV, hepatitis B, and hepatitis C). The epidemiology of transmission, baseline testing considerations, and need for prophylaxis will be discussed for each pathogen with the goal of providing practitioners a reasonable approach for such situations.

However, in all cases, particularly when prophylaxis is needed, discussion with an infectious disease specialist should be considered. Providers also should be aware that healthcare occupational exposures always warrant discussion with the patient's institutional employee health services.

Considerations When Evaluating Exposures

When confronted with nonoccupational blood and body fluid exposures in the community, providers should conceptually stratify the risk of transmission by considering several factors. (*See Table 1.*) These may be separated into considerations regarding the source (the individual whose blood or body fluid could be a possible source of a pathogen), the recipient (the characteristics of the individual who has been exposed to the potentially infected blood or body fluid), the specific event or injury (such as the surface or tissue that was exposed to potentially contaminated blood or body fluid), and, finally, any instruments or devices associated with the exposure (such as the characteristics of a contaminated needle that was involved in a penetrating injury).

The source of the blood or body fluid potentially is the most important factor providers must consider in exposure situations. Sources with known and uncontrolled infections from bloodborne pathogens constitute the highest risk of possible transmission and nearly always require postexposure prophylaxis (if available) with the guidance of an infectious disease specialist. Below that risk stratum are those sources with known but controlled infections — that is, individuals with bloodborne pathogen infection who are under treatment for the pathogen of concern and with low or undetectable levels of the agent. Such situations still demand the input of an infectious disease specialist, and likely prophylaxis, but are less likely to result in bloodborne pathogen transmission. Next, below that level, are those with unknown status in terms of bloodborne pathogen infection — the most frequently encountered situation. Because of the ambiguity and diversity of circumstances such scenarios present, providers must enter nuanced discussions with patients and families regarding the risks and

Table 1. Risk Stratification in Community, Nonoccupational Blood and Body Fluid Exposures

	Source	Recipient	Tissue Involved	Instrument Characteristics
Highest risk	• Known positive for HIV, HBV, or HCV • Uncontrolled infection or high viral load	Unimmunized for hepatitis B	• Broken skin • Underlying tissues and capillary beds (laceration or deep needlestick)	• Fresh blood • Large-bore needle • Significant reservoir of blood in the hub
Intermediate risk	• Unknown HIV, HBV, or HCV status • Positive status but undetectable viral load	Incomplete hepatitis B immunization	• Mucous membranes • Conjunctivae	
Lowest risk	• Known negative HIV, HBV, or HCV status	Complete immunization series for hepatitis B	• Failure to penetrate outer layers of skin	• Dry needle • Smaller bore • No reservoir

HIV: human immunodeficiency virus; HBV: hepatitis B virus; HCV: hepatitis C virus

benefits of postexposure prophylaxis, which may be assisted by contacting an infectious disease specialist. Finally, sources with negative, recent, and sensitive testing for bloodborne pathogens constitute the lowest risk, but they still require attentive history-taking and consideration.

Characteristics regarding the recipient of the blood or body fluid exposure also must be considered in risk stratification. Providers should undertake a detailed past medical history with special attention to immunization history (particularly in regard to hepatitis B and tetanus immunization), any immunologic deficiencies or concern for such (patients with insufficient response to immunizations will be at higher risk for hepatitis B and tetanus), and any underlying conditions that would complicate the postexposure prophylaxis regimen of choice, should one be warranted (for example, renal disease in an individual who is under consideration for HIV nonoccupational exposure prophylaxis).

Next, the provider should interrogate the equitable and economical access to effective therapies circumstances of the exposure event. The surfaces that were exposed should be considered carefully and stratified by risk, such as intact skin (lowest risk), mucous membranes, conjunctivae, and penetrating injuries to underlying tissues and capillary beds (highest risk). Intact skin that has come into contact with blood or other body fluids constitutes a low- or essentially no-risk situation, provided the provider has not overlooked any injuries to the patient's skin such as abrasions, cuts, etc. Mucous membranes and conjunctivae constitute an intermediate-risk situation, since bloodborne pathogens are capable of crossing such barriers. Finally, penetrating injuries leading to direct contact of the source's blood or bodily fluid with the recipient's underlying tissues or capillary beds always constitute a high-risk situation. In considering possible penetrating injuries, such as needlesticks, the provider should ask whether the patient or family noted visible blood or bleeding at the site of the injury.

