Occupational Health Update

Focus on Preventing the Acquisition of Infections with Pre-exposure Prophylaxis and Postexposure Prophylaxis

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KEYWORDS

• Occupational health • Health care personnel • Vaccines • Postexposure prophylaxis
• Hepatitis B • Hepatitis C • HIV

KEY POINTS

- An effective occupational program is a key aspect of preventing the acquisition of an infection by health care providers through pre-exposure assessment of immunity to vaccine-preventable diseases and immediate access to medical evaluation for postexposure prophylaxis (PEP) after exposure to a communicable disease.
- All health care providers should be immune to mumps, measles, rubella, varicella, pertussis, and influenza. Health care providers with the potential for blood or body fluid exposure should also be immune to hepatitis B.
- PEP is available after exposure to several diseases, including hepatitis A, hepatitis B, HIV, measles, pertussis, invasive meningococcal infection, and syphilis.
- Health care personnel (HCP) with certain communicable disease need to be evaluated for work restrictions or furlough.

INTRODUCTION

Health care is the fastest-growing sector of the US economy, employing more than 18 million persons.[1] HCP face a range of noninfectious hazards on the job, including back injuries, strains and sprains, latex allergy, violence, and stress.[1] HCP are also commonly exposed to infectious agents via sharp injuries (eg, hepatitis C virus [HCV], hepatitis B virus [HBV], and human immunodeficiency virus [HIV]), direct patient

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care (eg, respiratory viruses, gastrointestinal pathogens, and pertussis), and the contaminated environment (eg, *Clostridium difficile*). Cases of nonfatal occupational injury and illness among HCP are among the highest of any industry sector.[1] The risks and methods preventing occupational acquisition of infection by HCP have been reviewed.[2–7] Minimizing the risk of disease acquisition is based on 6 key recommended practices: (1) proper training of HCP at initiation of health care practice and annually (eg, infection control practices and sharp injury prevention); (2) immunity to vaccine-preventable diseases[2,6,8–11]; (3) evaluation of HCP who were exposed to communicable diseases for receipt of PEP[2,12–14]; (4) adherence to standard precautions when providing patient care,[15] especially the performance of appropriate hand hygiene before and after patient care[16–18]; (5) rapid institution of appropriate isolation precautions for patients with a known or suspected communicable disease[15,19,20]; and (6) proper use of personal protective equipment, such as masks, N95 respirators, eye protection, and gowns when caring for patients with potentially communicable diseases.[15,21] Prevention of laboratory-acquired infection requires adherence to recommended administrative protocols (eg, no eating, drinking, or smoking in areas where microbiologic or pathologic samples are processed), engineering controls (eg, containment hoods), personal protective equipment (eg, N95 masks when culturing *Mycobacterium tuberculosis*), and appropriate immunizations.[22,23]

DEFINITIONS

HCP refers to all paid and unpaid persons providing services in health care settings who have the potential for exposure to patients and/or infectious materials, including body substances, contaminated medical supplies and equipment, contaminated environmental surfaces, or contaminated air. These HCP may include but are not limited to those listed in **Box 1**. In general, HCP who have regular or frequent contact with patients, body fluids, or specimens have a higher risk of acquiring or transmitting infections than do HCP who have only brief contact with patients and their environment (eg, beds, food trays, and medical equipment). All HCP who work within the confines of a health care facility, however should be covered by the occupational health service (OHS) and receive appropriate screening and pre-exposure prophylaxis even if they do not provide direct patient care because they frequently interact with HCP providing direct care and are, therefore, at risk for acquiring or transmitting infectious pathogens.

Box 1
Health care personnel whose care should be covered by an occupational health service

- Emergency medical service personnel
- Nurse and nursing assistants
- Physicians and dentists
- Technicians
- Therapists (eg, occupational health, physical, and respiratory care)
- Pharmacists
- Students and trainees
- Contractual staff not employed by the health care facility
- Persons not directly involved in patient care (eg, clerical, dietary, housekeeping, laundry, security, maintenance, administrative, billing, volunteers, laboratory, and mortuary)

Health care settings refers to locations where health care is provided and includes, but is not limited to, facilities that provide acute care, long-term care, assisted living, rehabilitation, home health, dialysis, and ambulatory surgery. It also includes vehicles that transport patients (eg, ambulances, medical helicopters, and planes).

Occupational health programs refer to formal, well-designed, organized plans that provide OHSs to HCP. Most commonly, OHSs are provided onsite within the health care facility in which HCP are performing patient care but may also be provided offsite. Occupational health programs should include a variety of activities designed to minimize the risk for HCP to acquire an infectious disease, to evaluate HCP with a potential exposure to a communicable disease, and to evaluate HCP with a communicable disease (**Box 2**).

Occupational health programs should be aware of appropriate guidelines from the Centers for Disease Control and Prevention and professional organizations. They should adhere to appropriate state and federal laws and regulations. Specific regulations promulgated by the US Occupational Health and Safety Administration (OSHA) related to HCP include Bloodborne Pathogens (1910.1030)[24] and Tuberculosis/Respiratory Protection (1910.134).[25] The federal Needlestick Safety and Prevention Act (HR 5178), which was enacted in 2000, requires the use of safety engineered devices whenever possible to reduce the likelihood of sharp injuries.[26]

PRE-EXPOSURE SCREENING AND IMMUNIZATIONS

Pre-exposure Screening

All new HCP should undergo a new personnel orientation. As part of the orientation process, new HCP should undergo screening and education directed at reducing the risk of acquisition of infection diseases by health care providers (see **Box 2**). All information obtained should be entered into an electronic database.

Immunizations

General recommendations regarding vaccination of HCP have been published by the Centers for Disease Control and Prevention (CDC),[2] the Advisory Committee on Immunization Practices (ACIP),[8,27,28] the American Academy of Pediatrics (AAP),[11] and the Association for Professionals in Infection Control and Epidemiology (APIC).[10] The most recent ACIP recommendations, which are summarized yearly, should always be consulted.[28] It is recommended that all HCP be immune to mumps, measles, rubella, varicella, pertussis, and influenza.[2,8,10,27,28] Depending on the vaccine-preventable disease, immunity may be assured by several different measures (**Table 1**). HCP who are not immune should receive appropriate immunization(s) (**Table 2**). Even if HCP are considered immune to a vaccine-preventable disease transmitted by the droplet (pertussis, invasive meningococcal infection, mumps, or rubella) or airborne route (varicella), they should wear a mask (don prior to entering the room) while providing care to a patient with one of these disease because immunization is not 100% effective in preventing infection.

All HCP with potential exposure to blood or body fluids should be immune to hepatitis B. Influenza vaccine should be offered to all HCP yearly. In the past few years, editorials and commentaries have recommended that yearly influenza immunization (unless contraindicated) should be a condition of employment for HCP.[29–31] In February 2012, the National Vaccine Advisory Committee issued a statement that provided recommendations on how to achieve the Healthy People 2020 annual influenza vaccine coverage goal (90%) for HCP; for facilities that have implemented the recommended initial strategies but have "not consistently achieved the Healthy People goal

Box 2
Components of an occupational health service for health care personnel

At initial of employment or patient care

- Evaluation for ability to perform job functions
- Screen for illicit drugs
- Medical evaluation of selected HCP
  - Department of transportation (required for use of certain motor vehicles)
  - Flight physical (required of pilots)
  - Police/security for use of weapons
- Review of immunity to vaccine-preventable diseases (see **Tables 1** and **2**)
- Evaluation for tuberculosis
  - Symptom review for active tuberculosis
  - Testing for latent tuberculosis (TST or IGRA)
- Allergy screening for common health care–associated products
  - Latex/natural rubber, germicides (antiseptics and disinfectants)
- Counseling for pregnant or immunocompromised personnel (voluntary)
- Education
  - Fire and electrical safety
  - Prevention of sharps injury
  - Appropriate hand hygiene and proper use of personal protective equipment
  - Workplace violence
  - Disaster planning: weather, bomb threats, biothreats, chemical spills
  - Reporting infectious disease exposures, injuries, illnesses
  - OHSA required (if applicable): blood-borne pathogens, tuberculosis/respiratory protection

