**Chapter 25
Protection of EMS personnel from occupationally acquired infections**

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**Introduction**

This chapter reviews measures designed to minimize transmission of infectious diseases to EMS providers. EMS personnel and prehospital transport environments are specifically included as health care providers (HCP) and health care settings, respectively, in guidance published by the Centers for Disease Control and Prevention (CDC), the Health Care Infection Control Practices Advisor Committee (HICPAC), and the Occupational Safety and Health Administration (OSHA) [1].

The EMS medical director should be aware of state and federal regulations as well as current CDC guidelines and other standards for immunization of EMS personnel, circumstances requiring barrier precautions or notification of possible exposure, disinfection of equipment and apparatus, and both immediate management and medical follow-up of providers exposed to infectious pathogens in the course of their duties. An individual EMS provider service may be subject to enforcement of federal or state OSHA regulations, or may have adopted voluntary standards such as National Fire Protection Association (NFPA) occupational health and safety titles. These regulations and standards are generally derived from legislation, CDC guidelines, or other expert consensus processes, and should be considered minimal acceptable practices.

**Standards, laws, and regulations**

**CDC guidelines**

Formal guidelines for reducing transmission of infectious diseases in hospital settings have been published since 1970, but the first to include prehospital providers in the definition of HCP were the “universal precautions” and “body fluid isolation” (BSI) documents, published in 1985 and 1987, respectively [2,3]. These were developed to address the risk of occupational exposure to hepatitis B and C, as well as the newly characterized human T-lymphocytotrophic virus-3 (HTLV-3), now known as human immunodeficiency virus (HIV). They defined which body fluids besides blood should be considered infectious (Box [25.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-fea-0001)), prescribed the personal protective equipment (PPE) that should be worn by care providers exposed to potentially infectious material, and offered guidance on safer handling of needles and other sharps in clinical settings. Most importantly, these guidelines emphasized the potential prevalence of unrecognized infections with blood-borne pathogens in all patient populations. They mandated the use of appropriate PPE any time procedures involving blood or body fluids are performed, regardless of whether a patient is known to have hepatitis or HIV.

**Box 25.1 Body fluid infectivity**

Other potentially infectious material (OPIM)

* Cerebrospinal fluid
* Synovial fluid
* Pleural fluid
* Pericardial fluid
* Amniotic fluid

Material not considered infectious unless visibly bloody

* Feces
* Nasal secretions
* Saliva
* Sputum
* Sweat
* Tears
* Urine
* Vomitus

These CDC guidelines were updated in 1996, and expanded to include the broader isolation precautions aimed at preventing nosocomial infections in hospitals [4]. At that time, the concepts of universal precautions for procedures involving blood or body fluids [2], and BSI [3] that applies to all moist body substances except for sweat, including mucous membranes and non-intact skin, were synthesized to produce the “standard precautions” that are still used. The introduction of standard precautions for all patient care, alone, is not sufficient to prevent all HCP exposure to infectious agents or nosocomial transmission in health care settings. Full implementation of standard precautions did, however, allow HICPAC to reduce the number of existing sets of isolation precautions to just three types, and these were based on the modes of transmission of the various organisms: air-borne, droplet, and contact. Each of these sets of precautions reinforces the use of standard precautions and then goes on to enumerate additional measures [5]. Many pathogens are infectious through more than one route, so infected patients may require multiple sets of isolation precautions.

The 1996 guidelines also emphasized hand hygiene as part of standard precautions. For the first time, hand washing was required after every patient encounter, in between procedures involving the same patient, and every time gloves and other PPE were doffed, regardless of known or suspected exposure to infectious pathogens. Other measures invoked as part of either standard or transmission-specific precautions addressed placement of patients within a facility, precautions that should be used when transporting potentially infectious patients through common areas, and the use of PPE including masks, eye protection, face shields, respiratory protection, gowns, and other protective clothing. These guidelines also defined circumstances that required special handling of patient care equipment or disposable supplies, processing of linens, and cleaning of patient care areas while a patient is there or prior to use for another patient.

The current guidelines, published in 2007, largely retained the format of the1996 recommendations, with some important additions [1]. First, the target audience was expanded to include providers in all health care settings, acknowledging the wide variety of venues other than hospitals in which acute patient care now occurs. Standard precautions were updated to include respiratory hygiene (cough etiquette). The list of interventions comprising standard precautions and the corresponding HICPAC recommendations is shown in [Table 25.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-tbl-0001).

[**Table 25.1**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-tbl-0001) Recommendations for application of standard precautions for the care of all patients in all health care settings

