Contents

INTRODUCTION ................................................................................................................... 4
  Learning Objectives ........................................................................................................ 4

HISTORY ............................................................................................................................ 5

BASIC BIOLOGY OF PATHOGENS ..................................................................................... 5
  Bacteria ............................................................................................................................... 6
    Biology ............................................................................................................................................................. 6
    Bacterial Diseases ......................................................................................................................... 6
    Treatment and Prevention .......................................................................................................... 7
  Viruses ........................................................................................................................................... 7
    Biology ............................................................................................................................................................. 7
    Viral Diseases ............................................................................................................................................... 8
    Treatment and Prevention .............................................................................................................. 9
  Fungi .................................................................................................................................................. 10
    Biology ........................................................................................................................................................... 10
    Fungal Diseases .............................................................................................................................. 10
    Treatment and Prevention ........................................................................................................ 10
  Parasites ............................................................................................................................................ 10
    Biology ........................................................................................................................................................... 10
    Parasitic Diseases ......................................................................................................................... 11
    Treatment and Prevention ........................................................................................................ 11
  Prions ............................................................................................................................................... 11

THE IMMUNE SYSTEM ........................................................................................................ 12
  Barriers to disease ............................................................................................................... 13
    Immune Cells .......................................................................................................................................... 13
    Allergy and Anaphylaxis ............................................................................................................ 13
    Auto-immune Diseases ............................................................................................................. 14
  Hygiene Hypothesis ............................................................................................................... 14

BLOODBORNE DISEASES .................................................................................................. 14
  HIV/AIDS ............................................................................................................................... 14
  Hepatitis B and C .................................................................................................................... 15

AIRBORNE DISEASES ......................................................................................................... 16
  Tuberculosis ............................................................................................................................ 16
  Influenza ...................................................................................................................................... 16
  Meningitis ..................................................................................................................................... 17

OTHER DISEASES ............................................................................................................... 18
  Methicillin-resistant Staphylococcus aureus (MRSA). ................................................................. 18
  Norovirus ............................................................................................................................... 19
Ebola ................................................................. 19
Severe Acute Respiratory Syndrome (SARS) ................................................................. 20
Middle East Respiratory Syndrome (MERS) ................................................................. 21
SUMMARY ......................................................................................................................... 21
APPENDIX A: INFECTIOUS DISEASES ............................................................................. 22
APPENDIX B: PERSONAL PROTECTIVE EQUIPMENT (PPE) ............................................. 26
  Donning PPE................................................................................................................. 26
  Doffing PPE .................................................................................................................. 26
  Hand Washing ........................................................................................................... 27
  Equipment Decontamination ....................................................................................... 27
  Masks .......................................................................................................................... 27
  Eye Protection ............................................................................................................ 27
  Gloves .......................................................................................................................... 28
  Sharps .......................................................................................................................... 28
APPENDIX C: EXPOSURES ............................................................................................... 29
  Percutaneous Exposures ............................................................................................ 29
  Skin or Mucus Membrane Exposures ......................................................................... 29
  Post Exposure Prophylaxis (PEP) for Bloodborne Diseases ..................................... 29
  Post Exposure Prophylaxis (PEP) for Airborne Diseases ......................................... 29

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INTRODUCTION

As health care providers you come in contact with various diseases and infections from the patients that you treat. This overview is designed to give you, the prehospital healthcare provider, a summary of different types of infectious diseases that you may come in contact with and their common routes of transmission. As with many things, knowledge and awareness are your first lines of defense. The information presented here may go beyond what you will use on an average call, but no one knows when the next hemorrhagic fever (like Ebola) or mouse-borne illness (like Hanta) or respiratory infection like severe acute respiratory syndrome (SARS) will present itself in the form of a 911 call. The knowledge you gain in this course will help you think critically about infectious disease both at work and at home.

Since most of us in this country have access to clean water, good nutrition, health care, and effective vaccines, we live in a place and time in history where we are mostly free from diseases that would have sickened and killed our ancestors as recently as 100 years ago. This is still not true in of much of the world. While the rates of non-infectious diseases such as stroke, COPD, and heart attack are increasing, infectious disease remains the major cause of morbidity and mortality worldwide. Many more people do not die from infectious diseases, but suffer the consequences with a range of disabilities such as weakness, malnutrition, blindness, anemia, and cognitive impairment.

