**Chapter 25
Infectious and communicable diseases**

**Russell D. MacDonald**

**Introduction**

Paramedics are typically the first health care personnel to encounter sudden illnesses or other health care emergencies in the community, placing them at risk of communicable and infectious diseases. The Occupational Safety and Health Administration (OSHA) identifies more than 1.2 million community-based first response personnel, including law enforcement, fire, and EMS personnel, who are at risk for infectious exposure [1]. While infectious and communicable disease preparation may not have previously been a priority in some EMS agencies, the 2003 severe acute respiratory syndrome (SARS) outbreaks made it one. Emergency medical personnel during the onset of the SARS outbreaks in Toronto and Taipei were exposed to or contracted SARS in significant numbers resulting in one paramedic fatality [2,3]. More importantly, the loss of paramedics available for work due to exposure, illness, and quarantine affected the ability to maintain staffing during the outbreak, and highlighted the need for EMS systems to adequately prepare and protect the workforce from potential exposure [4].

**Paramedic and patient**

An *infectious* disease results from the invasion of a host by disease-producing organisms, such as bacteria, viruses, fungi or parasites. A *communicable* (or contagious) disease is one that can be transmitted from one person to another. Not all infectious diseases are communicable. For example, malaria is a serious infectious disease transmitted to the human bloodstream by a mosquito bite, but malaria is infectious, not communicable. On the other hand, chickenpox is an infectious disease which is also highly communicable because it can be easily transmitted from one person to another.

The mode of transmission is the mechanism by which an agent is transferred to the host. Modes of transmission include contact transmission (direct, indirect, droplet), airborne, vector borne, or common vehicle (food, equipment). Contact transmission is the most common mode of transmission in the EMS setting, and can be effectively prevented using routine practices.

Direct contact transmission occurs when there is direct contact between an infected or colonized individual and a susceptible host. Transmission may occur, for example, by biting, kissing, or sexual contact. Indirect contact occurs when there is passive transfer of an infectious agent to a susceptible host through a contaminated intermediate object. This can occur if contaminated hands, equipment, or surfaces are not washed between patient contacts. Examples of diseases transmitted by direct or indirect contact include human immunodeficiency virus (HIV), hepatitis, and methicillin-resistant *Staphylococcus aureus* (MRSA).

Droplet transmission is a form of contact transmission requiring special attention. It refers to large droplets generated from the respiratory tract of a patient when coughing or sneezing, or during invasive airway procedures (e.g. intubation, suctioning). These droplets are propelled and may be deposited on the mucous membranes of the susceptible host. The droplets may also settle in the immediate environment, and the infectious agents may remain viable for prolonged periods of time to be later transmitted by indirect contact. Examples of diseases transmitted by droplet transmission include meningitis, influenza, rhinovirus, respiratory syncytial virus (RSV), and severe acute respiratory syndrome (SARS).

Airborne transmission refers to the spread of infectious agents to susceptible hosts through the air. In this case, infectious agents are contained in very small droplets which can remain suspended in the air for prolonged periods of time. These agents are dispersed widely by air currents and can be inhaled by a susceptible host located at some distance from the source. Examples of airborne transmission diseases include measles (rubeola), varicella (chickenpox), and tuberculosis.

Vector-borne transmission refers to the spread of infectious agents by means of an insect or animal (the “vector”). Examples of vector-borne illnesses include rabies, where the infected animal is the vector, and West Nile virus or malaria, where infected mosquitos are the vectors. Transmission of vector-borne illness does not occur between emergency personnel and their patients.

Common vehicle transmission refers to the spread of infectious agents by a single contaminated source to multiple hosts. This can result in large outbreaks of disease. Examples of this type of transmission include contaminated water sources (*E. coli*), contaminated food (Salmonella), or contaminated medication, medical equipment, or IV solutions.

**General approach and patient assessment**

The risk of communicable disease is not as apparent as other physical risks, such as road traffic, power lines, firearms, or chemical agents. EMS personnel must use the same level of suspicion and precaution whenever approaching a patient. The use of routine practices, as a minimum, is necessary for every patient encounter in order to mitigate this risk. All personnel must take appropriate precautions when a patient presents with any signs or symptoms suspected to be due to an infectious or communicable disease. All EMS and first responder agencies must provide appropriate training that enables personnel to identify at-risk patients and use appropriate personal protective equipment (PPE).

The risk assessment begins with information from an EMS dispatch or communication center, prior to making patient contact. Call-taking procedures should include basic screening information to identify potential communicable disease threats and provide this information to all responding personnel. The screening information can identify patients with symptoms of fever, chills, cough, shortness of breath, or diarrhea. The call-taker can also identify if the patient location, such as nursing home, group home or other institutional setting, poses a potential risk to the responding personnel. This information helps responding personnel to determine what precautions are necessary before they make patient contact.