Source: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. [www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf](http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf)

| **Component** | **Recommendations** |
| --- | --- |
| Hand hygiene | After touching blood, body fluids, secretions, excretions, contaminated items; immediately after removing gloves; between patient contacts |
| Personal protective equipment (PPE) |  |
|  Gloves | For touching blood, body fluids, secretions, excretions, contaminated items; for touching mucous membranes and non-intact skin |
|  Gown | During procedures and patient care activities when contact of clothing/exposed skin with blood/body fluids, secretions, and excretions is anticipated |
|  Mask, eye protection (goggles), face shield[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0001) | During procedures and patient care activities likely to generate splashes or sprays of blood, body fluids, secretions, especially suctioning, endotracheal intubation |
| Soiled patient care equipment | Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; perform hand hygiene |
| Environmental control | Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient care areas |
| Textiles and laundry | Handle in a manner that prevents transfer of microorganisms to others and to the environment |
| Needles and other sharps | Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; place used sharps in puncture-resistant container |
| Patient resuscitation | Use mouthpiece, resuscitation bag, other ventilation devices to prevent contact with mouth and oral secretions |
| Patient placement | Prioritize for single-patient room if patient is at increased risk of transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk of acquiring infection or developing adverse outcome following infection |
| Respiratory hygiene/cough etiquette (source containment of infectious respiratory secretions in symptomatic patients, beginning at initial point of encounter, e.g., triage and reception areas in emergency departments and physician offices) | Instruct symptomatic persons to cover mouth/nose when sneezing/coughing; use tissues and dispose in no-touch receptacle; observe hand hygiene after soiling of hands with respiratory secretions; wear surgical mask if tolerated or maintain spatial separation, >3 feet if possible |

[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0001)During aerosol-generating procedures on patients with suspected or proven infections transmitted by respiratory aerosols (e.g. SARS), wear a fit-tested N95 or higher respirator in addition to gloves, gown, and face/eye protection.

Precautions associated with infectious respiratory syndromes and direct patient contact were updated in the 2007 guidelines to reflect international experience with SARS-CoV and epidemic norovirus, and the increasing prevalence of multiply drug-resistant strains or species of staphylococcus, enterococcus, *Clostridium difficile*, and *Mycobacterium tuberculosis.*Transmission-based precautions that should be used when when caring for patients with various clinical syndromes, even prior to identification of the infecting organisms, appear in [Table 25.2](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-tbl-0002).

[**Table 25.2**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-tbl-0002) Clinical syndromes or conditions warranting empiric transmission-based precautions in addition to standard precautions pending confirmation of diagnosis[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0002)

Source: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. [www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf](http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf)

| **Clinical syndrome or condition**[**†**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0003) | **Potential pathogens**[**‡**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0004) | **Empiric precautions (always includes standard precautions)** |
| --- | --- | --- |
| **Diarrhea** |
| Acute diarrhea with a likely infectious cause in an incontinent or diapered patient | Enteric pathogens[§](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0005) | Contact precautions (pediatrics and adult) |
| **Meningitis** | *Neisseria meningitidis*Enteroviruses*M. tuberculosis* | Droplet precautions for first 24 h of antimicrobial therapy; mask and face protection for intubationContact precautions for infants and childrenAir-borne precautions if pulmonary infiltrateAir-borne precautions plus contact precautions if potentially infectious draining body fluid present |
| **Rash or exanthems, generalized, etiology unknown** |
| Petechial/ecchymotic with fever (general)– If positive history of travel to an area with an ongoing outbreak of VHF in the 10 days before onset of fever | *Neisseria meningitidis*Ebola, Lassa, Marburg viruses | Droplet precautions for first 24 h of antimicrobial therapyDroplet precautions plus contact precautions, with face/eye protection, emphasizing safety sharps and barrier precautions when blood exposure likely. Use N95 or higher respiratory protection when aerosol-generating procedure performed |
| Vesicular | Varicella zoster, herpes simplex*,*variola (smallpox), vaccinia virusesVaccinia virus | Air-borne plus contact precautionsContact precautions only if herpes simplex, localized zoster in an immunocompetent host or vaccinia viruses most likely |
| Maculopapular with cough, coryza and fever | Rubeola (measles) virus | Air-borne precautions |
| **Respiratory infections** |
| Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient or a patient at low risk for HIV infection | *M. tuberculosis,*respiratory viruses, *Strep. pneumoniae, Staph. aureus*(MSSA or MRSA) | Air-borne precautions plus contact precautions |
| Cough/fever/pulmonary infiltrate in any lung location in an HIV-infected patient or a patient at high risk for HIV infection | *M. tuberculosis,*respiratory viruses, *Strep. pneumoniae, Staph. aureus*(MSSA or MRSA) | Air-borne precautions plus contact precautionsUse eye/face protection if aerosol-generating procedure performed or contact with respiratory secretions anticipated.If tuberculosis is unlikely and there are no air-borne infection isolation rooms and/or respirators available, use droplet precautions instead of air-borne precautionsTuberculosis more likely in HIV-infected individual than in HIV-negative individual |
| Cough/fever/pulmonary infiltrate in any lung location in a patient with a history of recent travel (10–21 days) to countries with active outbreaks of SARS, avian influenza | *M. tuberculosis,*severe acute respiratory syndrome virus (SARS- CoV), avian influenza | Airborne plus contact precautions plus eye protectionIf SARS and tuberculosis unlikely, use droplet precautions instead of airborne precautions |
| Respiratory infections, particularly bronchiolitis and pneumonia, in infants and young children | Respiratory syncytial virus, parainfluenza virus, adenovirus, influenza virus, human metapneumovirus | Contact plus droplet precautions; droplet precautions may be discontinued when adenovirus and influenza have been ruled out |
| **Skin or wound infection** |
| Abscess or draining wound that cannot be covered | *Staph. aureus*(MSSA or MRSA)*,*group A streptococcus | Contact precautionsAdd droplet precautions for the first 24 h of appropriate antimicrobial therapy if invasive group A streptococcal disease is suspected |

[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0002)Infection control professionals should modify or adapt this table according to local conditions. To ensure that appropriate empiric precautions are implemented always, hospitals must have systems in place to evaluate patients routinely according to these criteria as part of their preadmission and admission care.