Annual

- Evaluation for tuberculosis
- Review of immunity to vaccine-preventable diseases
  - Influenza immunization
- Miscellaneous
  - Hearing evaluation if part of OSHA-required hearing conservation program
  - Test for color blindness if performing high level disinfection
- Education
  - OHSA required (if applicable): blood-borne pathogens, tuberculosis/respiratory protection
  - Others as recommended/required by health care facility

When needed

- Evaluation for possible communicable disease
  - Consideration for treatment and job restriction/furlough if disease poses threat to patients or other HCP
- Evaluation for PEP
  - Consideration for treatment and job restriction/furlough if disease poses threat to patients or other HCP
- Evaluation of injured personnel (eg, strains, sprains, and lacerations)
  - Provide first aid
  - Refer to emergency department or specialize clinic for severe injuries
  - Provide long-term care
  - Communicate with workers' compensation department
- Return to work evaluation for non–work-related injuries/illnesses
- Fit for duty examination (may include drug and alcohol testing)

Abbreviations: IGRA, interferon gamma release assay; TST, tuberculin skin test.

Table 1
Methods of demonstrating proof of immunity of health care personnel

Vaccine	Birth Before 1957	Physician Diagnosis	Positive Serology	Self-Report	Documented Appropriate Vaccine Series[a]
Mumps (MMR)	Yes[b]	Yes[d]	Yes	No	Yes
Measles (MMR)	Yes[b]	Yes[c]	Yes	No	Yes
Rubella (MMR)	Yes[b,c]	No	Yes	No	Yes
Varicella	No	Yes	Yes	Yes[e]	Yes
Hepatitis B	No	—	≥10 mIU/mL[f]	No	Yes
Pertussis (Tdap)	No	No	No	No	Yes
Influenza	No	No	No	No	Yes

Yes in any column is acceptable evidence of immunity. Greater than 96% of HCP born before 1957 were demonstrated to be immune to measles, mumps or and rubella (2006–2008).[118]

[a] Written documentation (ie, signed by a health care provider).

[b] Consider immunization of HCP born before 1957; recommend during an outbreak.

[c] All HCP of childbearing potential should be immunized.

[d] Requires laboratory confirmation of infection.

[e] Based on published literature: greater than 97% of HCP born before 1980 were demonstrated to be immune to varicella in 2014.[119]

[f] Obtain anti-HBs titer, 1 to 2 months post last vaccine dose; if immunization remote and anti-HBs titer not available, see text for management.

Adapted from Weber DJ, Rutala WA, Schaffner W. Immunization for vaccine-preventable diseases: why aren't we protecting our students? Infect Contr Hosp Epidemiology 2011;32:912–4.

for vaccination coverage of HCP in an efficient and timely manner," it was recommended that they should "strongly consider an employer requirement for influenza immunization."[32] HCP should be provided vaccines that are recommended for adults,[28] such as human papillomavirus, herpes zoster (HZ), and pneumococcal vaccines, or referred to their local medical provider. In special circumstances, HCP and laboratory personnel and researchers should be offered immunization with other vaccines, including polio, rabies, hepatitis A, vaccinia (smallpox), and anthrax (**Box 3**). In addition, HCP who are traveling outside the United States for work-related activities should be evaluated and provided CDC recommended immunizations, such as typhoid, cholera, and Japanese encephalitis.[33,34]

Immunocompromised HCP require special consideration in the provision of immunizations.[8,27,28,35] First, live, attenuated virus vaccines (eg, measles-mumps-rubella [MMR] vaccine; varicella vaccine; and live, attenuated influenza vaccine [LAIV]) may be contraindicated. Second, vaccines not routinely recommended may be indicated (eg, pneumococcal, meningococcal, *Haemophilus influenzae* type b). Third, higher antigen doses (eg, hepatitis B vaccine in people with end-stage renal disease), additional doses of vaccine (eg, rabies vaccine in immunocompromised persons), or postimmunization serologic evaluation may be indicated (eg, antibody to hepatitis B surface antigen [anti-HBs] titer after hepatitis B vaccine or antibody response to rabies vaccine) because immunization of immunocompromised people may elicit a lower antibody response. Finally, such personnel should be individually evaluated for reassignment (with the consent of the employee) depending on their job duties. Caring for an immunocompromised patient is not a contraindication to receipt of a live, attenuated vaccine, although HCP receiving LAIV should not work in a protected environment (eg, stem cell transplant unit) for 7 days postimmunization.[28,36]

Table 2
Immunizations recommended for nonimmune health care personnel

Vaccine	Health Care Personnel	Comments
Mumps	All (2 doses)	Provide as MMR
Measles	All (2 doses)	Provide as MMR
Rubella	All (1 dose)	Provide as MMR
Varicella	All (2 doses)	—
Hepatitis B	HCP with potential exposure to blood or contaminated body fluids (3 doses)	—
Meningococcal (serogroups A, C, Y, W)	Clinical microbiologists (1 dose; booster every 5 y)	Use conjugate vaccine for HCP 18–54 y of age and polysaccharide vaccine for HCP ≥55 y of age
Meningococcal (serogroup B)	Clinical microbiologists (2 doses)	—
Tdap	All (1 dose; no boosters recommended)	Especially important for HCP who have contact with children
Influenza	All (1 dose each year)	HCP who care for severely immunocompromised persons who require care in a protected environment should receive IIV or RIV; HCP who receive LAIV should avoid providing care for severely immunocompromised persons (ie, persons receiving care in "protected" hospital unit, such as BMTU) for 7 d after immunization.

Abbreviations: BMTU, bone marrow transplant unit; IIV, inactivated influenza vaccine; RIV, recombinant influenza vaccine.

Pregnant HCP also require special consideration in the provision of immunizations. The risks from immunization during pregnancy are largely theoretic.[27] The benefit of immunization among pregnant women usually outweighs the potential risks for adverse reactions, especially when the risk for disease exposure is high, infection would pose a special risk to the mother or fetus, and the vaccine is unlikely to cause harm.[27,28,37–40] Furthermore, newer information continues to confirm the safety of vaccines given inadvertently during pregnancy. Ideally, women of childbearing age, including HCP, should have been immunized against measles, mumps, rubella, varicella, tetanus, diphtheria, pertussis, meningococcus, polio, hepatitis A, and hepatitis B as children or adolescents before becoming pregnant. Because this may not have occurred, however, it is especially important that all HCP be screened for immunity to vaccine-preventable diseases. Nevertheless, live, attenuated vaccines should be provided only to nonpregnant HCP and deferred for pregnant women. The ACIP has recommended that "healthcare personnel should administer [tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis] Tdap during all pregnancies, preferably during the third or late second trimester (after 20 weeks' gestation)." If not administered during pregnancy, Tdap should be administered immediately postpartum. Women who are pregnant during respiratory virus season should receive inactivated influenza immunization.[28] There is no convincing evidence of risk from immunizing pregnant women with other inactivated virus or bacterial vaccines, or toxoids. Susceptible pregnant women at high risk for specific infections should receive, as indicated, the

Box 3
Special use vaccines

- Anthrax: PEP, research, biothreat attack
- Diphtheria (Tdap): Outbreak
- Hepatitis A: PEP, outbreak, travel
- Hepatitis B: PEP, travel
- Measles (MMR): PEP, outbreak
- Meningococcal serotypes A, C, W, Y: outbreak, travel
- Meningococcal serotype B: outbreak
- Mumps (MMR): outbreak
- Pertussis (Tdap): outbreak
- Poliomyelitis: research, outbreak
- Rabies: PEP, research, travel
- Rubella (MMR): outbreak
- Smallpox (Vaccinia): PEP, research, biothreat attack
- Tetanus (Tdap or Td): PEP
- Varicella: PEP, outbreak
- Vaccinia (smallpox): PEP, research, biothreat attack

Additional vaccines may be recommended for researchers or travel, such as yellow fever, Japanese encephalitis, cholera, and so forth.
Abbreviation: PEP, postexposure prophylaxis.

following vaccines: hepatitis A, hepatitis B, pneumococcal polysaccharide, meningococcal, rabies, and poliovirus (inactivated) (see **Box 3**).[27] The indications for use of immunoglobulin preparations are the same in pregnant and nonpregnant women. Breastfeeding does not adversely affect the response to immunization and is not a contraindication for any of the currently routinely recommended vaccines.