When patient contact is made, personnel can determine if the patient has a potential risk for a communicable disease. A rapid history and physical examination can help raise suspicion. The following screening questions help identify a patient with a communicable disease.

* Do you have a new or worsening cough or shortness of breath?
* Do you have a fever?
* Have you had shakes or chills in the past 24 hours?
* Have you had an abnormal temperature (>38 °C)?
* Have you taken medication for fever?
* Have you recently returned, or been in contact with someone who has recently returned, from a geographic region where an outbreak is underway?

A screening physical examination will also identify obvious signs of a communicable disease. They may include any new symptom of infection (fever, headache, muscle ache, cough, sputum, weight loss, and exposure history), rash, diarrhea, skin lesions, or draining wounds.

### Influenza

Influenza classically presents with the abrupt onset of fever, usually 38–40 °C, sore throat, non-productive cough, myalgias, headache, and chills. Influenza is caused by a virus with three subtypes: A, B, and C. Influenza A causes more severe disease and is mainly responsible for pandemics. Influenza A has different subtypes determined by surface antigens H (hemagglutinin) and N (neuraminidase). Influenza B causes more mild disease and mainly affects children. Influenza C rarely causes human illness and has not been associated with epidemics [5].

Influenza transmission occurs primarily through airborne spread when a person coughs or sneezes, but may also occur through direct contact of surfaces contaminated with respiratory secretions. Hand-washing and shielding coughs and sneezes help prevent spread. Influenza is transmissible from one day before symptom onset to about 5 days after symptoms begin and may last up to 10 days in children. Time from infection to development of symptoms is 1–4 days [6].

Influenza has been responsible for at least 31 pandemics in history. The most lethal “Spanish flu” pandemic of 1918–1919 is estimated to have caused 40 million deaths globally with 700,000 of those deaths occurring in the USA in a single year. In this pandemic, deaths occurred mainly in healthy 20–40 year olds, which differs from the usual young children and elderly pattern of mortality and morbidity in the seasonal outbreaks of influenza.

Influenza vaccine is the principal means of preventing influenza morbidity and mortality. The vaccine changes yearly based on the antigenic and genetic composition of circulating strains of influenza A and B found in January to March, when influenza reaches its peak activity. When the vaccine strain is similar to the circulating strain, influenza vaccine is effective in protecting from illness 70–90% of those younger than age 65 who are vaccinated. Among those aged 65 and older, the vaccine is 30–40% effective in preventing illness, 50–60% effective in preventing hospitalization, and up to 80% effective in preventing death. EMS personnel should be immunized annually, typically in October.

Four antiviral drugs are available for preventing and treating influenza in the US. When used for prevention of influenza, they can be 70–90% effective. Antiviral agents should be used as an adjunct to vaccination, but should not replace vaccination. The Centers for Disease Control and Prevention (CDC) recommends influenza antivirals for individuals who have not as yet been vaccinated at the time of exposure, or who have a contraindication to vaccination, and are also at high risk of influenza complications. Also, if an influenza outbreak is caused by a variant strain of influenza not controlled by vaccination, chemoprophylaxis should be considered for health care providers caring for patients at high risk of influenza complications, regardless of their vaccination status. In the setting of an influenza outbreak, EMS systems may opt to restrict duties for EMS providers who are not immunized or who have not yet received prophylactic antiviral therapy in an attempt to prevent spread of the outbreak [5].

### Avian influenza

Influenza A virus infects humans and also can be found naturally in birds. Wild birds carry a type of influenza A virus, called avian influenza virus, in their intestines and usually do not get sick from them. However, avian influenza virus can make domesticated birds (including chickens, turkeys, and ducks) quite ill and lead to death.

The avian influenza virus is chiefly found in birds, but infection in humans from contact with infected poultry has been reported since 1996. A particular subtype of avian influenza A virus, H5N1, is highly contagious and deadly among birds. In 1997 in Hong Kong, an outbreak of avian influenza H5N1 occurred not only in poultry but also in 18 humans, six of whom died. In subsequent infections of avian influenza H5N1 in humans, more than half of those infected with the virus have died. In contrast to seasonal influenza, most cases of avian influenza H5N1 have occurred in young adults and healthy children who have come into contact with infected poultry, or surfaces contaminated with H5N1 virus. By the end of 2007, there were 346 documented human infections with influenza H5N1 and 213 deaths (62%). Although transmission of avian influenza H5N1 from human to human is rare, inefficient, and unsustained, there is concern that the H5N1 virus could adapt and acquire the ability for sustained transmission in the human population. If the H5N1 virus could gain the ability to transmit easily from person to person, a global influenza pandemic could occur. A vaccine is now available for H5N1, as a two-dose regimen. It is not currently available or advocated for use in the general population, but is being stockpiled by several countries. The H5N1 virus is resistant to the adamantanes, but likely sensitive to the neuraminidase inhibitors [7].