[†](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0003)Patients with the syndromes or conditions listed below may present with atypical signs or symptoms (e.g. neonates and adults with pertussis may not have paroxysmal or severe cough). The clinician's index of suspicion should be guided by the prevalence of specific conditions in the community, as well as clinical judgment.

[‡](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0004)The organisms listed under the column “Potential pathogens” are not intended to represent the complete, or even most likely, diagnoses, but rather possible etiologic agents that require additional precautions beyond standard precautions until they can be ruled out.

[§](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0005)These pathogens include enterohemorrhagic *Escherichia coli* O157:H7, *Shigella* spp, hepatitis A virus, noroviruses, rotavirus, *C. difficile*.

The other major addition to the 2007 guidelines from an EMS perspective was a brief presentation of the precautions that should be used for management of patients infected with CDC Category A bioterrorism threats. These select agents include anthrax, botulism, Ebola and other viral hemorrhagic fevers, plague, smallpox, and tularemia. Summaries of routes of transmission and infectivity together with the consensus recommendations for precautions are outlined in [Table 25.3](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-tbl-0003).

[**Table 25.3**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-tbl-0003) Infection control considerations for high-priority (CDC Category A) disease that may result from bioterrorist attacks or are considered to be bioterrorist agents ([www.bt.cdc.gov](http://www.bt.cdc.gov/))

Source: Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. [www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf](http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf)