Finally, the characteristics of any instrument involved in the blood or body-fluid exposure should be considered. Needles or other sharps vary in their likelihood of transmission, depending on the amount and viability of the contaminating blood or body fluid. Wet, fresh blood in large quantities always poses far greater risk than desiccated, older blood in smaller quantities.[1] To this end, the provider should ask how recently the needle or sharp was used (if known); whether any wet or fresh blood or body fluid was observed on the instrument prior to the injury; and whether the needle was hollow-bore, and what the bore of the needle was or if there was a significant reservoir of blood in the hub. Larger-bore needles are capable of holding larger amounts of blood and protecting the contents in the bore or hub from desiccation.

In all situations, regardless of risk level, initial wound care remains the same. All needlestick and other penetrating injuries should be washed appropriately with soap and water as soon as possible. Bleeding should be controlled. Sutures should be used for lacerations according to typical emergency wound care.

Providers also should carefully evaluate patients with penetrating injuries for their tetanus immunization status, and wounds should be stratified based on whether gross contamination (such as from dirt, soil, or feces) is present or absent. (*See Table 2.*)

Children and adolescents with "clean" wounds who have not received at least three doses of tetanus-containing vaccines should receive an age-appropriate booster dose.[2,3] Fully vaccinated patients with "clean" wounds who have not received a tetanus-containing vaccine in the past 10 years also should receive a booster dose.

Contaminated wounds among unimmunized or partially immunized patients may require the administration of tetanus immune

Table 2. Tetanus Toxoid Recommendations

Past Number of Doses of Previous Tetanus Toxoid-Containing Vaccines	Clean, Minor Wound		Any Other Wound, Including Those Contaminated by Dirt or Feces, as well as Frostbite, Crush Injuries, and Burns	
	DTaP, Tdap, or Td	TIG	DTaP, Tdap, or Td	TIG*
Unknown or < 3	Yes	No	Yes	Yes
≥ 3	No**	No	No***	No

DTaP: diphtheria, tetanus, and pertussis; Tdap: tetanus, diphtheria, and pertussis; Td: tetanus and diphtheria ; TIG: tetanus immune globulin
*Patients with human immunodeficiency virus or severe immunocompromise with grossly contaminated wounds should receive TIG regardless of past immunization status.
**Yes, if it has been 10 years or more since the patient's last tetanus toxoid-containing vaccine.
***Yes, if it has been five years or more since the patient's last tetanus toxoid-containing vaccine.
Adapted from: Centers for Disease Control and Prevention. Tetanus: For clinicians. Updated Jan. 23, 2020. https://www.cdc.gov/tetanus/clinicians.html

globulin alongside a booster dose of tetanus-containing vaccine, to be administered in separate limbs. Fully vaccinated patients with contaminated wounds who have not received a tetanus-containing vaccine in the past five years also should receive a booster dose, although not tetanus immunoglobulin. Patients younger than age 7 years should receive diphtheria, tetanus, and pertussis (DTaP), while older children and adolescents should receive tetanus, diphtheria, and pertussis (Tdap). If the child has had a previous Tdap administered in the past, tetanus and diphtheria (Td) vaccine also is an acceptable option. It should also be noted that immunocompromised patients with contaminated wounds may require the administration of tetanus immunoglobulin regardless of previous immunization status.