In April 2009, a novel influenza A (H1N1) virus, similar to but genetically and antigenically distinct from other influenza A (H1N1) viruses, was determined to be the cause of respiratory illnesses that spread across North America and many areas of the world. Influenza morbidity caused by the 2009 pandemic influenza A (H1N1) remained above seasonal baselines throughout spring and summer 2009, and was the first pandemic since 1968. Data from epidemiological studies conducted during the 2009 influenza A (H1N1) pandemic indicate that the risk for influenza complications among adults aged 19–64 years who had 2009 pandemic influenza A (H1N1) was greater than typically occurs for seasonal influenza [8].

### Tuberculosis

Tuberculosis is caused by the *Mycobacterium* tuberculosis complex. The majority of active TB is pulmonary (70%), while the remainder is extrapulmonary (30%). Patients with active pulmonary TB will typically present with cough, scant amounts of non-purulent sputum and possibly hemoptysis. Systemic signs such as weight loss, loss of appetite, chills, night sweats, fever, and fatigue may also be present. Clinically, the EMS provider will be unable to distinguish pulmonary TB from other respiratory illnesses. However, certain risk factors may alert the EMS provider to the possibility of tuberculosis: immigration from a high-prevalence country, homelessness, exposure to active pulmonary TB, silicosis, HIV infection, chronic renal failure, cancer, transplantation, or any other immunosuppressed state [9,10].

Active pulmonary TB is transmitted via droplet nuclei from people with pulmonary tuberculosis during coughing, sneezing, speaking, or singing. Procedures such as intubation or bronchoscopies are high risk for the transmission of TB. Respiratory secretions on a surface rapidly lose the potential for infection. The probability of infection is related to duration of exposure, distance from the case, concentration of bacilli in droplets, ventilation in the room, and the susceptibility of the host exposed. Effective medical therapy eliminates communicability within 2–4 weeks of starting treatment [11].

If transporting a patient who is known to have or suspected of having TB, respiratory precautions should be followed by EMS providers, including use of submicron masks. Patients should cover their mouths when coughing or sneezing, or wear surgical masks. In the event of suspected exposure to a patient with active pulmonary tuberculosis, report the case and the exposure to the EMS system or public health authority. Close contacts should be monitored for the development of active TB symptoms. Two tuberculin skin tests should be performed, based on public health recommendations, on those closely exposed to patients with active TB [12]. Because the incubation period after contact ranges from 2 to 10 weeks, the first test is typically done as soon as possible after exposure, and the second test is typically done 8–12 weeks after the exposure. If the EMS provider or contact develops either active TB with symptoms or latent asymptomatic TB, as diagnosed with a new positive TB skin test, treatment should be offered.

Treatment for latent TB is typically isoniazid (INH) for 6–9 months [13]. This single-drug regimen is 65–80% effective. For active TB, a four-drug regimen is typically used for 2 months: isoniazid, rifampin, pyrazinamide, and ethambutol. This is followed by INH and rifampin for an additional 4 months. Several forms of multidrug-resistant TB and extensively drug-resistant TB have been identified [14]. These forms require an aggressive, multidrug regimen for prolonged periods of time and are dependent on the organism’s patterns of drug sensitivity and resistance. In all cases, a physician skilled in management of TB must initiate and monitor treatment and provide suitable follow-up. Public health officials must also be notified [15].

### SARS and related coronaviruses

It is difficult to distinguish SARS from other respiratory infections because patients present with symptoms similar to other febrile respiratory illnesses [16,17]. Fever is the most common and earliest symptom of SARS, often accompanied by headache, malaise or myalgia [18]. In patients with SARS, high fever, diarrhea, and vomiting were more common compared to patients with other respiratory illnesses [19]. Cough occurred later in the course of diseaseand patients were less likely to have rhinorrhea or sore throat compared to other lower respiratory tract illness [20]. Since clinical features alone cannot reliably distinguish SARS from other respiratory illnesses, knowledge of contacts is essential [21]. Contact with known SARS patients, contact with SARS-affected areas, or linkage to a cluster of pneumonia cases should be obtained in the history [22].

Severe acute respiratory syndrome was first recognized in 2003 after outbreaks occurred in Toronto, Singapore, Vietnam, Taiwan, and China [23]. The illness is caused by a coronavirus. About 11% of those who develop SARS eventually die, usually due to respiratory failure. The case fatality is less than 1% for SARS patients less than age 24 and up to 50% for those age 65 and greater or those with comorbid illness [24].

The coronavirus is found in respiratory secretions, urine, and fecal matter. Transmission is via droplets spread from respiratory secretions, with a high risk of transmission during intubation and procedures which aerosolize respiratory secretions. Transmission can also occur from fecal or urine contamination of surfaces. There have been no confirmed cases of transmission from asymptomatic cases.