The best form of prevention is through good hand washing before and after each patient contact, and by using personal protective equipment (PPE). It is important you know the difference between an exposure and infection. An exposure occurs when that a prehospital healthcare provider has come in contact with an individual who has a specific disease or infection. For an infection to occur in a prehospital healthcare provider, the source patient has to have a high viral load, there has to be a mode of transmission via broken skin or mucus membrane contact, additionally the prehospital care provider must have an immune system that is not able to handle the insult.

In the course of your work as prehospital healthcare provider, you are frequently exposed to disease. Whether or not you become infected depends on your recognition of the risk and your ability to protect yourself. You have a responsibility to educate yourself about the changing world of infectious disease. This is the best way to take care of your patients and keep you and your family safe. By having a good understanding of the disease process, utilizing good hand washing practices, using PPE, and following a post exposure plan, it will help reduce your risk of acquiring an infectious disease.

Learning Objectives

At the end of this overview, you will be able to:

- Identify the basic biology and paths of transmission of common pathogens.
- Identify the characteristics of infectious diseases that are a threat to EMS providers.
- Distinguish between the infectious diseases EMS providers can encounter.
- Describe the appropriate measures for protecting yourself against infectious diseases.
- Explain the appropriate actions to take for exposure to an infectious disease.


HISTORY

Until the invention of the microscope and the discovery of microbes, it must have seemed inconceivable that something as small as a bacteria or a virus could sicken and even kill a human being.

In the days before vaccination, antibiotics, or medications, a simple bacterial infection, a parasitic disease, or a viral infection could kill thousands. Until modern times, infectious disease was the number one cause of death for all age groups.

In the 1800s, diseases like cholera were attributed to bad air coming from cesspools, swamps, and dumps. Today we know that cholera is spread by infected feces. Part of our understanding comes from Dr. John Snow, who in 1854, discovered that most of the cholera deaths in a particular neighborhood in London occurred among people who drank the water from one pump. Further investigation revealed that the well was contaminated by fecal material from a nearby cesspool. When the pump handle was removed so people could no longer drink water from that pump, the cases of cholera dropped dramatically. While Dr. Snow is often considered the father of modern epidemiology and public health, at the time, he had no idea what type of agent caused the disease.

That investigation was left to three scientists: Louis Pasteur, Joseph Lister, and Robert Koch. Pasteur discovered that the infectious agent causing milk to sour (a bacteria) was alive, and that it could be killed by heat, a process we now call pasteurization. Lister, a surgeon, realized that infection in his patients could be caused by a similar agent, and that infection could be prevented by keeping such agents away from the operating field. “Listerine,” though a different chemical, pays tribute to Dr. Lister. Finally, Koch, using a microscope and special stains, identified many bacteria, including those that cause anthrax, cholera, and tuberculosis.

The stage was set for our modern view of infectious disease. Let’s start with an introduction to the many different types of pathogens.

BASIC BIOLOGY OF PATHOGENS

What are pathogens? Put simply, they are disease-causing entities. They come from all walks of microbial life and vary greatly in their biology, appearance, and mode of action. The most familiar pathogens and the ones most likely to cause disease in your patients, are bacteria and viruses.
Bacteria

Biology

Bacteria are very simple, one-celled organisms. They are so small that several thousand would sit on the eraser of your pencil. Though you will see, there are things smaller than bacteria.

Bacterial reproduction is simple. One bacterium divides into two, and then each of those divide into two, and so on. This is a very efficient process. Given ample food, one bacterium can produce hundreds or thousands of descendants in just a day! This also explains why bacterial sepsis can be so devastating. The bacteria reproduce so quickly that it may be difficult for the body’s defenses to keep up.

Most bacteria are harmless. Many are helpful. Although you are probably unaware of them, you have millions of bacteria living in and on your body, on your skin, in your nose, in your mouth, and in your large intestine. You actually have ten times more bacterial cells in and on your body, than you have human cells! Scientists are learning more and more about this human “microbiome” and how essential these bacteria are. They help you digest your food, synthesize vitamins, and keep other pathogens such as fungi and yeast in check.