Before the administration of any vaccine, HCP should be evaluated for the presence of condition(s) that are listed as a vaccine contraindication or precaution.[27] If such a condition is present, the risks and benefits of vaccination need to be carefully weighed by the health care provider and the patient. The most common contraindication is a history of an anaphylactic reaction to a previous dose of the vaccine or to a vaccine component. Factors that are not contraindications to immunization include the following: household contact with a pregnant woman; breastfeeding; reaction to a previous vaccination, consisting only of mild to moderate local tenderness, swelling, or both, or fever less than 40.5°C; mild acute illness with or without low-grade fever; current antimicrobial therapy (except for oral typhoid vaccine) or convalescence from a recent illness; personal history of allergies except a history of an anaphylactic reaction to a vaccine component; and family history of allergies, serious adverse reactions to vaccination, or seizures.[27]

POSTEXPOSURE PROPHYLAXIS

General guidelines on PEP are available from the CDC,[2] ACIP,[8] AAP,[41] APIC,[7] and the American Public Health Association (APHA).[42] All HCP should be educated at their

initiation of employment or providing service when and how to report an infectious disease exposure. In general, HCP should complete an incident form, have it signed by their supervisor, and then report to the occupational health clinic. Occupational health evaluation should be available 24/7 for exposed HCP. The incident form should be reviewed by occupational health and communicated to the workers' compensation department. HCP with serious or life-threating injuries or exposures should be referred to an emergency department or specialty clinic as appropriate. If patient or visitor exposures also occurred, the infection control department should be notified.

A well-defined protocol should be in place that details the steps in evaluation of an HCP potentially exposed to an infectious agent (**Box 4**). Proper counseling of the exposed HCP is critical (**Box 5**). Appropriate first aid should be provided, including proper care of any sharp injury or mucosal membrane exposure (eg, copious rinsing of eyes in the case of splash to eyes). A proper evaluation of the source case should also be conducted to confirm the report by the exposed HCP that the source patient does have a communicable disease. Appropriate laboratory tests should be obtained from the source patient to determine if the source patient can transmit HIV, HBV, or HCV.

PEP is available for many diseases, including but not limited to, diphtheria, hepatitis A and B, HIV, influenza, measles, invasive meningococcal infection, pertussis, rabies, syphilis, tuberculosis, and varicella-zoster. PEP is also available for some exposures, including animal bites (eg, dogs, cats, rodents, and primates) and human bites. Unfortunately, PEP is not available for exposure to arboviruses, hepatitis C, mumps, parvovirus B-19, rubella, and Middle East respiratory syndrome–coronavirus. PEP may consist of antivirals, antibiotics, immunoglobulin preparations and/or vaccines (see **Box 3**). Immunoglobulin preparations may be indicated as part of PEP for exposure to hepatitis A (immune globulin [IG]), hepatitis B IG (HBIG), measles (IG), rabies IG, tetanus (tetanus IG), varicella (varicella-zoster IG), and vaccinia (vaccinia IG). More than 1 modality may be recommended. Pre-exposure prophylaxis with recommended immunization is not considered sufficient protection after an exposure to the following diseases, and postexposure antimicrobial prophylaxis is still recommended: pertussis, invasive meningococcal infection, and diphtheria (discussed later).

Box 4
Management of an infectious disease exposure

- Obtain name, medical record number, and location of source case
- Determine if source case has an infection and is infectious (ie, capable of transmitting infection)
- Determine if transmission possible (ie, appropriate exposure without appropriate personal protection)
- Determine if health care provider is susceptible (may require laboratory tests)
- Determine if PEP is available and indicated
- Consider alternative prophylaxis (if available) if health care provider has a contraindication to the prophylaxis of first choice
- Administer prophylaxis with informed consent (HCP may choose not to accept prophylaxis)
- Arrange follow-up
- Document all of the above in the medical record

Box 5
Postexposure prophylaxis counseling of the exposed health care provider

- Information to be provided to health care providers who are exposed to an infectious agent
  - Risk (if known) of acquiring the infectious disease
  - Risk (if known) of transmitting any infection that is acquired to patients, other HCP, and contacts (eg, household members)
  - Methods of preventing transmission of infection to other persons
  - Need for work restrictions (if any)
  - Recommended follow-up
- Information to be provided to health care providers who are offered prophylaxis
  - Recommendations for prophylaxis
  - Alternative methods of prophylaxis if the primary method is contraindicated
  - Degree of protection provided by the therapy
  - Potential side effects of the therapy
  - Safety laboratory tests (if recommended)
  - Risks (if known) of infection if PEP is refused

Sharp Injuries

Occupational blood and body fluid exposures to blood-borne pathogens remain a serious public health concern.[43] The CDC estimates that 5.6 million workers in the health care industry and related occupations are at risk of occupational exposure to blood-borne pathogens. More than 30 different pathogens have caused documented occupational infection after exposure to blood or body fluids in HCP or hospital laboratory personnel.[44] The most important blood-borne pathogens are HIV, HBV, and HCV.[44,45] The key features for assessing the risk of transmission of HBV, HCV, and HIV are for each agent their seroprevalence in the general population, their environmental survival, and transmissibility via percutaneous, mucous membrane or nonintact skin exposure. The seroprevalence of these viruses in the general population is HBV approximately 0.4%, HCV approximately 1.3%, and HIV approximately 0.31%.[46] HBV has been demonstrated to survive and remain infectious greater than 7 days on environmental surfaces.[47] The data on HCV environmental survival are varied, with articles reporting survival of 16 hours,[48] 5 days,[49] and up to 6 weeks.[50] For HIV, the half-life has been reported as 28 hours,[51] with a maximum of several days.[52] The risk of transmission of HBV depends on the route of exposure, whether the exposed person is immune (via immunization or natural infection), and serologic status of the source patient. Rates of clinical hepatitis/serologic evidence of HBV infection in susceptible exposed HCP after a percutaneous exposure have been reported as 22% to 31%/37% to 62% if the source is hepatitis B surface antigen (HBsAg) positive and but hepatitis B e antigen (HBeAg) positive; rates of transmission have been reported as 1% to 6%/23% to 37% if the source is HBsAg positive but HBeAg negative.[53] The risk of transmission of HCV after percutaneous exposure has been reported as 1.8% to 1.9% (range, 0%–7%).[46,54] The risk of transmission of HIV after percutaneous exposure has been reported as 0.3% (95% CI, 0.2%–0.5%).[46]

In addition to percutaneous transmission, the blood-borne viruses HBV, HCV, and HIV can be transmitted via blood or contaminated fluid exposure of mucous membranes, nonintact skin, or human bites. The risk of transmission by these routes has not been quantitated for HBV and HCV. The risk of transmission by the mucosal route for HIV has been reported to be 0.09% (95% CI, 0.01%–0.5%).[46] The risk of transmission of HIV via exposure of nonintact skin is likely less than 0.1% but has not been

completely quantified. The risk from a human bite has also not been quantified. Transmission of HBV,[55] HCV,[56] and HIV[57] by human bites, however, has been reported. Human bites that penetrate the skin, however, should be considered as possible 2-way exposure (from patient-to-HCP and HCP-to-patient).