If SARS is suspected, EMS providers must use all routine practices and additional precautions [25]. EMS systems may also elect to limit or avoid any procedures that may increase risk to EMS personnel. These include tracheal intubation, deep suctioning, use of non-invasive ventilatory support, administration of nebulized medication, and any other procedure that may aerosolize respiratory secretions. During the SARS outbreaks in Toronto, EMS medical direction modified medical directives such that paramedics did not intubate patients or deliver nebulized therapy in the prehospital setting [26]. Finally, EMS personnel and systems should also notify the receiving facility of a patient suspected of SARS, permitting the staff to have appropriate PPE in place and a suitable isolation room prepared for the patient [27,28].

There have not been any cases of SARS infections since 2004 anywhere in the world. However, a novel coronavirus related to SARS emerged in 2012 to cause a number of fatal infections. This new virus is referred to as Middle East respiratory syndrome coronavirus, or MERS-CoV. As of 9 May 2014, 536 laboratory-confirmed cases have been reported to the World Health Organization [29]. Of those, 145 (27%) were fatal. All diagnosed cases were among people who resided in or traveled from one of four countries, Kingdom of Saudi Arabia, United Arab Emirates, Qatar, or Jordan, within 14 days of their symptom onset, or who had close contact with people who resided in or traveled from those countries. Cases with a history of travel from these countries or contact with travelers from these countries have been identified in residents of France, the United Kingdom, Tunisia, and Italy. Like SARS, this novel coronavirus has spread from ill people to others through close contact. However, the virus has not been shown to spread in a sustained way throughout communities. Two cases were reported in the United States, both of them imported by Americans working as health care providers in Saudi Arabia.

## Biological weapons

The CDC categorizes bioterrorism agents as shown in [Box 25.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/c25.xhtml#c25-fea-0001). Certain of these agents are discussed here; additional information about all agents is available via the CDC website ([www.bt.cdc.gov/bioterrorism/](http://www.bt.cdc.gov/bioterrorism/)). Some of the listed agents, such as botulisim toxin and ricin, are not infectious diseases but rather biological toxins.

## Box 25.1 Centers for Disease Control and Prevention categorization of bioterrorism agents (source: [www.bt.cdc.gov/agent/agentlist-category.asp](http://www.bt.cdc.gov/agent/agentlist-category.asp))

### Category A

High-priority agents include organisms that pose a risk to national security because they:

* can be easily disseminated or transmitted from person to person
* result in high mortality rates and have the potential for major public health impact
* might cause public panic and social disruption; and
* require special action for public health preparedness.
* Anthrax (*Bacillus anthracis*)
* Botulism (*Clostridium botulinum* toxin)
* Plague (*Yersinia pestis*)
* Smallpox (variola major)
* Tularemia (*Francisella tularensis*)
* Viral hemorrhagic fevers (filoviruses, e.g. Ebola, Marburg, and arenaviruses, e.g. Lassa, Machupo)

### Category B

Second highest priority agents include those that:

* are moderately easy to disseminate
* result in moderate morbidity rates and low mortality rates; and
* require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.
* Brucellosis (*Brucella* species)
* Epsilon toxin of *Clostridium perfringens*
* Food safety threats (e.g. *Salmonella* species, *Escherichia coli* O157:H7, *Shigella*)
* Glanders (*Burkholderia mallei*)
* Melioidosis (*Burkholderia pseudomallei*)
* Psittacosis (*Chlamydia psittaci*)
* Q fever (*Coxiella burnetii*)
* Ricin toxin from *Ricinus communis* (castor beans)
* Staphylococcal enterotoxin B
* Typhus fever (*Rickettsia prowazekii*)
* Viral encephalitis (alphaviruses, e.g. Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis)
* Water safety threats (e.g. *Vibrio cholerae*, *Cryptosporidium parvum*)

## Category C

Third highest priority agents include emerging pathogens that could be engineered for mass dissemination in the future because of:

* availability
* ease of production and dissemination
* potential for high morbidity and mortality rates and major health impact
* emerging infectious diseases such as Nipah virus and hantavirus.

### Anthrax

The symptoms of anthrax are determined by the route of transmission of the bacterium which causes anthrax, *Bacillus anthracis*. There are three forms of anthrax: cutaneous, gastrointestinal, and inhalational [30,31].

Cutaneous anthrax presents as a small, painless, pruritic papule, which progresses to a vesicle which ruptures and erodes, leaving a necrotic ulcer that later gets covered with a black, painless eschar. Pathognomonic features of anthrax include the presence of an eschar, lack of pain, and edema out of proportion to the size of the lesion. Associated symptoms include swelling of adjacent lymph nodes, fever, malaise, and headache. Cutaneous anthrax is caused by *B. anthracis* entering a cut or abrasion in exposed areas of the body such as the face, neck, arms, and hands. The case-fatality rate can be as high as 20% without antibiotic therapy, but 1% with therapy.