Exposures Because of Needles Found in the Environment

Nearly all needlesticks secondary to sharps found outdoors fail to transmit any bloodborne pathogens. Indeed, one multicenter study in Montreal disclosed that, in more than 270 cases of children with community-acquired needlesticks from sharps discovered in parks, streets, and other neighborhood locations over a 19-year period between 1995 and 2006, there were no observed seroconversions for HIV, hepatitis B, or hepatitis C.[4] Prophylactic antiretrovirals were offered to these children beginning in 1997. Another study from South Africa in 1999 determined that after more than 50 children experienced a mass exposure event from discarded needles left on a soccer playing field, none experienced seroconversion for HIV, hepatitis B, or hepatitis C, although these children did receive HBV vaccination and antiretroviral prophylaxis at presentation.[5] Further observational studies, case reports, and a systematic review broadly confirm that environmental needlesticks are extremely low risk for bloodborne pathogen transmission.[6,7]

These incidents illustrate a fundamental fact regarding the transmission of bloodborne pathogens. When blood and body fluids dry over the course of days to weeks, most viral pathogens of concern become nonviable. The provider still should obtain a careful history and strive to determine whether the needle or sharp may have been used recently prior to the exposure event, although such situations appear to be rare.

In any case, providers will need to discuss the risks vs. benefits of initiating antiretroviral prophylaxis and hepatitis B booster vaccination in the context of dubious transmissibility. Furthermore, anxious parents may be reassured at knowing the nonviability of most bloodborne pathogens in environmental needlesticks. However, providers should consider contacting a local infectious disease specialist in all but the most straightforward cases. Parents occasionally bring the offending sharp into the office or emergency department following an environmental needlestick event. This can be useful for the provider to determine the above characteristics (gauge, reservoir, etc.) to risk-stratify the exposure event. However, parents also may request that the needle should be tested for bloodborne pathogens directly. Unfortunately, testing from such surfaces likely would prove insensitive, and no validated, commercially available testing is available for such requests.

Specific Bloodborne Pathogens of Concern

HIV

As of 2018, an estimated 1.2 million people in the United States currently live with HIV, and 36,400 new cases were reported, for an incidence rate of 13.3 new cases per 100,000 people.[8] The primary modes of transmission in new cases include sexual contact, injection drug use (including sharing needles), and perinatal transmission. Although the prevalence of HIV infection remains lowest among those younger than 25 years of age, this same demographic remains at the highest risk of harboring undiagnosed HIV infections.[8] It is estimated that 45% of individuals living with HIV in this age group are unaware of their HIV-positive status.

Parents and patients typically are most concerned for HIV transmission following a community-acquired needlestick injury or body fluid exposure.[1] At this time, the rate of transmission for nonoccupational,

accidental exposures is unknown for HIV. In the healthcare (occupational) setting, the rate of transmission of HIV because of needlesticks and other blood and body fluid exposures is believed to be approximately 0.3%.[1]

HIV is very susceptible to drying and heat, and rates of transmission in the setting of a community-acquired needlestick injury or accidental exposure are thought to be very low.[9] To date, there have been no known, credible cases of accidental environmental needlestick injuries leading to HIV transmission.[4,7,10]

However, providers should be vigilant and obtain an appropriate history in such cases. As mentioned, providers should inquire about the nature and depth of the injury, whether the source of the needle is known, and whether the needle appeared to be used recently, as well as its specific physical attributes. An infectious disease specialist should be contacted in all but the most straightforward cases.

If the source is unknown, but the needle is larger in bore and blood was visible on or in the needle prior to the injury, baseline testing is indicated and an infectious disease specialist should be contacted immediately.[1] If no blood was visible on the needle, many infectious disease physicians will err on the side of recommending baseline serologic testing anyway.

Unfortunately, there is no consensus on whether postexposure prophylaxis is indicated in the situation of environmental needlesticks, but the risk of infection with HIV is theoretically higher if visible blood was on the needle or in the reservoir prior to the injury, and prophylaxis should be seriously considered. In other situations where the source of the needle is known and the individual is at low risk for HIV infection, postexposure prophylaxis can be delayed until testing of the source individual can be performed. In the highest risk category, if the needle or sharp is from a known HIV-positive patient, baseline testing and postexposure prophylaxis should be initiated with the guidance of an infectious disease specialist.[10]

Individuals exposed to blood or body fluids from an HIV-positive or HIV-unknown source should undergo baseline testing with a fourth-generation antibody/antigen test. While a needlestick without visible blood from an environmental source is highly unlikely to lead to transmission, most infectious disease physicians recommend erring on the side of obtaining baseline and follow-up serologic testing, even if prophylaxis is not pursued.