The CDC has estimated that approximately 385,000 percutaneous injuries occurred annually among HCP in the United States in the time period of 1997 to 1998.[43] Although the incidence of needlestick injuries has been reduced by advances in education, needle disposal, engineering changes, and personnel protection, institutions and HCP must continue to assume responsibility in further lowering the risk. Several methods of reducing exposure to blood and other potential infectious body fluids have been described (**Box 6**).

All occupational exposures to blood and other potentially infectious material place HCP at risk for infection with a blood-borne pathogen. OSHA defines blood to mean human blood, blood components, and products made from human blood.[24] Other potentially infectious material includes body fluids, such as semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pericardial fluid, pleural fluid, peritoneal fluid, human milk, amniotic fluid, saliva associated with dental procedures, and body fluid that is visibly contaminated with blood. All body fluids should be considered infectious in situations where it is difficult or impossible to differentiate between bloody fluids. Any unfixed tissues or organs (other than intact skin) from a human (living or dead) are also considered potentially infectious material. For laboratory personnel, other potentially infectious material includes HIV-containing cell or tissue cultures, organ cultures, and HIV or hepatitis virus-containing culture medium or other solutions, as well as blood, organs, or tissues from experimental animals infected with HIV, HBV, or HCV.

Care for HCP who have been exposed to blood or potentially contaminated fluids has been reviewed.[46,53,54,58–62] Exposed HCP should immediately be provided with

Box 6
Methods of reducing percutaneous, mucous membrane, or nonintact skin exposure to blood or potentially infectious body fluids

- Strict adherence to standard precautions including appropriate hand hygiene and use of personal protective equipment (eg, gloves, gowns, masks, and eye shields)
- Use of safety engineered devices (needles, syringes, scalpels, etc.)
- Use of double-gloves during surgical procedures with an increased risk of glove puncture
- Use of blunted surgical needles, when possible
- Work practice controls to reduce risk of injuries, such as elimination of capping needles, using a tray to pass sharp devices, and immediately and appropriately discard used sharp instruments
- Puncture resistant sharp disposal units
- Precautions should be taken to prevent sharps injuries during procedures and during cleaning/disinfection of instruments
- Mouthpieces, resuscitation bags, or other ventilation devices should be available whenever their need can be anticipated
- Health care personnel who have exudative lesions or weeping dermatitis on exposed body areas (hands/wrist and face/neck) must be excused from providing direct patient care or working patient equipment (OSHA regulation)
- Enhanced education on the proper use of safety engineered device

first aid. Exposed mucous membranes should be flushed with water. Wounds and skin sites that have been in contact with blood or body fluids should be washed with soap and water. Antiseptics, such as chlorhexidine, have not been shown to reduce the risk of HBV transmission. There is no contraindication, however, to their use as long as they are not injected into the wound. It is not recommended to squeeze the wound to express fluid or using potentially harmful agents, such as bleach. The following exposures do not require PEP: (1) contact of intact skin with blood or body fluids; (2) skin was not breached by a sharp; (3) contact with saliva (nondental), urine, vomit, or feces that was not visibly contaminated with blood; and, (4) a sharp that was used before the injury.

The source patient for blood and body fluid exposures should be tested for HIV using a 4th-generation test (combined antibody and antigen test), HBsAg, hepatitis C antibody, and other tests as indicated by the source patient's medical history (eg, malaria, syphilis, or HTVL). If a source patient's HCV test is positive, an HCV polymerase chain reaction (PCR) should be obtained.

Hepatitis B

The risk of HBV acquisition by HCP has declined dramatically over the years. The number of HBV infections among HCP declined by approximately 98% from an estimated 17,000 infections in 1983 to 263 acute HBV infections in 2010.[53] This decline was likely due to decreased exposure from improved work practice controls (see **Box 6**) and HBV immunization of HCP. The risk of HBV transmission from patient-to-HCP provider remains, however, because there are an estimated 800,000 to 1.4 million persons in the United States living with chronic HBV infection.[53]

The key method of preventing health care–associated HBV infection among HCP is HBV immunization prior to beginning direct patient care of all HCP with potential blood or body fluid exposure. Furthermore, all HCP should know their immune response to vaccination. For HCP immunized in training or at initiation of patient contact, an anti-HBs quantitative titer should be drawn 1 to 2 months after the last dose of vaccine. HCP with greater than or equal to 10 mIU/mL anti-HBs are considered immune for life. HCP who do not respond adequately should be reimmunized with 3 additional doses of vaccine and tested for immunity 1 to 2 months after the last (6th dose). HCP who have not responded adequately ($\geq$10 mIU/mL anti-HBs) should be tests for HBsAg. Nonresponders to 6 doses of vaccine should be counseled to return to report any exposures to blood or body fluids because they may be prophylaxed with HBIG (**Table 3**). HCP, especially trainees, with a remote history of hepatitis B vaccine should have their immunity to HBV assessed using the algorithm recommended by the CDC.[53]

HCP exposed to an HBsAg-positive patient should be evaluated for prophylaxis per the recommended CDC algorithm (see **Table 3**). HCP with known to have responded to vaccine ($\geq$10 mIU/mL anti-HBs) do not need any prophylaxis; unimmunized HCP or HCP with an unknown response should be managed per the CDC algorithm, which may entail the use of hepatitis B vaccine and/or HBIG. PEP should be provided as soon as possible but always within 7 days of exposure.[53] HBIG and hepatitis B vaccine can be administered simultaneously at separate injection sites.

Human Immunodeficiency Virus

The number of persons living with HIV infection has increased over the years in the United States due to the success of antiviral medications. The CDC has estimated that there are approximately 1.2 million people in the United States living with HIV at the end of 2012, of whom approximately 12.8% did not know they were infected.[63]

Table 3
Postexposure management to prevent hepatitis B infection of health care personnel after occupational percutaneous and mucosal exposure to blood and body fluids

	Postexposure Testing		Postexposure Prophylaxis		Postvaccination Serologic Testing[b]
HCP Status	**Source Patient (HBsAg)**	**HCP Testing (Anti-HBs)**	**HBIG[a]**	**Vaccination**	
Documented responder[c] after complete series (≥3 doses)	No action needed				
Documented nonresponder[d] after 6 doses	Positive/unknown	—[e]	HBIG × 2 separated by 1 mo	—	No
	Negative	No action needed			
Response unknown after 3 doses	Positive/unknown	<10 mIU/mL[e]	HBIG × 1	Initial revaccination	Yes
	Negative	<10 mIU/mL	None	—	—
	Any	≥10 mIU/mL	No action needed		
Unvaccinated/incompletely vaccinated or vaccine refusers	Positive/unknown	—[e]	HBIG × 1	Complete vaccination	Yes
	Negative	—	None	Complete vaccination	Yes

[a] HBIG should be administered intramuscularly as soon as possible after exposure when indicated. The effectiveness of HBIG when administered greater than 7 days after percutaneous, mucosal, or nonintact skin exposures is unknown. HBIG dosage is 0.06 mL/kg.
[b] Should be performed 1 to 2 months after the last dose of the HepB vaccine series (and 4–6 months after administration of HBIG to avoid detection of passively administered anti-HBs) using a quantitative method that allows detection of the protective concentration of anti-HBs (≥10 mIU/mL).
[c] A responder is defined as a person with anti-HBs ≥10 mIU/mL after ≥3 doses of HepB vaccine.
[d] A nonresponder is defined as a person with anti-HBs less than 10 mIU/mL after ≥6 doses of HepB vaccine.
[e] HCP who have anti-HBs less than 10 mIU/mL, or who are unvaccinated or incompletely vaccinated, and sustain an exposure to a source patient who is HBsAg-positive or has unknown HBsAg status, should undergo baseline testing for HBV infection as soon as possible after exposure, and follow-up testing approximately 6 months later. Initial baseline tests consist of total anti-HBc; testing at approximately 6 months consists of HBsAg and total anti-HBc.