Gastrointestinal anthrax presents with more non-specific symptoms. There are two forms: oropharyngeal and intestinal. Oropharyngeal anthrax starts with edematous lesions at the base of the tongue or tonsils that progress to necrotic ulcers with a pseudomembrane. Sore throat, fever, cervical adenopathy, and profound oropharynx edema are associated symptoms. This form of anthrax initially presents with fever, nausea, vomiting, abdominal pain, and tenderness that may progress to hematemesis, bloody diarrhea, and abdominal swelling from hemorrhagic ascites. Gastrointestinal anthrax is caused by consumption of meat contaminated with anthrax. The case-fatality rate of gastrointestinal anthrax is estimated to be 25–60%.

Inhalational anthrax initially causes non-specific symptoms that mimic influenza. These early symptoms are low-grade fever, non-productive cough, malaise, and myalgias. Two to three days later, the patient rapidly progresses to severe dyspnea, profuse sweating, high fever, cyanosis, and shock. Hemorrhagic meningitis occurs in up to half of patients. It is critical that the EMS provider attempt to distinguish any influenza-like illness from anthrax, because of the narrow window of opportunity for successful treatment. Nasal congestion and rhinorrhea are not common with inhalational anthrax, but more common with influenza-like illness. Further, shortness of breath is more common in inhalational anthrax and less common in influenza-like illness. Chest x-ray demonstrates mediastinal widening or pleural effusion. These findings are the most accurate predictors of inhalational anthrax. Inhalational anthrax can be caused by inhalation of spores, commonly seen following intentional release of aerosolized anthrax, or from the processing of materials from infected animals, such as goat hair. The case-fatality rate of inhalational anthrax can be as high as 97% without antibiotics and up to 75% with antibiotics.

Human-to-human transmission of any form of anthrax is rare. A vaccine for anthrax is licensed in the US and is administered in a six-dose schedule with annual boosters thereafter. Vaccination is not currently recommended for emergency first responders or medical personnel. However, it may be indicated for certain military personnel. In cases of deliberate use of anthrax as a biological weapon, first responders should wear a full-face respirator with HEPA filters or a self-contained breathing apparatus, gloves, and splash protection. If clothing is contaminated, it should be removed and placed in plastic bags. Soap and copious amounts of water should be used to decontaminate skin, and bleach should be applied for 10–15 minutes in a 1:10 dilution if there is gross contamination. If exposure to aerosolized anthrax occurs, postexposure prophylaxis (PEP) with ciprofloxacin or doxycycline should begin and continue for 60 days. Vaccination for PEP should be administered because of the persistence of anthrax spores in the lungs. Quarantine is not appropriate for persons exposed to anthrax as they are not contagious. Patients suspected of being infected with anthrax and requiring hospitalization should be immediately started on IV antibiotics [32–34].

### Botulism

Botulism is caused by a neurotoxin produced by *Clostridium botulinum*, which ultimately leads to a flaccid paralysis. There are four forms of botulism based on site of toxin production: food-borne, wound, intestinal, and inhalational [35].

In food-borne botulism, early symptoms are non-specific gastrointestinal symptoms, and include nausea, vomiting, and diarrhea. This may progress to blurred vision, double vision, dry mouth, and difficulty in swallowing, breathing, and speaking. Descending muscle paralysis occurs, starting with shoulders and progressing to upper arms, lower arms, thighs, and then calves. Respiratory muscle paralysis ultimately leads to death. Food-borne botulism is caused by the ingestion of *Clostridium botulinum* toxin present in contaminated food, or by deliberate contamination as a biological weapon. The case-fatality rate in the USA is 5–10%.

Intestinal botulism is rare and occurs mainly in infants. It causes a striking loss of head control, constipation, loss of appetite, weakness, and an altered cry. Intestinal botulism occurs with ingestion of botulism spores, rather than ingestion of toxin. Spores, which may come from honey, food and dust, germinate in the colon. The case-fatality rate of hospitalized cases is less than 1%.

Wound botulism causes the same symptoms as food-borne botulism. This is rare and is caused by spores entering an open wound from soil or gravel. Inhalational botulism would be the most common form if botulinum toxin were used as a biological weapon. Symptoms would be the same as food-borne botulism, but the incubation period may be longer.

There are no reported cases of person-to-person transmission of botulism. Therefore, EMS providers do not require any special equipment to manage a patient with suspected or known botulism infection. In the case of suspected aerosol exposure to the toxin, clothing should be removed and placed in plastic bags, and the exposed person should shower thoroughly.

### Plague

Plague is caused by the bacterium *Yersinia pestis*. Initial signs and symptoms may be non-specific and include fever, chills, sore throat, malaise, and headache. Tender, swollen, warm, and suppurative lymph nodes, mainly in the inguinal area, often follow. Patients infected with the plague may progress to septicemia, meningitis, pneumonia, or shock. Untreated plague has a case-fatality rate of 50–90%. If treated, the death rate is 15%.