While most bacteria are harmless or even helpful, some bacteria can be harmful. Even good bacteria, such as the ones in the gut, can be harmful if they invade a part of the body that is normally sterile. For example, the bacteria Hemophilus and Neisseria live in the nasopharynx of some people, usually causing no trouble at all. However occasionally they may travel up into the nervous system and cause bacterial meningitis, a life-threatening illness, as well as one that is potentially transmissible.

How do bacteria do their damage? As part of their metabolism, bacteria release enzymes and other chemicals. Some of these can be harmful to human cells. In some bacterial infections, the bacteria die, and their disintegrating cell bodies cause a harmful reaction in our cells.

Bacterial Diseases

Examples of bacterial diseases which can be transmitted through a variety of means including direct contact, aerosol droplets, feces or soil:

- methicillin-resistant Staphylococcus aureus (MRSA)
- Staphylococcus (staph)
- Streptococcus (strep)
- tetanus
- botulism
- cholera
- tuberculosis
- anthrax
Treatment and Prevention

Bacterial infections are treated with antibiotics. Antibiotics such as penicillin and streptomycin are prepared from fungi, and they kill bacteria or prevent them from reproducing. Differences between bacterial cells and human cells explain why the drugs do not harm human cells.

Overuse or inappropriate use of antibiotics can cause antibiotic resistance. When this happens, a simple bacterial infection can become deadly and require stronger and stronger antibiotics to kill the bacteria. Bacterial infections such as MRSA, are becoming increasingly common, especially in hospitals where many patients are taking antibiotics. Some bacterial infections remain untreatable in spite of many trials of different antibiotics. Bacteria that are resistant to multiple antibiotics are frequently referred to as “superbugs”. Patients with these types of infections often die of overwhelming sepsis or other complications. Some scientists worry that we are approaching the limit of antibiotic effectiveness when treating antibiotic resistant infections.

Viruses

Biology

By the late 1880s, scientists realized that there were some diseases that were not caused by bacteria. The disease-causing agents could not be observed under the microscope, and they passed undeterred through the finest filter. Unlike bacteria, however, these mystery agents could not be coaxed to grow on culture plates. They seemed to only replicate in living cells.

By the early 1900s, the mystery was solved with the discovery of viruses. Viruses are truly tiny. Many millions could fit on a pinhead. They can only be seen in the most powerful of electron microscopes.

Viruses are not cells. They consist of a bit of genetic information (DNA or RNA) surrounded by a protein coat. Many also have the equivalent of hooks or suction cups that they use to attach themselves to a host cell.
How do viruses do their damage? When a virus enters the body, it immediately begins searching for a host cell to attack, and more specifically, for a particular attachment point on that cell. The type of cell attacked depends on the type of virus. Norovirus, which causes diarrhea, attacks the cells of the gastrointestinal (GI) tract. Rabies attacks the cells of the nervous system. Human immunodeficiency virus (HIV), the virus that causes acquired immune deficiency syndrome (AIDS), attacks the cells of the immune system.

Once it attaches, the virus enters the cell or injects its genetic information into the cell. At that point, a coup is underway. Directed by the genetic material of the virus, the cell turns its attention to the instructions encoded in the viral DNA or RNA. Those instructions direct the cell to produce more viral particles using the cell’s own energy and the cell’s own materials. At this point, the cell has been turned into a virus-producing factory, churning out viral particles, one after another. Soon the cell becomes full of virus, the dying cell’s membranes break down, and the viral particles escape to infect new cells.

**Viral Diseases**

Examples of viral diseases which can be transmitted through a variety of means including blood, aerosol droplets, insects and feces:

- influenza
- norovirus
- chickenpox
- smallpox
- human immunodeficiency virus (AIDS)
- measles
- common cold
- rabies
- West Nile virus
- severe acute respiratory syndrome (SARS)
- ebola
- hantavirus
- herpes
- hepatitis A, B, and C
Treatment and Prevention

How are viral diseases treated? Unlike most bacteria, which do their damage inside the body but outside living cells, viruses invade cells. As such, they are difficult to target for eradication. This is one of the reasons that we have no cure for the common cold or many other viral diseases.