From Schillie S, Murphy TV, Sawyer M, et al; Centers for Disease Control and Prevention. CDC guidance for evaluating health-care personnel for hepatitis B virus protection and for administering postexposure management. MMWR Recomm Rep 2013;62(RR-10):1–19.

In the United States, 58 confirmed and 150 possible cases of occupationally acquired HIV infection were reported to the CDC between 1985 and 2013.[64] Since 1999, only 1 confirmed case (a laboratory technician who sustained a needle puncture while working with a live HIV culture in 2008) has been reported.[64]

The management of HCP exposed to blood or body fluids from HIV-infected persons is well described in the literature.[45,46,59–61,65,66] OSHA requires that all US health care facilities provide postexposure management of HIV exposures consistent with the most recent US Public Health Service guideline.[60] This guideline delineates the situations for which expert consultation for HIV PEP is recommended as well as the recommended follow-up for HCP exposed to known or suspected HIV-positive sources.[60] The preferred HIV PEP regimen is Truvada (tenofovir disoproxil fumarate/TDF [Viread], 300 mg, plus emtricitabine/FTC [Emtrival] 200 mg), 1 tablet orally once daily, plus raltegravir/RAL (Isentress), 400 mg orally, twice daily (**Table 4**).[60] The authors' retrovirologists prefer raltegravir to dolutegravir because dolutegravir has more drug interactions and is substantially more expensive. The following antiretroviral agents should be used for PEP only with expert consultation: abacavir/ABC (Ziagen), efavirenz/EFV (Sustiva), enfuvirtide/T-20 (Fuzeon), fosamprenavir/FOSAPV (Lexiva), maraviroc/MVC (Selzentry), saquinavir/SQV (Invirase), and stavudine/d4t (Zerit). The following agents are generally not recommended for PEP: didanosine/ddI (Videx EC), nelfinavir/NFV (Viracept), and tipranavir/TPV (Aptivus). Neverapine/NVP (Viramune) is contraindicated at PEP.

Table 4
Alternative regimens for HIV postexposure prophylaxis

Column A	Column B
Raltegravir/RAL (Isentress)	Tenofovir disoproxil fumarate/TDF (Viread) + emtricitabine/FTC (Emtriva); available as Truvada
Darunavir/DRV (Prezista) + ritonavir/RTV (Norvir)	
Etravirine/ETR (Intelence)	Tenofovir disoproxil fumarate/TDF (Viread) + lamivudine (Epivir; 3TC)
Rilpivirine/RPV (Edurant)	
Atazanavir/ATV (Reyataz) + ritonavir/RTV (Norvir)	Zidovudine/ZDV/AZT (Retrovir) + lamivudine (Epivir; 3TC); available as Combivir
Lopinavir/ritonavir LPV/RTV (Kaletra)	Zidovudine/ZDV/AZT (Retrovir) + emtricitabine/FTC (Emtriva)

Should combine 1 drug or drug pair from the left column with 1 pair of nucleoside/nucleotide reverse-transcriptase inhibitors from the right column; prescribers unfamiliar with these agents/regimens should consult physicians familiar with the agents and their toxicities).

The following alternative is a complete fixed-dose combination regimen, and no additional antiretrovirals are needed: Stribild (elvitegravir, cobicistat, tenofovir DF, emtricitabine).

Adapted from Kuhar DT, Henderson DK, Struble KA, et al. Updated US Public Health Service guidelines for the management of occupational exposures to human immunodeficiency virus and recommendations for postexposure prophylaxis. Infect Control Hosp Epidemiol 2013;34:875–92.

Invasive Meningococcal Infections

Neisseria meningitidis, a Gram-negative diplococcus and causative agent of invasive meningococcal disease, has at least 13 serogroups based on capsular typing. Five serogroups (A, B, C, W, and Y) cause most disease worldwide; 3 of these serogroups (B, C, and Y) cause most of the illness in the United States.[67,68] The incidence of invasive meningococcal disease varies over time and by age and location.[69,70] In recent years, the incidence of invasive disease has declined in the United States.[8] Based

on reported cases in 2014, the CDC estimated that there were 450 cases (0.14/100,000) and 65 deaths (0.02/100,000) in the United States.[68]

N meningitidis is transmitted person-to-person via respiratory and throat secretions (saliva or spit) during close (eg, coughing or kissing) or lengthy contact (eg, living in the same household).[67] The carriage frequency of *N meningitidis* in children and young adults is approximately 10% in children and among young adults is approximately 10%.[71] Outbreaks most often occur in communities, schools, colleges, prisons, and other closed populations.[67] HCP have acquired invasive meningococcal infection as a result of providing direct care (eg, assisting in endotracheal intubation and airway suctioning) to infected patients.[72] It has been estimated that clinical microbiologists have an attack rate greater than 50 times high than the background rate of invasive meningococcal disease.[73] For this reason, the CDC/ACIP recommend that clinical and research microbiologist who might be routinely exposed to isolates of *N meningitidis* receive both the quadrivalent meningococcal vaccine (Men4*ACWY*) and the meningococcal serogroup B vaccine (Men*B*).[8,28] Fatal meningitis in a microbiologist due to *N meningitidis* serotype B was recently reported.[74] Such HCP should receive a booster dose of Men*ACWY* every 5 years if they remain at increased risk.

Chemoprophylaxis of household members of an index case of invasive meningococcal disease is recommended.[41,42,75] Chemoprophylaxis of exposed HCP is advised for all persons who have had intensive, unprotected contact (eg, without wearing a mask) with infected patients (eg, via mouth-to-mouth resuscitation, endotracheal intubation, or endotracheal tube management). Chemoprophylaxis for HCP should be recommended even if the HCP has been vaccinated with either the conjugate or polysaccharide vaccine.[8] Because the rate of secondary disease for close contacts is highest immediately after onset of disease in the index patient, antimicrobial chemoprophylaxis should be administered as soon as possible (ideally less than 24 hours after identification of the index patient). Conversely, chemoprophylaxis administered greater than 14 days after exposure to the index patient is probably of limited or no value. Oropharyngeal or nasopharyngeal cultures are not helpful in determining the need for chemoprophylaxis and might delay institution of this preventive measure unnecessarily.

There is strong evidence that several antibiotics (ie, rifampin, ciprofloxacin, and ceftriaxone) and moderate evidence that other antibiotics (ie, azithromycin and cefixime) are highly effective in eradication of meningococcal carriage (90%–95%).[76–78] The preferred drugs for exposed HCP are rifampin (600 mg orally every 12 hours for 2 days) or ciprofloxacin (500 mg orally $\times$ 1 dose). The preferred agent in pregnant women is ceftriaxone (250 mg intramuscularly $\times$ 1 dose, diluted with 1% lidocaine to decrease pain at the injection site).[41] Although sporadic resistance to rifampin and ciprofloxacin have been reported worldwide, meningococcal resistance to chemoprophylaxis antibiotics remains rare in the United States.[78] This was recently reaffirmed in a recent population-based surveillance of antimicrobial resistance in *N meningitis* strains from the United States.[79] All strains tested were susceptible to ceftriaxone and azithromycin; 99% of strains were susceptible to ciprofloxacin and rifampin.