Plague is transmitted to humans by bites, scratches, respiratory droplets, or by direct skin contact. Bites from infected rat fleas are the most frequent source of transmission, but bites or scratches from cats may also transmit plague. With deliberate use as a biological weapon, plague bacilli would be transmitted via the aerosolized airborne droplets. Direct contact with tissue or body fluids of a plague-infected sick or dead animal can lead to transmission to humans through a break in the skin [36,37].

For patients with pneumonic plague, strict isolation is indicated with precautions against airborne spread until 48 hours after start of antibiotic therapy. Close contacts of patients infected with pneumonic plague should receive chemoprophylaxis and be placed under surveillance for 7 days. Articles soiled with sputum or purulent discharges should be disinfected.

*Yersinia pestis* could be used as a potential biological weapon disseminated through aerosol spread and leading to pneumonic plague. Many patients presenting with fever and cough, particularly hemoptysis in a fulminant course with high case-fatality, should raise suspicions for a biological weapon [38–40].

### Smallpox

There are two clinical forms of smallpox: variola major and variola minor. Variola major is the more severe form of disease with a case-fatality rate of greater than 30%, while variola minor is less severe form with a case-fatality rate less than 1%. All smallpox begins with a prodrome that lasts 2–4 days. The prodrome starts abruptly and consists of fever, headache, nausea, vomiting, muscle pain, headache, and malaise.

Variola major has four principal clinical presentations: ordinary, modified, flat, and hemorrhagic. Ordinary is the most common, occurring in 90% of cases. Modified is mild. Flat and hemorrhagic forms are uncommon, but usually severe and fatal [41].

In ordinary smallpox, after the prodrome, mucous membrane lesions called enanthem begin in the mouth. This consists of red spots on the tongue and mucosa which enlarge and ulcerate quickly, followed by a rash on the face. The rash then progresses from the proximal extremities to the distal extremities and trunk within 24 hours. The macules progress to papules, vesicles, pustules, and crusts. Crusts later separate leaving depigmented skin and pitted scars. The case-fatality rate for ordinary smallpox is about 30%.

Modified smallpox occurs in previously vaccinated persons. During the prodrome, fever is absent and the illness is less severe. The skin rash is more superficial and progresses quickly, and lesions are less numerous. This form is more easily confused with chickenpox.

Flat smallpox has a more severe prodrome with soft, flat skin lesions that contain little fluid. Most cases are fatal.

Hemorrhagic smallpox consists of a more severe and prolonged prodrome along with extensive bleeding into the skin, mucous membranes, and gastrointestinal tract. The skin rash remains flat and does not progress beyond the vesicular stage. Hemorrhagic smallpox is usually abruptly fatal between the 5th and 7th days of illness. The case-fatality rate for hemorrhagic and flat smallpox is greater than 90%.

Variola minor produces a rash like ordinary smallpox but results in much less severe systemic reactions.

Transmission is via virus inhalation from airborne droplets or fine particle aerosols from the oral, pharyngeal, or nasal mucosa of an infected person, physical contact with an infected person, or with contaminated articles through skin inoculation. EMS personnel should be able to identify the rash due to smallpox, and try to distinguish it from other less virulent diseases, particularly chickenpox. Information to differentiate these illnesses from smallpox is available from the CDC at [www.bt.cdc.gov/agent/smallpox/](http://www.bt.cdc.gov/agent/smallpox/).

The last naturally occurring cases of smallpox were identified in 1977, and in 1980 the World Health Organization declared smallpox officially eradicated from the planet. While there are only two sanctioned repositories of smallpox virus in storage and for research purposes, there may exist virus samples outside these two sanctioned repositories. Any new suspected cases of smallpox are a medical and public health emergency. Strict respiratory and contact isolation of confirmed or suspected smallpox cases must be undertaken.

Medical personnel in contact with suspected or confirmed smallpox cases should be wearing N95 fit-tested masks, and use other standard precautions. All bedding and clothing should be autoclaved or laundered in hot water with bleach.

### Tularemia

Tularemia, caused by the bacterium *Francisella tularensis*, has various clinical manifestations related to the route of introduction. All forms have a sudden onset of non-specific influenza-like symptoms, including high fever, cough, sore throat, chills, headache, and generalized body aches. Sometimes nausea, vomiting, and diarrhea may also occur. All forms may lead to sepsis, pneumonia, and meningitis. The clinical forms include ulceroglandular, glandular, oculoglandular, septic, oropharyngeal, and pneumonic [42].