Since seroconversion from a transmission event can take several weeks, testing is expected to be negative in the acute setting, and it is performed primarily to document a negative serostatus in the exposed individual. If baseline testing is positive, an infectious disease specialist should be contacted if one has not already been involved, confirmatory testing should be undertaken, and further history regarding possible perinatal exposure, sexual activity (or abuse), or drug use should be explored.

Following a negative baseline antibody/antigen test, repeat testing should be performed on exposed individuals at four to six weeks, and then again at three months.[11] If symptoms concerning for acute HIV infection (also known as acute retroviral syndrome) occur within six weeks of injury, viral load and antibody level testing is indicated.[1] Symptoms of acute retroviral syndrome often are described as "mononucleosis-like" and can include nonspecific manifestations, such as a polymorphous rash, lymphadenopathy, malaise, and fever.[10]

If indicated, postexposure prophylaxis should be initiated within 72 hours of exposure, and an infectious disease specialist should be consulted.[10] Postexposure prophylaxis typically consists of a three-drug regimen for 28 days with antiretrovirals selected according to guidelines provided by the Centers for Disease Control and Prevention (CDC). (*See Table 3*).

Hepatitis B

The CDC estimated that there were about 21,600 new cases of acute hepatitis B in 2018.[12] Risk factors for transmission included intravenous drug use, sexual contact, and exposures in healthcare settings. Acute hepatitis B infection is frequently asymptomatic in adults and children, but some symptoms can include nonspecific malaise, nausea, or anorexia. Progression to jaundice or fulminant hepatitis also is reported. Extrahepatic manifestations include arthralgias, arthritis, macular rashes, polyarteritis nodosa, glomerulonephritis, and, rarely, papular acrodermatitis.[13]

The risk of chronic hepatitis B after acute infection changes according to age at that time of exposure. Almost 90% of infants who contract acute hepatitis B in the first year of life will become chronically infected, as opposed to only 5% to 10% of older children (> age 5 years) or adults.[13] The rate of both acute hepatitis B infection, as well as subsequent conversion to chronic hepatitis B, has decreased significantly since the advent of the hepatitis B vaccine. Since 1990, the incidence of acute hepatitis B infection has declined 93% to 98% for children and young adults.

In comparison to other bloodborne pathogens, HBV particles are particularly resilient, with documented viability on surfaces for up to seven days.[13] Transmission rates from contaminated instruments tend to be higher as well; transmission rates in healthcare workers with needlestick injuries range from 23% to 62%.[1] However, community-acquired needlestick injuries remain much lower risk. At the time of this writing, there have been only two documented cases of hepatitis B infection associated with an environmental needlestick injury.[7,14,15]

Following an exposure event, all patients should undergo hepatitis B surface antigen, surface antibody, and total core antibody testing. Surface antigen and core antibody testing are expected to be negative, since these are markers of active or past infection. These markers are obtained to serve as documentation that the patient was not infected prior to the exposure event.

If these tests are positive, an infectious disease specialist should be contacted if they have not already

Table 3. Preferred Antiretroviral Medication 28-Day Regimens

Patient Group	Preferred Antiretroviral Regimen*
Adults and adolescents aged ≥ 13 years, including pregnant women, with normal renal function (creatinine clearance ≥ 60 mL/min)	Tenofovir disoproxil fumarate 300 mg AND Fixed dose combination emtricitabine 200 mg (Truvada) once daily WITH Raltegravir 400 mg twice daily
Adults and adolescents aged ≥ 13 years with renal dysfunction (creatinine clearance ≤ 59 mL/min)	Zidovudine AND Lamivudine, with both doses adjusted to degree of renal function** WITH Raltegravir 400 mg twice daily
Children aged 2 to 12 years	Tenofovir disoproxil fumarate AND Emtricitabine AND Raltegravir, with each drug dosed to age and weight**
Children aged 4 weeks to < 2 years	Zidovudine oral solution AND Lamivudine oral solution WITH Raltegravir, with each drug dosed according to age and weight**

*An infectious disease specialist should be contacted if starting any child on antiretroviral prophylaxis.