| **Disease** | **Anthrax** |
| --- | --- |
| **Site(s) of infection; transmission mode**Cutaneous and inhalation disease have occurred in past bioterrorist incidents | **Cutaneous:** contact with spores**RT** (inhalation of spores)**GIT** (ingestion of spores – rare)**Comment:** Spores can be inhaled into the lower respiratory tract. The infectious dose of *B. anthracis* in humans by any route is not precisely known. In primates, the LD50 (i.e. the dose required to kill 50% of animals) for an aerosol challenge with *B. anthracis* is estimated to be 8,000–50,000 spores; the infectious dose may be as low as 1–3 spores |
| **Incubation period** | **Cutaneous**: 1–12 days**RT**: usually 1–7 days but up to 43 days reported**GIT**: 15–72 hours |
| **Clinical features** | **Cutaneous:** painless, reddish papule, which develops a central vesicle or bulla in 1–2 days; over next 3–7 days lesion becomes pustular and then necrotic, with black eschar; extensive surrounding edema**RT:** initial flu-like illness for 1–3 days with headache, fever, malaise, cough; by day 4 severe dyspnea and shock, and is usually fatal (85–90% if untreated; meningitis in 50% of RT cases)**GIT**: if intestinal form, necrotic, ulcerated edematous lesions develop in intestines with fever, nausea and vomiting, progression to hematemesis and bloody diarrhea; 25–60% fatal |
| **Diagnosis** | **Cutaneous:** swabs of lesion (under eschar) for IHC, PCR, and culture; punch biopsy for IHC, PCR, and culture; vesicular fluid aspirate for Gram stain and culture; blood culture if systemic symptoms; acute and convalescent sera for ELISA serology**RT:** CXR or CT demonstrating wide mediastinal widening and/or pleural effusion, hilar abnormalities; blood for culture and PCR; pleural effusion for culture, PCR, and IHC; CSF if meningeal signs present for IHC, PCR, and culture; acute and convalescent sera for ELISA serology; pleural and/or bronchial biopsies IHC**GIT:** blood and ascites fluid, stool samples, rectal swabs, and swabs of oropharyngeal lesions if present for culture, PCR, and IHC |
| **Infectivity** | **Cutaneous:** person-to-person transmission from contact with lesion of untreated patient possible, but extremely rare**RT and GIT:** person-to-person transmission does not occur**Aerosolized powder, environmental exposures:**highly infectious if aerosolized |
| **Recommended precautions** | **Cutaneous**: standard precautions; contact precautions if uncontained copious drainage**RT and GIT:** standard precautions.**Aerosolized powder, environmental exposures:**respirator (N95 mask or PAPRs), protective clothing; decontamination of persons with powder on them ([www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a3.htm))**Hand hygiene:** handwashing for 30–60 seconds with soap and water or 2% chlorhexidene gluconate after spore contact (alcohol handrubs inactive against spores [Weber DJ *JAMA*2003;289:1274])**Postexposure prophylaxis following environmental exposure**: 60 days of antimicrobials (either doxycycline, ciprofloxacin, or levofloxacin) and postexposure vaccine under IND |
| Disease | Botulism |
| **Site(s) of infection; transmission mode** | **GIT:** ingestion of toxin-containing food**RT:** inhalation of toxin-containing aerosol**Comment:** toxin ingested or potentially delivered by aerosol in bioterrorist incidents. LD50 for type A is 0.001 µg/mL/kg |
| **Incubation period** | 1–5 days |
| **Clinical features** | Ptosis, generalized weakness, dizziness, dry mouth and throat, blurred vision, diplopia, dysarthria, dysphonia, and dysphagia followed by symmetrical descending paralysis and respiratory failure |
| **Diagnosis** | Clinical diagnosis; identification of toxin in stool, serology unless toxin-containing material available for toxin neutralization bioassays |
| **Infectivity** | Not transmitted from person to person. Exposure to toxin necessary for disease |
| **Recommended precautions** | Standard precautions |
| Disease | Ebola hemorrhagic fever |
| **Site(s) of infection; transmission mode** | As a rule infection develops after exposure of mucous membranes or RT, or through broken skin or percutaneous injury |
| **Incubation period** | 2–19 days, usually 5–10 days |
| **Clinical features** | Febrile illnesses with malaise, myalgias, headache, vomiting and diarrhea that are rapidly complicated by hypotension, shock, and hemorrhagic features. Massive hemorrhage in <50% pts |
| **Diagnosis** | Etiological diagnosis can be made using RT-PCR, serological detection of antibody and antigen, pathological assessment with immunohistochemistry and viral culture with EM confirmation of morphology |
| **Infectivity** | Person-to-person transmission primarily occurs through unprotected contact with blood and body fluids; percutaneous injuries (e.g. needlestick) associated with a high rate of transmission; transmission in healthcare settings has been reported but is prevented by use of barrier precautions |
| **Recommended precautions** | **Hemorrhagic fever-specific barrier precautions**: If disease is believed to be related to intentional release of a bioweapon, epidemiology of transmission is unpredictable pending observation of disease transmission. Until the nature of the pathogen is understood and its transmission pattern confirmed, standard, contact, and air-borne precautions should be used. Once the pathogen is characterized, if the epidemiology of transmission is consistent with natural disease, droplet precautions can be substituted for air-borne precautions. Emphasize: (1) use of sharps safety devices and safe work practices; (2) hand hygiene; (3) barrier protection against blood and body fluids upon entry into room (single gloves and fluid-resistant or impermeable gown, face/eye protection with masks, goggles or face shields); and (4) appropriate waste handling. Use N95 or higher respirators when performing aerosol-generating procedures. In settings where AIIRs are unavailable or the large numbers of patients cannot be accommodated by existing AIIRs, observe droplet precautions (plus standard precautions and contact precautions) and segregate patients from those not suspected of VHF infection. Limit blood draws to those essential to care. See text for discussion and Appendix A for recommendations for naturally occuring VHFs |
| Disease | Plague |
| **Site(s) of infection; transmission mode** | **RT:** Inhalation of respiratory droplets**Comment**: pneumonic plague most likely to occur if used as a biological weapon, but some cases of bubonic and primary septicemia may also occur. Infective dose 100–500 bacteria |
| **Incubation period** | 1–6, usually 2–3 days |
| **Clinical features** | Pneumonic: fever, chills, headache, cough, dyspnea, rapid progression of weakness, and in a later stage hemoptysis, circulatory collapse, and bleeding diathesis |
| **Diagnosis** | Presumptive diagnosis from Gram stain or Wayson stain of sputum, blood, or lymph node aspirate; definitive diagnosis from cultures of same material or paired acute/convalescent serology |
| **Infectivity** | Person-to-person transmission occurs via respiratory droplets; risk of transmission is low during first 20–24 hours of illness and requires close contact. Respiratory secretions probably are not infectious within a few hours after initiation of appropriate therapy |
| **Recommended precautions** | Standard precautions, droplet precautions until patients have received 48 hours of appropriate therapy**Chemoprophylaxis:** consider antibiotic prophylaxis for health care workers with close contact exposure |
| Disease | Smallpox |
| **Site(s) of infection; transmission mode** | **RT:** inhalation of droplet or, rarely, aerosols and skin lesions (contact with virus)**Comment:** if used as a biological weapon, natural disease, which has not occurred since 1977, will likely result |
| **Incubation period** | 7–19 days (mean 12 days) |
| **Clinical features** | Fever, malaise, backache, headache, and often vomiting for 2–3 days; then generalized papular or maculopapular rash (more on face and extremities), which becomes vesicular (on day 4 or 5) and then pustular; lesions all in same stage |
| **Diagnosis** | Electron microscopy of vesicular fluid or culture of vesicular fluid by WHO-approved laboratory (CDC); detection by PCR available only in select LRN labs, CDC and USAMRID |
| **Infectivity** | Secondary attack rates up to 50% in unvaccinated persons; infected persons may transmit disease from time rash appears until all lesions have crusted over (about 3 weeks); greatest infectivity during first 10 days of rash |
| **Recommended precautions** | Combined use of standard, contact, and air-borne precautions until all scabs have separated (3–4 weeks)Only immune HCWs to care for pts; postexposure vaccine within 4 days**Vaccinia:** HCWs cover vaccination site with gauze and semi-permeable dressing until scab separates (>21 days). Observe hand hygiene**Adverse events with virus-containing lesions:**standard plus contact precautions until all lesions crusted |
| Disease | Tularemia |
| **Site(s) of infection; transmission mode** | **RT:** inhalation of aerosolized bacteria**GIT:** ingestion of food or drink contaminated with aerosolized bacteria**Comment:** pneumonic or typhoidal disease likely to occur after bioterrorist event using aerosol delivery. Infective dose 10–50 bacteria |
| **Incubation period** | 2–10 days, usually 3–5 days |
| **Clinical features** | Pneumonic: malaise, cough, sputum production, dyspneaTyphoidal: fever, prostration, weight loss and frequently an associated pneumonia |
| **Diagnosis** | Diagnosis usually made with serology on acute and convalescent serum specimens; bacterium can be detected by PCR (LRN) or isolated from blood and other body fluids on cysteine-enriched media or mouse inoculation |
| **Infectivity** | Person-to-person spread is rareLaboratory workers who encounter/handle cultures of this organism are at high risk for disease if exposed |
| **Recommended precautions** | Standard precautions |

BSL, biosafety level; CSF, cerebrospinal fluid; CT, computed axial tomography; CXR, chest x-ray; GIT, gastrointestinal tract; HCW, health care worker; IHC, immunohistochemistry; PAPR, powered air purifying respirator; PCR, polymerase chain reaction; RT, respiratory tract.