Although there are antiviral medications, most treatment of viral diseases is symptomatic, supporting the patient while waiting for the immune system to gear up. The immune system can do what modern medicine has found so difficult. It targets infected cells and destroys them, without harming healthy cells. This explains why you are able to recover from a viral disease such as influenza or the common cold.

Antibiotics have no effect on viral infections, other than to prevent or treat a secondary bacterial infection. Taking antibiotics unnecessarily increases the risk of antibiotic resistance among bacteria, as well as damaging the healthy bacterial biome of the body.

However, although viral diseases are often difficult to treat, in many cases it is possible to prevent viral diseases through vaccination. Vaccination is an extension of the body’s own response to a viral infection. For example, if you came down with a case of chickenpox as a child, your body responded to the infection by making antibodies. These antibodies protect you from a future exposure by circulating in your blood. If, at some point in the future, you are exposed to chickenpox again, those antibodies recognize the virus and bind to it, creating a complex that the immune system can recognize and destroy.

A vaccine is made from a disabled version of a virus. The vaccine fools the body into thinking that it has been exposed to the virus, causing it to make antibodies that will protect against a future exposure.

It is reasonable to ask; given how successful vaccines have been against many diseases, why we don’t have a vaccine for all viral diseases? For example, why is there no vaccine against HIV disease, in spite of years of research? The answer is that some viruses, such as HIV, are exceedingly variable due to frequent mutations. So far, scientists haven’t been able to identify any portion of the viral protein coat that is consistent enough to make a suitable vaccine. High mutations rates and therefore changes in the virus are also the reasons that we need a flu shot every year.
Fungi

Biology

Fungi are unique organisms, neither animal nor plants, but living things that exist in a biological kingdom all their own. Examples of fungi include mushrooms, molds, and yeasts. Most have complicated lifecycles involving many different forms that look like entirely different organisms.

Fungi as a whole are incredibly beneficial. Fungi are responsible for decay, the breakdown of animal and vegetable matter. Imagine a world in which there is no decay, and everything that ever existed survives in its original form. Such would be a world without fungi.

Fungal Diseases

Serious fungal diseases in people are rare, though occasionally people who are immunosuppressed can develop fungal infections. These infections include cryptococcal meningitis, a fungal disease of the brain, and candidiasis, commonly known as “thrush,” a fungal disease of the mouth, genitals, and GI tract. Less serious are the dermatomycoses, which cause ringworm and athlete’s foot.

Sometimes fungal diseases occur when people alter the internal environment of their bodies. For example, a woman who takes antibiotics may develop a vaginal yeast infection. Why? Many beneficial bacteria live in the body and help control yeast and fungal growth. If the beneficial bacterial are eliminated along with the harmful bacterial, yeast overgrowth can occur.

Treatment and Prevention

Fungal diseases are treated by restoring the beneficial microbial biota in the body, such as with adding yogurt to a person’s diet, or with anti-fungal medications, such as clotrimazole, amphotericin B, and nystatin.

Parasites

Biology

Parasites are animals, big or small, that live in or on the body of another animal. As a lifestyle, parasitism is extremely successful. Virtually every species on the planet has its own list of parasites. Parasites range in size from that of a single cell, up to the size of a tapeworm, which can be up to 40 feet in length.

Parasites often have complex life cycles, spending part of the time in their human host and part of the time in another animal or in the soil or water. While some parasites are generalists, many are very specialized and can only survive in a particular species.
A good parasite lives without compromising its host, because if the host dies, the parasite will also, unless it can find a new host. In many developing countries, infection with parasites is nearly universal, causing general debilitation, malnutrition, malaise, anemia, and increased susceptibility to other infections and diseases. To quote Robert Desowitz, a well-known parasitologist, “Such persons may never know for a single day the feeling of perfect health.”

Parasitic Diseases

Examples of parasitic diseases which can be transmitted through a variety of means including water or food, insect bites or soil:

- giardia
- cryptosporidia
- toxoplasmosis
- tapeworms
- pinworms
- malaria
- hookworm
- trichinosis

Treatment and Prevention

Depending on the parasite, a variety of different medications are used to prevent and treat infections. Understanding the lifestyle of the parasite is often the key to its eradication. Filtering water, the use of bed-nets to prevent mosquito bites, and cooking food thoroughly can be effective techniques.