**Dosing and schedule should be devised with the guidance of an infectious disease specialist and/or a pharmacist.

Adapted from: Dominguez KL, Smith DK, Vasavi T, et al. Updated guidelines for antiretroviral postexposure prophylaxis after sexual, injection drug use, or other nonoccupational exposure to HIV—United States, 2016. Centers for Disease Control and Prevention. Updated May 23, 2018. https://stacks.cdc.gov/view/cdc/38856

been involved, confirmatory testing should be undertaken, and further history regarding possible perinatal exposure, sexual activity (or abuse), or drug use should be explored. In immunized individuals, surface antibody testing is expected to be positive, which indicates a successful prior response to vaccination. Individuals who have previously received the hepatitis B immunization but fail to demonstrate a positive surface antibody are considered vaccine nonresponders and should be treated as if they are unimmunized. Follow-up testing is unnecessary in individuals with positive hepatitis B surface antibody at baseline (indicating immunity).

For those with negative hepatitis B surface antibody at baseline, follow-up testing can be considered, although no specific guidelines for community exposures are available. In this situation, it is reasonable to obtain hepatitis B surface antigen, surface antibody, and total and immunoglobulin M (IgM) core antibody at six months following exposure, based on occupational exposure recommendations.[13]

The efficacy of postexposure prophylaxis is believed to wane with time, so treatment should be initiated as soon as possible after a needlestick injury, preferably within 24 hours. (*See Table 4.*) As mentioned previously, the exposure should first be stratified according to whether the source is known to be hepatitis B-surface-antigen-positive or unknown. The exposed patient then should be stratified into one of three groups: unimmunized, partially immunized, or fully immunized, with prophylaxis choices varying based on each stratification.

In environmental needlestick injuries, the hepatitis B status of any previous users of the needle or sharp often is unknown. In this setting, given the low risk of transmission, the fully immunized patient requires no further treatment. The unimmunized patient should receive the first dose of the hepatitis B vaccine within 24 hours and then continue a normal vaccine schedule, as recommended by the CDC. Partially immunized patients should simply continue the normal vaccine series.[13]

If a community-associated exposure is caused by a needle or sharp used by a known hepatitis B-surface-antigen-positive source, the epidemiologic risk for transmission is much higher. In this setting, unimmunized patients should receive both hepatitis B immune globulin and the first hepatitis B vaccine within 24 hours of the exposure event, administered in different limbs. Partially immunized patients should still receive hepatitis B immune globulin within 24 hours of injury, but thereafter should continue with the standard vaccine schedule. Fully immunized patients should only receive a single booster dose of the hepatitis B vaccine within 24 hours of injury.[13]

Hepatitis C

In 2018, the CDC estimated there were 50,300 acute cases of hepatitis

Table 4. Hepatitis B Virus Postexposure Prophylaxis for Percutaneous (Bite*, Needlestick, etc.) or Mucosal Exposure to Potentially Infected Blood or Body Fluid**

	Unimmunized or Partially Immunized Recipient/Patient	Fully immunized Recipient/Patient
Blood or body fluid exposure from an HBsAg-positive source	Begin hepatitis B vaccine series and administer hepatitis B immune globulin in a separate limb.	Administer hepatitis B vaccine booster dose.
Blood or body fluid exposure from an HBsAg-unknown source	Begin hepatitis B vaccine series.	No treatment

HBsAg: hepatitis B surface antigen

*An infectious disease specialist should be contacted if starting any child on antiretroviral prophylaxis.

**Dosing and schedule should be devised with the guidance of an infectious disease specialist and/or a pharmacist.

Adapted from American Academy of Pediatrics. Hepatitis B. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2018 Report of the Committee on Infectious Diseases*. 31st ed. American Academy of Pediatrics; 2018:401-428.