The CDC periodically develops and publishes precaution guidelines that are specific to newly recognized infectious threats, or those that require isolation measures other than the more inclusive documents described above. A recent example that may be important to EMS providers, because clusters appear frequently in communities, pertains to norovirus [6]. Key considerations for providers caring for these patients are how readily it is transmitted in health care settings, and the recommendation that hand hygiene include soap and water cleansing, as alcohol-based preparations may not inactivate the organisms. EMS medical directors, along with occupational health providers, need to be aware of current and emerging infections, maintain surveillance for occupationally acquired infections, and follow both general and specific guidelines for prevention as they become available.

**OSHA regulations**

Workplace protection of HCP against exposure to blood-borne pathogens was required by OSHA as early as 1991 with the introduction of 29CFR 1910.130 into its Safety and Health Standards [7]. Expectations for PPE, engineering controls, training, and immunization against hepatitis B were consistent with the CDC guidelines. OSHA regulations also provided new definitions of infectious and regulated waste, along with rules for handling and labeling. Employee health records had to include exposure surveillance and documentation of clinical follow-up of known incidents. The Needlestick Safety and Prevention Act (PL 106-430, passed by the US Congress in 2000) compelled OSHA to revise this blood-borne pathogens standard in several ways [8].The 2001 revision, entitled “Needlestick and Other Sharps Injuries: Final Rule,” mandated use of needleless systems and other innovations to decrease the risk of injury while performing medical procedures, documentation of employee involvement in determination of the risk of exposure to blood-borne pathogens, and maintenance of a sharps injury log detailing each incident together with the type and brand of device involved.

**Ryan White Act**

The Ryan White Comprehensive AIDS Resources Emergency (CARE) Act of 1990, Subtitle B Emergency Response Employee Notification (PL 101-381), required that each emergency response agency have a designated infection control officer (ICO) and a system for rapid postexposure notification of employees. The Emergency Response Employee (ERE) notification provisions were excluded from the Ryan White Act, which mainly addressed AIDS care funding when it was reauthorized in 2006, but the provisions were restored and updated in the Ryan White HIV/AIDS Treatment Extension Act of 2009 (PL 111-87). The new regulation broadened the scope, and more precisely defined the circumstances for obligatory notification of ERE following potential, infectious exposure [9].

The list of potentially life-threatening infectious agents in the Ryan White Act Implementation document is similar to the CDC’s list in the 2007 isolation precautions [1], and is also organized according to modes of transmission. Ways in which an ERE can be exposed to the various diseases are defined, and the responsibilities of medical facilities for reporting exposures to them are outlined in detail. The two situations mandating reporting by health care facilities are when an ERE believes an exposure has occurred, and when the health care facility identifies one of the listed infections in a patient who was potentially infectious when he or she was cared for by an ERE [9]. In each of these cases, the health care facility is obligated to make one of the following determinations with respect to the ERE involved.

* The ERE has been exposed to a listed pathogen based on:
	+ the mode of transmission and the ERE’s contact with the patient, AND
	+ the identity of the infectious agent has been confirmed through laboratory or clinical data.
* The ERE has not been exposed to a listed pathogen based on:
	+ the mode of transmission and the absence of a credible ERE exposure to infectious material OR
	+ there is sufficient information to conclude that the source patient did not have a listed infection.
* The medical facility does not know whether a putative source patient had a listed infection at the time of a suspected exposure.
	+ If the source patient was transported and/or treated by the medical facility for an unrelated medical condition, the patient may not have been tested for potential, occult infection.
	+ This determination should be revised appropriately if the medical facility acquires additional information relevant to the exposure.
* The facts of the potential exposure incident are insufficient for the medical facility to determine the plausibility of significant exposure.

Emergency response employees should obtain appropriate follow-up for medical prophylaxis, testing, or acute care as indicated by the nature of the exposure. Postexposure prophylaxis (PEP) may include administration of vaccine, antibiotics, or other treatment to prevent acquisition of disease. For the Ryan White laws to be effective, EMS agencies, with their medical oversight and occupational health providers, must collaborate with hospital infection control and infectious disease specialists. Essential program elements include education, protocol development, and training at all levels to ensure appropriate evaluation and timely PEP for exposed EREs [10].

**NFPA standards**

The NFPA 1500 series of standards are voluntary, consensus standards relating to occupational safety and health in fire service environments. They are periodically revised by a multidisciplinary technical committee, and published by the NFPA. Adherence to these standards is at the discretion of the authority having jurisdiction, i.e. departments or municipalities choose whether or not to adopt them. As industry standards, however, they may be cited as expectations by OSHA or in litigation following occupational illness, injury, or death.