Ulceroglandular tularemia is the most common form. It begins at the skin site of the bite of a tick or fly. A papule appears that becomes pustular and later ulcerates, and finally develops into an eschar. Regional lymph nodes become swollen, painful, and tender and rarely suppurate and discharge purulent material. Glandular tularemia has no skin involvement, only regional lymphadenopathy similar to that which occurs with ulceroglandular disease. Oculoglandular tularemia is caused by the bacillus entering the eye. Conjunctival ulceration occurs followed by regional lymphadenopathy of the cervical and preauricular nodes. Septic tularemia begins with non-specific symptoms of fever, nausea, vomiting, and abdominal pain, eventually leading to confusion, coma, multisystem organ failure, and septic shock.

Oropharyngeal tularemia is caused by consumption of contaminated water or food, leading to exudative pharyngitis which may be accompanied by oral ulceration. Abdominal pain, diarrhea, and vomiting may accompany this type. Regional lymphadenopathy occurs affecting the cervical and retropharyngeal nodes.

Pneumonic tularemia may be caused by lung exposure to an infective aerosol from soil, grain, or hay, or due to deliberate use of an infective aerosol as a bioterrorist attack. The clinical presentation may be cough, pleuritic pain, and rarely dyspnea. Despite the lungs being the primary route of entry, it is not uncommon for tularemic pneumonia to present as non-specific systemic signs without respiratory symptoms, and often a normal chest-x-ray.

Tularemia is transmitted through the skin, mucous membranes, lungs, and gastrointestinal tract. The bacteria pass through the skin by bites, oropharyngeal mucosa, and conjunctiva by contaminated water, or by contaminated blood or tissue while handling carcasses of infected animals. Through the gastrointestinal tract, it is transmitted by ingestion of insufficiently cooked meat of infected animals or by consumption of contaminated water. Finally, tularemia can be transmitted through the lungs by contaminated soil, by handling contaminated furs, or by deliberate aerosolization of the bacterium as a biological weapon. The incubation period is usually 3–5 days but can range from 1 to 14 days.

There is no documented person-to-person transmission of tularemia. Routine precautions are adequate when transporting and caring for patients. The vehicle and equipment, however, must be thoroughly cleaned and decontaminated after patient transport.

### Viral hemorrhagic fevers

Viral hemorrhagic fevers are caused by different families of viruses and lead to similar clinical syndromes. In the case of bioterrorist attack, it is essential that first responders are able to recognize the illness associated with the intentional release of the biological agent.

In hemorrhagic fever, the initial signs and symptoms are non-specific and include high fever, headache, muscle aches, and severe fatigue. There may be associated gastrointestinal symptoms of nausea, vomiting, diarrhea, and abdominal pain. Respiratory symptoms of cough and sore throat may also occur. About 5 days after the onset of illness, a truncal maculopapular rash develops in most patients. As the disease progresses, bleeding occurs from internal organs, the mouth, eyes, ears, and from under the skin, which would be evidenced as petechiae and ecchymosis. Shock, coma, seizures, and kidney failure may ensure in severe cases.

Viral hemorrhagic fevers are caused by viruses in four families: arenaviruses, bunyaviruses, flaviviruses, and filoviruses, causing diseases such as Ebola hemorrhagic fever, hantavirus pulmonary syndrome, Lassa fever, Marburg hemorrhagic fever, hemorrhagic fever with renal syndrome, and Crimean-Congo hemorrhagic fever [43]. Transmission occurs when humans have direct contact with infected animals, mainly rodents, or are bitten by a mosquito or tick vector. Once a person has become infected, some viruses can be transmitted from person to person, mainly by close contact with infected people but also indirectly by objects contaminated with infected body fluids.

Transmission of viral hemorrhagic fever mainly occurs in the later stages of illness when the patient suffers vomiting, diarrhea, shock, and hemorrhage. In the case of Ebola virus, there are reports of transmission within a few days of the onset of fever. The incubation period ranges from 2 days to 3 weeks, and no transmission has been documented during the incubation period.

While there is currently no vaccine for viral hemorrhagic fevers, except for yellow fever and Argentine hemorrhagic fever, significant research and clinical trials are underway to develop a vaccine for Ebola. There are also several experimental treatments under development for patients who have contracted Ebola. To prevent infection, contact with rodents and bites from ticks and mosquitos should be prevented. Person-to-person transmission can be prevented by strict adherence to routine precautions. In addition, patients with known or suspected viral hemorrhagic fever must be isolated. While this is not routinely possible in the EMS setting, there exist portable isolation systems that can enhance the ability to isolate patients with active symptoms of viral hemorrhagic fever during prolonged or interfacility critical care transports. The transport vehicle itself can also serve as an isolation unit, enabling the patient to be isolated from the scene and while in transit.

If personnel are exposed to viral hemorrhagic fever, they should be placed under surveillance for fever. The World Health Organization and CDC have prepared a number of documents specific to viral hemorrhagic fever management and control, with detailed and comprehensive strategies to prevent spread and protect health care workers during an outbreak [44–47]. In 2014, an outbreak of Ebola viral hemorrhagic fever was declared in Guinea, Liberia, Sierra Leone, and Nigeria. As of 16 August 2014, there were 2240 confirmed and suspected cases, and 1229 deaths. Of particular interest was the air medical evacuation of two American health care workers infected with Ebola from Liberia to a hospital in the United States in August 2014. Due to the rapidly evolving nature of this recent Ebola outbreak, the CDC is maintaining up to date information, including methods to prevent disease transmission [48].