C in the United States, based on reported infections and probabilistic modelling.[16] Rates of acute hepatitis C have increased over recent years, particularly among people aged 20-39 years, who are believed to be the most severely affected by the ongoing opioid addiction crisis and intravenous drug use.

Up to 60% of acute hepatitis C cases reported to public health bodies in the United States are found among drug users who share needles or injection paraphernalia, and up to one-third of injection drug users 18 to 30 years of age are believed to be infected with hepatitis C.[17] Following acute transmission and infection, approximately 75% to 85% of adults will develop chronic infection, many of them asymptomatic or unknown. Overall, the general prevalence of HCV infection (acute and chronic) in the United States is estimated at 1.3%.[17]

Such epidemiologic factors should be considered in the context of households where injection drug use or other frequent percutaneous exposures (such as receipt of hemodialysis) are common. However, while frequent needle sharing between intravenous drug users increases the efficiency of bloodborne transmission, the actual rate of infection from discarded needles or incidental percutaneous exposure is believed to be quite low. According to data from 2002-2015, percutaneous exposure of U.S. healthcare providers to blood and body fluids from hepatitis C-antibody-positive individuals resulted in newly acquired HCV infection in only 0.2% of cases.[18] These incidents typically represent situations when fresh blood or body fluids are inoculated directly into the recipient. Thus, the rate of infection in discarded needles likely would be far less (perhaps, essentially, 0 in the vast majority of cases), since the virus is able to survive in the environment only 16 to 23 hours.[1]

In the case of exposure to blood or body fluids from an HCV-positive or unknown individual, pediatric emergency providers should undertake a thorough history (e.g., type of exposure, what kind of needle in the case of needlestick injury, visible blood, etc.) as delineated earlier. Patient risk factors and immunization history should be explored. Baseline testing for the hepatitis C antibody should be arranged.

Although most exposures (such as environmental needlesticks) likely will be extremely low risk, high-risk exposures from known HCV-positive individuals still are possible. In these situations, there is, unfortunately, no medication or immunoglobulin preparation approved for postexposure prophylaxis for HCV. After obtaining an appropriate history and baseline testing, providers should explain the risk and natural history of hepatitis C infection. Follow-up testing should be arranged. HCV ribonucleic acid may be detected by polymerase chain reaction four to six weeks after exposure, but ultimately ruling out infection is performed best by later serological testing.[1] Antibodies to HCV can be detected in 80% of newly infected patients within 15 weeks after exposure and in 97% of newly infected patients six months after exposure.

See Table 5 for recommendations on baseline and follow-up testing following exposure events.

Prevention of Bloodborne Pathogen Transmission

Primary prevention of bloodborne pathogen transmission is safer and more cost-effective than postexposure prophylaxis. Public health interventions focusing on decreasing the overall prevalence, incidence, and risk of bloodborne pathogen exposures in the community and environment may be of particular benefit. Providers should be aware of the benefits of universal hepatitis B vaccination, needle exchange and distribution programs, needle disposal programs, and sexual barrier protection programs.

The United States has undertaken an overarching strategy of eliminating hepatitis B infections through universal immunization of all infants and children younger than 18 years of age, prevention of perinatal hepatitis B virus infections through routine screening of all pregnant women and provision of perinatal prophylaxis, and immunization of previously unimmunized adults who may be at greater risk of infection.[13]

Table 5. Baseline and Follow-up Testing for Bloodborne Pathogens Following Exposure Events

Pathogen	Baseline Testing	Follow-up Testing
HIV	• HIV 1,2 antibody/antigen	Repeat HIV 1,2 antibody/antigen test at four to six weeks and again at three months. If concern arises for acute retroviral syndrome before then, immediately obtain HIV 1,2 antibody/antigen and quantitative RNA PCR testing.
Hepatitis B	• Hepatitis B surface antibody • Total core antibody • Surface antigen	If the patient's baseline hepatitis B surface antibody is positive, no further testing is needed. If surface antibody is negative or the patient is unimmunized, consider obtaining hepatitis B surface antigen, surface antibody, and total and IgM core antibody six months following exposure, especially if the source is known to be positive.
Hepatitis C	• Hepatitis C antibody	Repeat hepatitis C antibody testing in 15 weeks following exposure and again at six months following exposure.