Varicella

Prior to the introduction of the varicella vaccine in 1995, varicella was a common disease; an average of 4 million people got chickenpox; 10,500 to 13,000 were hospitalized (range, 8000–18,000) and 100 to 150 died each year.[80] Since the introduction of the varicella vaccine, there has been a dramatic decrease in the number of cases of varicella, hospitalizations and deaths.[80] Because varicella may be acquired from

exposure to varicella or zoster, however, exposure in health care settings will continue to occur. Multiple nosocomial outbreaks of varicella-zoster virus (VZV) have been reported.[8] Nosocomial transmission has been attributed to delays in the diagnosis or reporting of varicella or HZ and in failures to implement control measures promptly. In hospitals and other health care settings, airborne transmission of VZV from patients with either varicella or HZ has resulted in varicella in HCP and patients who had no direct contact with the index case patient.[80] Although all susceptible patients in health care settings are at risk for severe varicella disease with complications, certain patients without evidence of immunity are at increased risk: pregnant women, premature infants born to susceptible mothers, infants born at less than 28 weeks' gestation or who weigh less than or equal to 1000 g regardless of maternal immune status, and immunocompromised persons of all ages (including persons who are undergoing immunosuppressive therapy, have malignant disease, or are immunodeficient).[80]

Guidelines for postexposure management of HCP exposed to varicella or zoster have been published by the CDC,[8] AAP,[41] and APHA.[42] Exposure to VZV is defined as close contact with an infectious person, such as close indoor contact (eg, in the same room) or face-to-face contact. Experts differ regarding the duration of contact; some suggest 5 minutes, and others up to 1 hour; all agree that it does not include transitory contact.[41] PEP with vaccination or varicella-zoster IG depends on immune status of the exposed HCP. HCP who have received 2 doses of vaccine and who are exposed to VZV (varicella, disseminated HZ, and uncovered lesions of a localized HZ) should be monitored daily during days 8 to 21 after exposure for fever, skin lesions, and systemic symptoms suggestive of varicella. HCP can be monitored directly by occupational health program or infection-control practitioners or instructed to report fever, headache, or other constitutional symptoms and any atypical skin lesions immediately. HCP should be excluded from a work facility immediately if symptoms occur.[8] HCP who have received 1 dose of vaccine and who are exposed to VZV should receive the second dose within 3 to 5 days after exposure to rash (provided 4 weeks have elapsed after the first dose). After vaccination, management is similar to that of 2-dose vaccine recipients. Those who did not receive a second dose or who received the second dose greater than 5 days after exposure should be excluded from work for 8 to 21 days after exposure (see work restrictions discussed later).

For HCP at risk for severe disease for whom varicella vaccination is contraindicated (eg, pregnant or immunocompromised HCP without evidence of immunity), varicella-zoster IG after exposure is recommended. The varicella-zoster IG product currently used in the United States is VariZIG (Cangene Corporation, Winnipeg, Canada).[81] VariZIG, if indicated, should be administered as soon as possible after VZV exposure, ideally within 96 hours for greatest effectiveness but always within 10 days.[81] VariZIG is supplied in 125-IU vials and should be administered intramuscularly; the recommended dose is 125 IU/10 kg of body weight, up to a maximum of 625 IU (5 vials). If VariZIG is indicated but not available or greater than 10 days have elapsed since the exposure, PEP can be provided with oral acyclovir (20 mg/kg per dose administered 4 times per day, maximum daily dose 3200 mg) or oral valacyclovir (20 mg/kg per dose administered 3 times per day, maximum daily dose 3000 mg) beginning on day 8 postexposure and continuing for 7 to 14 days.

Pertussis

In the United States, the highest recorded annual incidence of pertussis occurred in 1934, when greater than 260,000 cases were reported.[82] After the introduction of diphtheria, tetanus, and whole-cell pertussis vaccine, the incidence dramatically declined. In recent years, however, there has been a resurgence of pertussis. Possible

explanations for this increase in disease include (1) genetic changes in *Bordetella pertussis*, making the vaccine less effective; (2) waning immunity among children, adolescents, and adults vaccinated during childhood especially those who received acellular pertussis vaccines; (3) lessened effectiveness of acellular pertussis vaccines compared with whole-cell vaccines; (4) greater awareness of pertussis and hence more diagnostic testing; and (5) the general availability of better laboratory tests.[83]

At the University of North Carolina Hospitals, pertussis is now the most common source of infectious disease exposure evaluations (David Weber, unpublished data, 1994–2015). Multiple nosocomial outbreaks of pertussis have been reported, including outbreaks in which an infected HCP was the source.[84] Nosocomial outbreaks have occurred for several reasons: (1) failure to immunize all HCP with Tdap; (2) failure to recognize and appropriately isolate infected patients, (3) failure to provide antibiotic prophylaxis to exposed staff, and (4) failure to furlough symptomatic staff.[85,86] Seroprevalence studies of HCP who did not receive pertussis vaccine since childhood have revealed that 6.4%[87] and 15%[88] had evidence of recent infection.

Prevention of pertussis transmission in health care settings involves diagnosis and early treatment of clinical cases, droplet isolation of infectious patients, exclusion from work of HCP who are infectious, and PEP.[8] Guidelines for postexposure management of HCP exposed to pertussis have been published by the CDC,[8] AAP,[41] and APHA.[42] Data on the need for PEP in Tdap-vaccinated HCP are inconclusive.[89] Tdap might not preclude the need for PEP. Postexposure antimicrobial prophylaxis is recommended for all HCP who have unprotected exposure to pertussis and are likely to expose a patient at risk for severe pertussis (eg, hospitalized neonates and pregnant women). Other HCP should either receive postexposure antimicrobial prophylaxis or be monitored daily for 21 days after pertussis exposure and treated at the onset of signs and symptoms of pertussis.

B pertussis is highly susceptible in vitro to erythromycin[90,91] and the newer macrolides, azithromycin and clarithromycin.[92] It is also susceptible to trimethoprim-sulfamethoxazole.[91–95] Azithromycin has been demonstrated to be effective in the prophylaxis and treatment of pertussis.[96] It is now the preferred agent because, compared with erythromycin, it requires a short period of PEP or therapy (5 vs 7–14 days) and reduced dosing frequency (1 vs 4 times per day) and is less likely to result in gastrointestinal distress.[96] Trimethoprim-sulfamethoxazole is the recommended alternative for treatment and for chemoprophylaxis of individuals intolerant to a macrolide, although its efficacy as a chemoprophylactic agent has not been evaluated.

Postexposure Prophylaxis: Others

Tetanus

Tetanus is an uncommon disease in the United States, with an average of 29 reported cases per year from 1996 through 2009.[97] Nearly all cases of tetanus are among people who have never received tetanus vaccine or adults did not stay current with their 10-year booster shots. HCP are not at greater risk for tetanus than the general population but like other adults may acquire tetanus if they are insufficiently immunized and they have puncture wounds, contaminate open wounds, burns, or crush injuries.[8] HCP with injuries that could lead to tetanus should be evaluated provided appropriate PEP based on the nature of the wound (clean, minor wound vs higher risk wounds) and their history of receipt of tetanus toxoid per recommendations of the CDC[98,99] and AAP.[41] If a tetanus toxoid and diphtheria toxoid (Td) booster is indicated, Tdap can be substituted if the HCP has not already received a Tdap.

Diphtheria

Although diphtheria was a widespread disease in the United States prior to the use vaccines, it is now a rare disease. Between 2004 and 2015, only 2 cases were reported in the United States, although the disease continues to cause illness globally.[100] The case-fatality rate is still 5% to 10%. HCP are not at greater risk for diphtheria than the general population.[8] For HCP exposed to nasopharyngeal secretions of a patient known or suspected to have diphtheria, the following postexposure measures should be taken regardless of their immunization status: (1) surveillance for 7 days for evidence of disease; (2) culture for *Corynebacterium diphtheria*, and (3) antimicrobial prophylaxis with erythromycin (1 g orally for 7–10 days) or a single injection of penicillin G benzathine (1.2 million U intramuscularly × 1). Asymptomatic exposed HCP should also receive a booster dose of Td, if they have not received a booster dose of a diphtheria toxoid-containing vaccine within 5 years (Tdap is preferred if the HCP has not received a dose of Tdap previously).[41] Exposed HCP should not receive equine diphtheria antitoxin because there is no evidence that antitoxin provides additional benefits for contacts who have received antimicrobial prophylaxis.