Prions

In the 1950s, an anthropologist by the name of Dr. Gajdusek described an unusual, progressive, and fatal neurologic disease in a tribe of people in New Guinea who practiced cannibalism. This disease, known as kuru caused significant changes in the brains of people who died of the disease; scientists
called it a spongiform encephalopathy. When the tribesmen and women ate the brains of those who had died, they too developed the disease. As expected, once cannibalism disappeared, so did kuru.

Fast forward to the 1980s, when cows in Great Britain began dying of a spongiform encephalopathy popularly called “mad cow disease.” Several hundred people over the next decade or two died of a human form of the disease called Creutzfeld-Jakob disease, likely becoming infected when they ate beef from a cow with the disease.

The causative agent of kuru, mad cow disease, and Creutzfeld-Jakob disease was likely a prion, a tiny bit of misshapen protein in the brain, which causes other proteins to become misshapen in a cascading effect. Prions are even smaller and more mysterious than viruses. There is no effective treatment for prion diseases. While exceedingly rare, prion diseases give us a glimpse into the cause of related and much more common diseases such as Alzheimer’s.

THE IMMUNE SYSTEM

The immune system is the unsung hero of the body. As a prehospital healthcare provider, you spend a great deal of time learning about the cardiovascular system, the respiratory system, the GI system. Malfunctions in these systems can cause disease, death or disability very quickly and very dramatically. Problems with the immune system, while more subtle, are also significant. AIDS is an example of a disease that attacks the immune system.

Unlike many of the body systems, the immune system does most of its work in secret. We are surrounded by potential pathogens, such as bacteria, viruses, parasites, fungi. These pathogens may be in the soil, in the water, in our food, on the surfaces that surround us, not to mention on the bodies of our friends, families, and pets. Even more remarkable, our own bodies play host to a variety of potential pathogens in the form of beneficial bacteria, any of which could become harmful if they get into the wrong place, such as in the urinary tract or the nervous system. Many of us are even infected with dormant forms of a variety of bugs, from tuberculosis to the parasite Toxoplasma, and we’re probably not even aware of it unless we’ve had a skin or blood test.

Surrounded by pathogens, why aren’t we sick every day? For this, we can thank the immune system, which is fighting battles against these pathogens on our behalf every minute of every day, mostly unnoticed.
**Barriers to disease**

How does the immune system protect us against disease? The first barriers are external. Intact skin is an excellent barrier. Beneficial bacteria colonize our skin, protecting us from “the bad guys.” Skin itself secretes antimicrobial compounds.

Beyond the skin, our mucus membranes are potential entry points for pathogens, but they are well defended. Saliva, tears, mucus, and vaginal secretions contain enzymes and other chemicals that have antimicrobial properties. Within the gastrointestinal and genitourinary systems, beneficial bacteria compete with disease-causing bacteria and fungi.

If a pathogen does evade these barriers and cause an infection, injured and dying cells release cytokines and other chemical messengers. The first response of the body to these chemicals is often inflammation, which causes redness, swelling, and pain. While this may appear bothersome rather than beneficial, inflammation increases blood flow to the area and attracts cells of the immune system to engage in battle. A little bit of inflammation in the right place is a good thing, but too much can be bad.

**Immune Cells**

Immune cells are leukocytes (white blood cells), which patrol the body in search of unwanted invaders. Using the circulatory system as their highway, they travel close to the site of infection and then make their way through the tissues to the battleground. The lymphatic system, a parallel system of vessels and ducts, also carries immune cells throughout the body, converging in the lymph nodes, which are staging areas for immune cells. You may have noticed swollen lymph nodes when you have an illness.

Different types of leukocytes specialize in bacteria, parasites, cells infected with virus, and even tumors. Some of these leukocytes appear to innately recognize pathogens; hence they are given the creative name natural killer cells. Others, such as B and T cells, participate in the branch of the immune system that must learn to recognize specific pathogens. Antibodies are produced when these cells encounter a pathogen. Antibodies often circulate for a lifetime, allowing the immune system to respond more quickly if it encounters the same pathogen again, as we learned with the chickenpox example.

This type of adaptive immunity means that the immune system must learn to distinguish self from non-self. This prevents the immune system from attacking the cells of the body instead of the invaders.