HIV: human immunodeficiency virus; RNA: ribonucleic acid; PCR: polymerase chain reaction; IgM: immunoglobulin M

Adapted from American Academy of Pediatrics. Injuries from discarded needles in the community. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2018 Report of the Committee on Infectious Diseases*. 31st ed. American Academy of Pediatrics; 2018:185-186; Dominguez KL, Smith DK, Vasavi T, et al. Updated guidelines for antiretroviral postexposure prophylaxis after sexual, injection drug use, or other nonoccupational exposure to HIV—United States, 2016. Centers for Disease Control and Prevention. Updated May 23, 2018. https://stacks.cdc.gov/view/cdc/38856; and American Academy of Pediatrics. Hepatitis B. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2018 Report of the Committee on Infectious Diseases*. 31st ed. American Academy of Pediatrics; 2018:401-428.

The introduction of this strategy has led to a significant drop in hepatitis B virus transmission in the United States. Since 1990, the incidence of acute hepatitis B infection has declined 93% to 98% for children and young adults. As the pediatric population ages and universal immunization continues, eventual elimination of HBV prevalence becomes increasingly likely, further decreasing the possibility of bloodborne transmission.

In terms of strategies directed against all bloodborne pathogen transmission, the aim of decreasing needle sharing has been proposed and used as a cost-effective public health intervention. Needle exchanges for injection drug users (in which clean needles are provided in exchange for used needles) have been proposed in recent years. In conjunction with addiction treatment, counseling, education, and ongoing research, needle exchanges currently are supported by the American Academy of Pediatrics as a means of decreasing bloodborne pathogen transmission between injection drug users and their families.[1] Studies regarding the efficacy of this intervention at reducing transmission of bloodborne pathogens have shown some benefit, but many had serious concerns for bias, so the overall benefit for decreasing transmission and decreasing overall economic burden still are unknown.[19]

Similarly, programs that allow for the safe disposal of needles have become prevalent only recently, and the effectiveness of this in reducing the incidence of bloodborne pathogens has yet to be seen. From a general public safety standpoint, this is a useful tool and should be encouraged among families and communities.

Although it is beyond the scope of this review to extensively discuss public health strategies regarding sexually transmitted infections, it is worth mentioning that such strategies are capable of decreasing the risk of bloodborne pathogen prevalence and transmission as well. It is well-documented that barrier protection (such as condom use) can decrease the transmission of sexually transmitted diseases, including the bloodborne pathogens discussed in this review. Similar to clean needles, providing sufficient supplies and consistent education about using barrier protection as a way to reduce transmission of sexually transmitted infections should have a theoretical benefit. There are many small- to moderate-scale campaigns that reportedly have shown some benefit in this regard.[20] However, the use of barrier protection can be inconsistent, especially in the adolescent population.[21] Studies regarding these interventions have been limited, however.

Conclusions

Nonoccupational blood and body fluid exposures may be encountered in the pediatric emergency department. Such exposures may occur in the home because of the presence of a household member with seropositivity for a bloodborne infection, or they may occur in the community because of the inappropriate disposal of needles and sharps.

In all situations, appropriate wound care and tetanus prophylaxis are essential. Subsequently, providers should be prepared to assess the level of risk for major bloodborne pathogens and their transmission. The child's current serostatus and immunization status should be evaluated. Prophylaxis should be administered thereafter according to the risk of bloodborne pathogen transmission. Follow-up serostatus testing and monitoring should be established. An infectious disease specialist should be contacted for guidance in all but the lowest-risk exposures.