Measles

The incidence of measles has decreased dramatically since the widespread use MMR vaccine. Since 2000, when measles was declared eliminated from the United States, the annual number of cases has ranged from a low of 37 in 2004 to a high of 667 in 2014.[101] Measles cases in the United States occur as a result of importations by people who were infected while in other countries and from transmission that may occur from those importations. Nosocomial measles is well documented in the literature and may aid in the propagation of community outbreaks.[8,84,102–104] Investigations of individual outbreaks have reported that 17% to 59% of cases were acquired in a medical setting. Measles represents an important health hazard for HCP because of the following: (1) it is highly infectious; (2) transmission via the airborne route; (3) persons become infectious 4 days before the onset of the characteristic rash; and (4) transmission in the outpatient setting has occurred even though the index cases had left the waiting or examination room up to 75 minutes earlier. Because of the greater opportunity for exposure, HCP are at higher risk than the general population for becoming infected with measles.

If measles exposures occur in a health care facility, all nonprotected HCP should be evaluated immediately for presumptive evidence of measles immunity.[8] HCP without evidence of immunity should be offered the first dose of MMR vaccine and excluded from work from day 5 to 21 after exposure.[8] Available data suggest that live virus measles vaccine, if administered within 72 hours of measles exposure, prevents or modifies disease. HCP without evidence of immunity who are not vaccinated after exposure should be removed from all patient contact and excluded from the facility from day 5 after their first exposure through day 21 after the last exposure, even if they have received postexposure intramuscular IG of 0.50 mL/kg; (maximal dose by volume, 15 mL). Those with documentation of 1 vaccine dose may remain at work and should receive the second dose. Immunoglobulin PEP is especially recommended for serosusceptible pregnant women and immunocompromised persons intravenous (400 mg/kg). If IG is administered to an exposed person, observations should continue for signs and symptoms of measles for 28 days after exposure because IG might prolong the incubation period.

Hepatitis A

Occasional outbreaks of hepatitis A virus (HAV) have been reported in hospitals.[105] Risk factors for HAV transmission to personnel have included activities that increase

the risk of fecal-oral contamination, including caring for a person with unrecognized hepatitis A infection; sharing food, beverages, or cigarettes with patients, their families, or the staff; nail biting; handling bile without proper precautions; and not washing hands or wearing gloves when providing care to an infected patients.[105] Routine immunization of HCP with hepatitis A vaccine, however, is not recommended because seroprevalence studies have not demonstrated that HCP are at increased risk for HAV infection because of occupational exposure.[8,105] Maintenance workers may be exposed to sewage are also not at increased risk for acquisition of hepatitis A and do not need to be vaccinated.

Hepatitis A vaccine may be used for PEP and control of nosocomial outbreaks for persons 18 to 40 years of age.[41] In these cases, only monovalent hepatitis A vaccine should be used and should be administered within 14 days of exposure. For persons 41 years old and older, IG (0.02 mL/kg intramuscularly) can be used, although hepatitis A vaccine can be used if IG is not available.[41] The efficacy of hepatitis A vaccine and IG for PEP when administered more than 2 weeks after exposure has not been established.

Human bites

HCP may occasionally suffer from a human bite, especially when caring for psychiatric patients. After a human bite, a semicircular or oval area of erythema or bruising is usually visible; the skin itself may or may not be intact. Wound care of a human bite is similar to that of an animal bite.[106] The bite area should be managed as follows: (1) clean the wound with an antiseptic; (2) trim any superficial devitalized tissue; (3) remove any foreign bodies or gross wound contaminants; and (4) assess the injury for tendon damage, vascular damage, or penetration into bone or joint. Most human bites should be left open to heal by secondary intention. If the wound may lead to a poor cosmetic result (eg, facial bites), however, the clinician may choose to close the wound. Human bites frequently develop infection. In general, all HCP with a human bite should receive antimicrobial prophylaxis with the first dose provided as soon as possible after the injury.[107] An initial parenteral dose of antibiotics is often provided to rapidly obtain an effective tissue level followed by 3 to 5 days of oral antibiotics.[107] Recommendations for specific antimicrobial therapy have been published.[107]

All HCP suffering bite should be assessed as to whether tetanus prophylaxis should be provided. As discussed previously, human bites may lead to patient-to-HCP and HCP-to-patient transmission of blood-borne pathogens (HIV, HBV, and HCV). Thus the HCP is both an exposed person as well as a potential source for transmission; hence, the same blood work ordered on the source patient should be obtained from the HCP.

Rabies

Rabies is primarily a disease of animals.[108] The epidemiology of human rabies is a reflection of both the distribution of the disease in animals and the degree of contact with these animals. Rabies is most commonly acquired via a bite or scratch from a rabid animal or from contact between nonintact skin and infective saliva. Saliva and nerve tissue are highly infectious. Generally, contact with other body fluids does not constitute exposure. Uncommon routes of infection include contamination of mucous membranes, corneal transplantation, exposure to aerosols from spelunking or laboratory activities, and iatrogenic infection through improperly inactivated vaccines. Human-to-human transmission has been rarely reported.[108] Human rabies cases in the United States are rare, with only 1 to 3 cases reported annually.[109]

Rabies prophylaxis may occasionally need to be provided to HCP who work out-of-doors (eg, maintenance workers and personnel who care for grounds) and suffer a bite

from a wild animal that could potentially transmit rabies (fox, raccoon, and so forth) or who have bat exposure. Concern about rabies transmission is frequent among HCP who have cared for human patients with rabies, especially because fluids from the upper and lower respiratory tracts of humans frequently test positive for rabies virus. One review article reported that approximately 30% of HCP who provided direct care for a patient with rabies were provided PEP.[110] The CDC recommends that patients with possible or known rabies be cared for using standard precautions.[15] Given HCP concerns and the rare possible risk of rabies transmission, however, the authors believe that HCP should use PPE to prevent contact with a patient's saliva and respiratory secretions (ie, gown, gloves, and face shield or mask with eye protection). HCP with mucous membrane or percutaneous skin exposure to a potentially rabid animal or human should receive postexposure rabies vaccine and rabies IG as recommended by the CDC.[111]

Ectoparasites

Exposure of HCP to ectoparasites (eg, scabies or pediculosis) is likely common. Such exposed personnel should be evaluated for signs and symptoms of an infestation and provided appropriate therapy for confirmed or suspected scabies.[2] Prophylactic treatment should not be provided to personnel, however, who have had skin-to-skin contact with patients or other persons with ectoparasites (eg, scabies).[2]

Syphilis

HCP are at risk for acquired syphilis via unprotected contact with syphilitic skin lesions, such as chancres (primary stage) and rashes or sores (secondary stage). It can also be acquired via contact with secretions of children with congenital syphilis.[112] Prior to the standard practice of using gloves by HCP to examine patients with skin lesions, there were reports of extragenital syphilitic lesions on HCP. Therefore, HCP who have had unprotected contact with a patient with early congenital syphilis before identification of the disease or during the first 24 hours of therapy should be examined clinically for the presence of lesions 2 to 3 week after contact.[41] Serologic testing should be performed and repeated 3 months after contact or sooner if symptoms occur. HCP with unprotected contact of skin lesions of a patient with primary or secondary state disease should be similarly managed. If the degree of exposure is considered substantial, immediate treatment should be considered.[41] The most current CDC sexually transmitted disease treatment guidelines should be used to guide postexposure therapy.[113]