## Other infections

### Chickenpox – varicella zoster virus

Varicella zoster virus (VZV) causes two distinct diseases: chickenpox and “shingles” (herpes zoster). Acute chickenpox is highly contagious and usually runs its course in about a week or two, producing immunity, but VZV is not eliminated from the body. The virus becomes dormant in the sensory ganglia and may reactivate decades later to produce zoster [49]. To decrease the incidence of chickenpox in adults who were never exposed to VZV as a child, routine childhood vaccination began in 1995. The full vaccine regimen (two doses) is 90–100% protective against chickenpox and “virtually 100% effective against severe disease [49].” Serological screening for VZV IgG is indicated for health care professionals who do not have a documented history of chickenpox. VZV is common, so ensuring prehospital employees are immune prior to patient care is important and cost-effective. Only immune health care professionals should care for patients with chickenpox or shingles. If a pregnant EMS provider has a documented history of chickenpox or has positive titers, she is considered immune and can care for patients. Both she and the fetus are protected.

Non-immune adults exposed to either chickenpox or zoster can develop acute chickenpox, complications of which include pneumonia, encephalitis, and death. Non-immune personnel exposed to chickenpox or disseminated zoster must avoid patient contact from 10 days after the exposure (the incubation period) until day 21 [49]. An exposure is defined as a breach of contact precautions (such as localized direct contact with uncovered lesions) and/or breach of airborne precautions (chickenpox or disseminated zoster).

If an unprotected exposure occurs to a non-immune health care professional, unless that person is pregnant or immunocompromised, the vaccine should be given within 3–5 days. If a pregnant or immunocompromised worker is exposed, varicella zoster immune globulin (VZIG) should be offered up to 96 hours after exposure.

### Meningitis – bacterial

*Neisseria meningitidis*, or meningococcus, is an uncommon nosocomial transmission [50–52] but it is possible to contract the disease from a patient infected with *N. meningitidis* when routine mask use on the patient is not observed. In addition, this disease has a high case-fatality rate (10%) [52]. All health care professionals should understand that preventing transmission of meningococcus requires use of droplet precautions and that it is not an airborne transmitted disease.

Postexposure prophylaxis should be administered when close, unprotected (mask) contact occurs, such as while performing unprotected mouth-to-mouth resuscitation on an infected patient, or if splash/splatter of secretions into mucous membranes occurs (as with suctioning, intubation, vomiting, coughing, or endotracheal tube management) [52]. Simple proximity to the patient does not qualify as close contact, unless the EMS provider was <3 feet from the patient for >8 hours [52]. Because many patients with symptoms consistent with *N. meningitidis* infection are actually infected with viruses or other organisms, PEP should be given only after substantial exposure (as defined above) to a patient with culture- or Gram stain-proven meningococcus.

Patients may be considered infectious for 1 week before the onset of symptoms and for 24 hours after effective treatment began. Exposed workers may return to duty 24 hours after PEP was begun. There is time to determine if *N. meningitidis* is present before empirically administering prophylaxis to many EMS personnel unnecessarily. PEP for meningococcus should be started within 24 hours (but may be begun up to 10 days) after exposure; options include ceftriaxone 250 mg IM, ciprofloxacin 500 mg PO once, or rifampin 600 mg PO bid for 2 days [52].

The medical director plays an important role in ensuring that prehospital personnel are treated quickly and appropriately when a true exposure to *N. meningitidis* has taken place. Often one of the following situations occurs.

* A crew transports a patient suspected of having meningitis to an ED and calls the infection control officer with concerns about exposure.
* Hospital infection control personnel attempt to contact exposed prehospital personnel involved with treatment/transport of an inpatient now diagnosed with meningococcus.

Usually the infection control officer is directly involved, but the medical director can assist hospital infection control, occupational health service, and ED providers by including prehospital providers in the pool of exposed providers. The designated infection control officer should gather specific information, confirming which (if any) prehospital personnel were close enough to the patient to warrant having them report for evaluation and possible PEP administration.

Routine vaccination is not recommended for any health care worker group, including fire/EMS personnel. However, such personnel may fall into any of the following categories, and if so, they should contact their regular provider or occupational health service to consider vaccination: persons aged 19–55 years who are at increased risk for meningococcal disease, including college freshmen living in dormitories, military recruits, microbiologists routinely exposed to isolates of *N. meningitidis*, travelers to or residents of countries in which *N. meningitidis* meningitis is hyperendemic or epidemic, persons with terminal complement-component deficiencies, and persons with anatomical or functional asplenia [52].