NFPA 1582 (Standard on Comprehensive Occupational Medical Program for Fire Departments) primarily addresses medical evaluation of candidates for firefighter positions and fitness for duty determinations for members of fire departments. This document does include requirements for screening and surveillance for occupationally acquired infectious diseases, and requires immunization of members according to current CDC recommendations [11].

NFPA 1581 (Standard on Fire Department Infection Control Program) outlines the duties of a departmental ICO as defined in Ryan White legislation, and proposes organizational mechanisms through which this function should be integrated in the department’s administrative structure [12]. According to NFPA 1581, the ICO also oversees all aspects of infection control in a fire department, including education and training of members, selection and use of engineering controls and PPE, cleaning of apparatus and equipment after potential exposure to infectious pathogens, prevention of food-borne illness and other potential exposures in fire department living spaces, and maintenance of records of these activities. Though written in standards language for departments that have adopted them, NFPA 1581 is a readily accessible single source of practical guidelines for infection control in fire and EMS agencies.

**Blood-borne pathogens**

The term blood-borne pathogens (BBP) is often used to refer to hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), but pathogenic microorganisms present in human blood can cause other diseases such as syphilis, babesiosis, and arboviral infections [8]. Exposures that put EMS personnel at risk for BBP infection are defined as percutaneous injuries, or contact of mucous membrane or non-intact skin with blood, tissue, or other body fluids that are potentially infectious, as outlined in [Box 25.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-fea-0001).

**Hepatitis B virus (HBV)**

Because of widespread use of HBV vaccine, the risk of both occupational exposure and infection with HBV has diminished greatly [13]. Agencies must have HBV vaccination programs in place, providing the vaccine free of charge to personnel at risk. EMS personnel should not serve as HCPs until they have received the first dose of vaccine or signed a declination form. If administration of the series is interrupted, the HCP should continue with the second or third dose; the only requirement is there should be at least a 2-month interval between the second and third doses.

Any HCP who has contact with patients or blood and is at risk for percutaneous injuries should have anti-HB levels determined 1–2 months after completing all three doses of the HBV vaccine. Those who do not respond to the initial series with anti-HBV levels >10 mIU/mL should receive a second three-dose series and be retested. Historically, 25–50% of initial non-responders develop positive titers and are considered protected. However, any HCP who remains a non-responder to the HBV vaccine should be counseled regarding prevention of HBV infection if exposed, and the need to obtain hepatitis B immune globulin (HBIG) prophylaxis if exposed to HBsAg-positive blood. Early HBIG administration provides approximately 75% protection from HBV infection [14]. Given HBV’s stability in the external environment (it is known to persist in dried blood for at least a week) [15], it is crucial to counsel the HCPs who are true vaccine non-responders. For others who have responded in the past, titers do decrease over time, but routine checking of titers following exposure is not recommended. See [Table 25.4](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-tbl-0004) for recommended PEP after exposure to HBsAg-positive blood [13].

[**Table 25.4**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-tbl-0004) Recommended postexposure prophylaxis for exposure to hepatitis B virus infection status of source

Source: Updated US Public Health Service Guidelines for the management of occupational eExposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. MMWR 29 June 2001;50(RR11):1–42. [www.cdc.gov/mmwr/preview/mmwrhtml/rr5011a1.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5011a1.htm)

|  | **Treatment** |
| --- | --- |
| Vaccination and antibody response status of exposed workers[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008a) | Source HBsAg[†](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008)positive | Source HBsAg[†](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008)negative | Source unknown or not available for testing |
| Unvaccinated | HBIG[§](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008x) × 1 and initiate HB vaccine series | Initiate HB vaccine series | Initiate HB vaccine series |
| Previously vaccinated |
| Known responder[\*\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0011) | No treatment | No treatment | No treatment |
| Known non-responder†† | HBIG × 1 and initiate revaccination or HBIG × 2§§ | No treatment | If known high-risk source, treat as if source were HBsAg positive |
| Antibody response unknown | Test exposed person for anti-HBs[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008b)1. If adequate,[\*\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0011)no treatment is necessary
2. If inadequate,††administer HBIG × 1 and vaccine booster
 | No treatment | Test exposed person for anti-HBs1. If adequate,[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008bb) no treatment is necessary
2. If inadequate,[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-note-0008c)administer vaccine booster and recheck titer in 1–2 months
 |

[\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008a)Persons who have previously been infected with HBV are immune to reinfection and do not require postexposure prophylaxis.

[†](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008)Hepatitis B surface antigen.

[§](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008x)Hepatitis B immune globulin; dose is 0.06 mL/kg intramuscularly.

[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008b)Hepatitis B vaccine.

[\*\*](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0011)A responder is a person with adequate levels of serum antibody to HBsAg (i.e. anti-HBs ≥10 mIU/mL).

[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008bb)A non-responder is a person with inadequate response to vaccination (i.e. serum anti-HBs <10 mIU/mL).

§The option of giving one dose of HBIG and reinitiating the vaccine series is preferred for non-responders who have not completed a second three-dose vaccine series. For persons who previously completed a second vaccine series but failed to respond, two doses of HBIG are preferred.

[¶](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#R_c25-note-0008c)Antibody to HBsAg.