Influenza

As discussed previously, all HCP should be immunized annually against influenza. The CDC, however, has provided detailed recommendations on PEP for HCP exposed to influenza as well as the use of antivirals in outbreak situations.[114,115] Unvaccinated HCP who have occupational exposures and who did not use adequate personal protective equipment at the time of exposure are potential candidates for chemoprophylaxis. Decisions on whether to administer antivirals for chemoprophylaxis should take into account an exposed person's risk for influenza complications, the type and duration of contact, recommendations from local or public health authorities, and clinical judgment. Chemoprophylaxis with antiviral medications is not a substitute for influenza vaccination when influenza vaccine is available. HCP receiving PEP should be informed that chemoprophylaxis lowers but does not eliminate the risk for influenza, that susceptibility to influenza returns once the antiviral medication is stopped, and that influenza vaccination is recommended if available. Either oseltamivir or zanamivir is recommended for antiviral chemoprophylaxis of influenza A (2009 H1N1), influenza

Table 5
Recommended work restrictions for health care personnel colonized/exposed or infected with selected infectious agents

Infection or Infectious Agent	Exposed or Colonized	Infected (Duration of Restrictions)
Conjunctivitis (adenovirus)	Exposed; no restriction unless illness develops	Restrict from patient contact and contact with the patient's environment (until discharge ceases)
Cytomegalovirus	No restriction	No restriction
Diarrheal diseases	No restriction unless illness develops	Acute disease: exclude from duty (until >48–72 h after symptoms resolve) Convalescent stage (*Salmonella* spp): restrict from care of high-risk patients and food handling (until symptoms resolve; consult local and state authorities for HCP/food handlers with *Salmonella typhi*)
Diphtheria	Exposed: no restriction unless illness develops	Exclude from duty (until antimicrobial therapy completed and 2 cultures obtained $\geq$24 h apart are negative)
Hepatitis A	Exposed: no restriction unless illness develops	Restrict from patient contact, contact with patient's environment, and food handling (until 7 d after onset of jaundice)
Hepatitis B (chronic)	—	Restrictions based on review of only HCP who perform exposure-prone procedures by expert panel (see text)
Hepatitis C	—	Restrictions based on review of HCP who perform exposure-prone procedures by expert panel (see text)
Herpes simplex (genital)	—	No restriction
Herpes simplex (hands; herpetic whitlow)	—	Restrict from patient contact and contact with the patient's environment (until lesions heal)
Herpes simplex (orofacial)	—	Evaluate for need to restrict from care of high-risk patients
HIV	—	Restrictions based on review of HCP who perform exposure-prone procedures by expert panel (see text)
Measles	Exposed (susceptible HCP): exclude from duty (From the 5th day after 1st exposure through 21st day after last exposure and/or after rash appears)	Exclude from duty (until 7 d after the rash appears)
Meningococcal infections	Exposed: no restriction unless illness develops Colonized (unrelated to invasive case): no restriction	Exclude from duty (until 24 h after start of effective therapy)

Methicillin-resistant *Staphylococcus aureus*	Colonized: no restrictions unless or ill or epidemiologically/molecular test linked to patient infections	Allow to work provided lesions can be contained under a bandage and clothes; if lesions on exposed area (eg, hand/wrists, face/neck), exclude from duty (until lesions healed)
Mumps	Exposed (susceptible HCP): exclude from duty (from the 12th day after 1st exposure through 26th day after last exposure or after onset of parotitis)	Exclude from duty (until 9 d after onset of parotitis)
Pertussis	Exposure (asymptomatic): no restriction unless develops illness (PEP recommended) Exposed (symptomatic): per active disease	Exclude from duty (from beginning of catarrhal stage through 3rd week after onset of paroxysms or until 5 d after start of effective antimicrobial therapy)
Rubella	Exposed (susceptible HCP): exclude from duty (from 7th day after 1st exposure through 21st day after last exposure)	Exclude from duty (until 5 d after rash appears)
Group A streptococcus	Colonized: no restrictions unless or ill or epidemiologically/molecular test linked to patient infections	Restrict from patient care, contact with patient's environment, or food handling (until 24 h after adequate treatment started)
Tuberculosis	Latent tuberculous infection: no restrictions	Active pulmonary tuberculosis; exclude from duty (until proved noninfectious)
Varicella	Exposed (susceptible): exclude from duty (from 10th day after 1st exposure through 21st day [27th day if varicella IG provided] after last exposure)	Exclude from duty (until all lesions dried and crusted)
Zoster	Exposed (susceptible): same as varicella	Localized, in healthy HCP: Allow to work provided lesions can be contained under a bandage and clothes; if lesions on exposed area (eg, hand/wrists, face/neck), exclude from duty (until lesions dried and crusted) Generalized or localized in immunosuppressed HCP: exclude from duty (until all lesions dried and crusted)
Viral respiratory tract infections (acute)	No restrictions unless illness develops[a]	Febrile: exclude from duty (until afebrile for >24 h) Afebrile: exclude from care immunocompromised patients (ie, patients cared for in a protected environment) (until afebrile for >24 h or 7 d since onset of symptoms, whichever is longer) – HCP should wear a mask providing care until symptom-free

[a] Consider restrictions if HCP exposed to high-contagious disease transmitted by the respiratory route or close contact (Middle East respiratory syndrome–coronavirus, Ebola virus, etc.).

Adapted from Boylard EA, Tablan OC, Williams WW, et al. Guideline for infection control in health care personnel. 1998. Available at: http://www.cdc.gov/hicpac/pubs.html; and Advisory Committee on Immunization Practices, Centers for Disease Control and Prevention. Immunization of Health-Care Personnel Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2011;60(RR-7):1–45.

A (H3N2), or influenza B influenza virus infection. An emphasis on early treatment is an alternative to chemoprophylaxis in managing HCP who have had a suspected exposure to influenza virus. Postexposure chemoprophylaxis is typically administered for a total of not more than 10 days after the most recent known exposure to a close contact known to have influenza.

Chemoprophylaxis can also be used as a control measure in outbreaks in health care facilities, especially if they house patients at higher risk for influenza complications.[114,115] In addition to antiviral medications, other outbreak-control measures include instituting droplet and contact precautions and establishing cohorts of patients with confirmed or suspected influenza, reoffering influenza vaccination (if available) to unvaccinated staff and patients, restricting staff movement between wards or buildings, and restricting contact between ill staff or visitors and patients. Chemoprophylaxis should be considered for all employees, regardless of their influenza vaccination status, if indications exist that the outbreak is caused by a strain of influenza virus that is not well matched by the vaccine. Such indications might include multiple documented breakthrough influenza virus infections among vaccinated persons who otherwise would be expected to respond to vaccination, studies indicating low vaccine effectiveness, or circulation in the surrounding community of suspected index case(s) of strains not contained in the vaccine. Specific antiviral dosing recommendations (drug, dose, route, and duration) are available from the CDC.

EVALUATION OF ILL HEALTH CARE PERSONNEL

HCP exposed to a communicable disease for which they are susceptible should be considered for work restrictions or furlough (**Table 5**). Similarly, HCP ill with a communicable disease susceptible should be considered for work restrictions or furlough (see **Table 5**). Importantly, infectious HCP have been the source for patient infection and the index case for outbreaks.[84,102] HCP-to-patient transmission has been well documented for HIV, HBV, and HCV but has most commonly been reported with HBV. For this reason, infected HCP who perform invasive procedures should be evaluated by a special panel for the need for education, additional engineering controls, and/or work restrictions per current guidelines from the Society for Healthcare Epidemiology of America[116] and CDC.[117] The differences between these guidelines has been described.[120]

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