Case Conclusion

After reviewing the child's immunizations, it is determined the boy is fully immunized, including both DTaP and hepatitis B vaccinations. His risk of developing tetanus is low, and his risk of contracting hepatitis B is low so long as he has responded to his prior doses of hepatitis B vaccine. In addition, you explain to the mother that his risk of contracting HIV is extremely low, and that the risk of medication side effects from starting antiretroviral prophylaxis likely outweighs any theoretical benefit at this time.

You recommend obtaining baseline serology studies for hepatitis B, hepatitis C, and HIV, which the mother agrees with, as well as follow-up studies in four to six weeks and three months for repeat HIV testing, 15 weeks and six months for hepatitis C testing, and six months for hepatitis B testing (if his baseline serology indicates lack of immunization or failure of immunization) with the boy's primary care physician.[1,11,13]

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CME/CE Questions

1. Which of the following factors regarding the risk of bloodborne pathogen transmission is true regarding evaluating a community needlestick event?
   a. Larger bore needles tend to be lower risk.
   b. Cleaning a needlestick injury raises risk, since scrubbing may further traumatize broken skin.
   c. Discarded needles associated with appropriate disposal facilities are lower risk than discarded needles found in the environment.
   d. Needlestick wounds that bleed indicate deeper and more traumatic injury and, thus, are higher risk.
2. A previously healthy, fully vaccinated 10-year-old boy presents after injuring his hand from a discarded needle. The injury occurred as he was scooping up a pile of leaves at a scout troop cleanup of a local park. The

needle poked through his work glove and has left a visible, bleeding injury in the base of his thumb. The family immediately washed the wound and brought the needle with them to the emergency department. The needle appears to be 18-gauge. It is dry and crusted with a small amount of dirt. The family asks if you can have the needle tested for bloodborne pathogens. Which of the following is true?

a. The needle should be tested for human immunodeficiency virus (HIV) and hepatitis C viral ribonucleic acid (RNA), as well as hepatitis B viral deoxyribonucleic acid (DNA).
b. The needle should be tested for HIV viral RNA and hepatitis B viral DNA, but not hepatitis C.
c. The needle should be tested only for HIV viral RNA.
d. It is not useful to attempt testing for viral nucleic acid from the needle.

3. A previously healthy 3-year-old girl is brought by her mother to your facility after she suffered an accidental self-injury from a needle at home. Her mother had just completed a self-injection with her home insulin when the child reached up and accidentally grabbed the needle while trying to climb into the mother's lap. The mother is HIV-positive and currently on antiretroviral therapy by an infectious disease physician. Which of the following questions is most useful in determining the level of risk in this exposure event?

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   a. What was the mother's most recent cluster of differentiation 4 count?
   b. What was the mother's most recent lymphocyte percentage in her cell count and differential?
   c. What was the mother's most recent HIV viral load?
   d. How many units of insulin did the mother inject prior to the exposure?

4. You obtain further information regarding the mother's HIV and her current health. After discussing the case with a local infectious disease specialist and consulting the Centers for Disease Control and Prevention Post-Exposure Prophylaxis Hotline for confirmation, it is decided that this exposure situation warrants post-exposure prophylaxis. Which of the following regimens are you likely to choose, after appropriately discussing the case with an infectious disease specialist?
   a. A 28-day course of zidovudine
   b. A 28-day course of zidovudine and nevirapine
   c. A 28-day course of tenofovir disoproxil fumarate, emtricitabine, and raltegravir
   d. A seven-day course of tenofovir disoproxil fumarate, emtricitabine, and raltegravir

5. In the course of your evaluation, you discover the mother's most recent labs indicate a positive hepatitis B surface antigen evaluation at her last visit with her physician. You also determine the exposed 3-year-old child has completed a full course of hepatitis B immunization. What are your next steps?
   a. Administer a booster dose of hepatitis B vaccine.
   b. Administer a booster dose of hepatitis B vaccine and hepatitis B immune globulin, both in the same limb where the needlestick occurred.
   c. Administer a booster dose of hepatitis B vaccine and hepatitis B immune globulin in different limbs.
   d. Administer hepatitis B immune globulin alone.

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- apply up-to-date therapeutic techniques to address conditions discussed in the publication;
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