**Hepatitis C virus (HCV)**

Hepatitis C was first recognized as a distinct virus in the late 1980s. Although less efficiently transmitted than HBV as a BBP, exposure to HCV is a significant risk for prehospital providers because there is no vaccine or PEP available [13]. Almost 4 million people in the United States are infected with HCV (75% chronically). Many are asymptomatic and not aware of their infections. Of those who develop acute HCV infection, 15–25% will clear the virus spontaneously and not develop chronic infection. The other 75–85% may have active disease (60–70%) or asymptomatic disease (30–40%) [13,16]. Therefore, it is essential that prehospital personnel use standard precautions with all patients.

This virus is occupationally transmitted primarily by percutaneous injury. The average risk for virus transmission after percutaneous exposure to a HCV-positive patient is 1.8%. These data were collected before 2001, when use of safety-engineered IV catheters became required by law [8]. Occupational transmission by mucous membrane exposure is rare, but infection via non-intact skin and conjunctival exposure have been documented [17]. Despite occupational exposures to prehospital personnel, including first responders, paramedics, and firefighters, excess incidence or prevalence of HCV has not been observed in these populations [18,19].

During initial evaluation of occupational HCV exposures, both the source patient and exposed HCP should be checked for HCV antibodies if possible. At the follow-up visit, and if the source patient is seropositive for HCV, the exposed HCP should undergo baseline testing for HCV and serum aminotransferase activity. Quantitative testing for HCV RNA should be performed again, subsequently, and if positive the infecting HCV should be genotyped. All assays used for serological and nucleic acid testing should be FDA approved [20,21].

There is no known PEP that effectively prevents infection with HCV. If the profile of serological, nucleic acid, and liver function studies, with or without other clinical signs, suggests the presence of hepatitis C, the exposed HCP should be referred for specialty care to manage this infection. It is not always clear whether an exposed HCP has acute or chronic hepatitis C when tested following an exposure incident. A specialist experienced in making this determination and in subsequent management of the infection should be consulted, as this distinction is critical to treatment [20,21].

Depending on many factors including comorbidities, size of inoculum, and potential coinfection with HIV, close to half of those with acute hepatitis C infection may experience spontaneous viral remission. It appears that increased evidence of acute hepatitis may correlate with a greater chance of viral remission. Treatment with pegylated interferons during the acute phase produces viral remission in up to 80% of patients. It is currently unclear whether it is preferable to begin therapy immediately upon recognition of the infection or to wait 12 or more weeks to avoid the side-effects in those who will spontaneously clear the virus without treatment [20,22].

**Human immunodeficiency virus (HIV)**

The risk of HCP infection following percutaneous exposure to blood from an HIV-infected patient is roughly 0.3% [23]. The risk ranges from 0.04% to 5% depending on whether there was deep injury by a hollow-bore sharp, visible blood on device, the device was previously placed in the source patient’s artery or vein, and/or the source patient had a high viral load or had terminal AIDS. When exposure to mucous membranes results from splash or splatter of infected blood or body fluids, the risk of transmission to the HCP is 0.09% [24].

Management of HCPs following exposure to blood or other potentially infectious material includes several steps. The HCP should be seen immediately to evaluate and document the exposure, provide local care of any wound incurred, complete cleaning if not already done prior to presentation, facilitate both source patient and HCP testing, start PEP if indicated, and arrange for follow-up by the appropriate occupational health service. Current CDC guidelines acknowledge that many exposures occur when occupational health services are not available, and recommend that the emergency department or other entities that provide postexposure services have clear protocols for accomplishing the testing, counseling, and medication required under these circumstances [25].

If the HIV status of the source patient in an exposure incident is unknown, FDA-approved test methods that provide reliable results in less than an hour should be used [25]. This CDC recommendation may be enforced by OSHA [8,26]. According to current CDC guidelines, if the source patient tests negative for HIV, PEP for HIV should not be offered. If the source patient is known to be HIV positive, found to be seropositive on rapid testing, or has risk factors for HIV but cannot be tested, PEP is usually warranted.

The preferred HIV PEP regimen at this time includes raltegravir plus the combination drug Truvada (tenofovir and emtricitabine). Medical directors should be aware when the guidelines [25] are updated and defer to the revised recommendations. The current recommendations for HIV PEP and summary information on the recommended medications are available on the internet [25].

The current recommendations eliminated attempts at correlating the severity of an exposure with the components of the PEP. If PEP is indicated, the same first-line or alternative regimens are used, regardless of any specific characteristics of the exposure incident. It should be started as soon as possible after exposure; it is thought to be less effective if started more than 72 hours later [25]. The duration of PEP is 4 weeks unless contraindicated by side-effects, adverse reactions, or other developments. The HCP should be under the care of an infectious disease/HIV specialist during this period.

Expert consultation is also recommended if the source patient is not known, if the exposed HCP is pregnant or breast feeding, or has significant, underlying comorbidity. In these cases, greater experience with the available PEP medications is necessary to counsel the HCP and manage ongoing care.

Follow-up blood tests for HIV seroconversion should be performed at 6 weeks, 12 weeks, and 6 months following the occupational exposure. If a HCP was exposed to a patient who was coinfected with HCV and HIV, and the HCP serocoverts to the HCV, an additional blood test for HIV should be done 1 year after the exposure [25].

**Air-borne, droplet, and contact transmission of infection**

[Table 25.2](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c25.xhtml#c25-tbl-0002) outlines the precautions that should be used in the presence of various clinical syndromes, reflecting the likely modes of transmission of the responsible pathogens. Potential or documented exposure to specific pathogens requires further evaluation of the emergency responder involved, and in a few cases, some form of PEP. Meningococcus and varicella zoster are frequently encountered examples that are discussed in greater detail in Volume 1, [Chapter 25](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/c25.xhtml). The responsibilities of the EMS provider, the agency, and the medical facility with respect to such exposures, as delineated under the Ryan White law [9], are enumerated above.

***Mycobaterium tuberculosis***

As part of the national strategic plan to eliminate pulmonary tuberculosis (TB), especially drug-resistant TB, the CDC TB guidelines were expanded in 2005 to include non-traditional health care settings such as the prehospital arena. Although TB cases have been decreasing, many areas within the United States have TB case rates higher than the national average [27]. Multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB), although present in the US, are still treatable and are not more infectious than other strains of TB [28,29].

Emergency medical services personnel can assist receiving hospitals by identifying potential TB patients early so they may be isolated. Prehospital personnel, both first responders and transporting HCPs, should maintain a high index of suspicion for patients with active, pulmonary TB. Symptoms may be non-specific but a patient who belongs to a high-risk group, has a history of TB, or has symptoms consistent with active infection should wear a surgical or procedure mask during transport [27], as long as this does not compromise his or her respiratory status. When the patient requires supplemental oxygen, the EMS crew (both the driver and the provider(s) attending the patient) should wear N-95 respirators. The ventilation system in the transport vehicle should be set to maximum non-recirculation, to draw as much fresh air into the patient care compartment as possible. Personnel should use the vehicle’s rear exhaust fan or a HEPA-filtered, supplemental recirculating unit if possible. The Ryan White Care Act mandates hospital-initiated notification of personnel who may have been unknowingly exposed to a patient with suspected or confirmed TB [9].

Currently, OSHA is enforcing the CDC 2005 TB guidelines for protection of health care workers. These guidelines require the health care setting to develop a risk assessment for TB infection. The results of the risk assessment will determine the need for a respiratory protection program. For example, many fire departments may no longer need to perform annual TB testing after initial screening. The TB risk assessment should be updated each year and added to the agency’s exposure control plan. The ICO should compile the risk assessment data, in consultation with local and state medical and epidemiological officials. Medical oversight personnel should be aware of local data and any resistance patterns with the help of such consultations.

**Recommended immunizations**

Wellness programs are gaining more importance because they effectively reduce risk and become both an employee and employer benefit. EMS personnel should be offered hepatitis B vaccine, MMR (measles/mumps/rubella) vaccine, varicella vaccine (if not immune), TB skin testing in accordance with TB risk assessment, annual flu shots, and others as necessary (e.g. those required for travel for providers who are part of deployable teams) [30]. In 2005, a combination vaccine providing booster immunization against tetanus, diphtheria, and pertussis (Tdap) became available. Tdap is recommended for HCPs who have direct patient contact; if prehospital personnel have not already received Tdap, they should receive a single dose of Tdap as soon as possible. HCP who have received Td boosters recently may receive Tdap 2 years after the booster.

Fire department personnel should follow recommendations outlined in NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments [12]. Following these recommendations may reduce the incidence of diseases by offering vaccine to non-immune individuals. The medical director should emphasize that these programs are cost-effective; numerous studies have shown that immunization of unprotected HCPs is 50–60% less costly than postexposure medical follow-up and/or treatment [31].

**Reporting an exposure**

There are many reasons to report prehospital exposures. These include helping state and local epidemiologists document and report the risks of prehospital patient care, identification of dangerous patterns, and increased possibility of treating and transporting patients with unknown HBV, HCV, and/or HIV status. But the first responsibility lies with the individual who sustained the exposure. Proof of absence of infection at the time of exposure is important, because if the HCP later tests positive for a BBP, it is more likely due to the occupational exposure. Although the chance of disease transmission is small, complications from such disease transmission may be very expensive. Development of disease that is not documented as attributable to an occupational exposure can affect future employment and access to disability insurance coverage [32]. Some states have laws regarding presumption of occupational exposure for EMS personnel.

As many as 40–80% of HCP exposed to BBP do not follow up with occupational health services as required [33–36]. Reporting an injury should be encouraged and remain uncomplicated. “Lack of time” and “low-risk patient” are common reasons resulting in failure to document percutaneous exposures. The ICO and/or the occupational health service, not the HCP, should determine whether a given exposure constitutes a risk. In addition, the ICO should encourage and enable the exposed worker to obtain appropriate follow-up. OSHA requires completion of an exposure report form and that the information on the form complies with not only the BBP standard [8] but also OSHA’s medical record standard [37]. An example of a fire department exposure form is available in NFPA 1581 [12].

**Conclusion**

Emergency medical services medical directors should remain committed to use of evidence-based guidelines when developing and updating exposure prevention programs. ICOs should ensure that proper PPE, safety devices, and training for these items are provided and that their use is encouraged. Prompt reporting of any potential exposures must be enabled and encouraged. Exposure response plans should be complete, comprehensive, and updated annually. The risk of exposures is real, but can be reduced through use of appropriate precautions. The risk of disease transmission and subsequent morbidity in the occupational setting is low, and can be further reduced through appropriate PEP and follow-up.

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