**Allergy and Anaphylaxis**

Occasionally, problems can arise resulting in a call to 911. Allergies and anaphylaxis are the result of the body’s exaggerated immune response to a harmless allergen like peanuts or a bee sting. The stage is set when the body produces large quantities of antibodies in response to an allergen. If the person encounters the allergen again, the antibodies cause an over-enthusiastic immune response. Large quantities of inflammatory chemicals like histamine are released, causing swelling, redness, and in more serious cases, hypotension and bronchoconstriction.
Auto-immune Diseases

Another problem occurs when the immune system gets confused and it starts attacking the cells of the body instead of invading pathogens. The result is an auto-immune disease. Type 1 diabetes is an auto-immune disease in which the immune system attacks the insulin-producing cells of the pancreas, eventually destroying them. Other auto-immune diseases include rheumatoid arthritis, systemic lupus, multiple sclerosis, inflammatory bowel disease, and even asthma. The incidence of these auto-immune diseases has been increasing. Why?

For many years, scientists have noticed that people in developing countries, who are frequently exposed to pathogens of many types, have a low incidence of auto-immune diseases. There are other clues as well. Children exposed to other children and animals in childhood have a lower incidence of asthma and allergy, as do babies born vaginally rather than via C-section. Laboratory mice from a strain that develops type 1 diabetes easily have a greatly reduced incidence of the disease if they are infected with a parasitic worm. What’s going on?

Hygiene Hypothesis

These observations led to the development of the hygiene hypothesis. The simple version of this hypothesis postulates that people in modern developed countries have less exposure to the pathogens with which we evolved. Lacking exposure to such pathogens, the immune system never learns to distinguish between self and non-self, between the body’s cells and those of an invader. Bored and uneducated, the immune system makes a mistake and goes after the wrong cells.

BLOODBORNE DISEASES

HIV/AIDS

In the spring of 1981, a physician in San Francisco noticed several cases of a very unusual pneumonia among young, previously healthy men. At the same time, a physician in New York City noticed several cases of a rare cancer, also in young previously healthy men. What was surprising about both the pneumonia and the cancer is that prior to these cases, such diseases were mostly seen among much older people or those whose immune systems were severely compromised. A CDC bulletin published in June 1981 was the first report of the disease that we now recognize as HIV/AIDS.
But it was not the beginning of AIDS. The origin of the disease in humans has now been convincingly dated, using genetic markers of the virus, back to the late 1800s or early 1900s in Africa. It is likely that the disease originated in chimps that were infected by a monkey virus very similar to HIV. Mutations in the body of the chimp caused the virus to change. When it was then introduced into the body of a human, likely during the butchering of a chimp for meat, the virus was adaptable enough that it could cause human infection.

AIDS is caused by HIV, human immunodeficiency virus. HIV attacks the cells of the immune system, specifically the T cells, which are responsible for organizing many aspects of the immune response. As the T cells are destroyed, the suppressed immune system can no longer fight off these pathogens. The person becomes susceptible to a wide variety of illnesses including bacterial diseases, viral diseases, fungal diseases, parasitic infections, and cancers. These are often referred to as opportunistic diseases or opportunistic infections. These diseases take opportunity of, or take advantage of, the body’s suppressed immune system. Ironically, when you evaluate and treat a patient with HIV disease, in many cases you are treating the patient for one of these opportunistic infections rather than symptoms caused by the virus itself.

**Hepatitis B and C**

Hepatitis B and C are liver diseases caused by the Hepatitis B and C viruses, respectively. These viruses are transmitted through infected blood, unprotected sex, mother to infant, or by a needle stick.

An estimated 240 million people worldwide are infected with hepatitis B and 150 million people have hepatitis C. Many of these will go on to develop cirrhosis, scarring of the liver which results in poor liver function, or liver cancer. At the other end of the spectrum, many people infected with hepatitis are unaware of it. They may be asymptomatic for years or feel only mild malaise and low-grade fever; however during this stage of the disease, they may still be able to transmit it to others.

Treatment for hepatitis B and C includes combination antiviral therapy. These treatments are long-term, have significant side effects, and are often ineffective. New antiviral drugs for hepatitis C have
recently been developed which are much more effective, safer, and better tolerated. Unfortunately these drugs are exceedingly expensive.

Hepatitis is a general term meaning inflammation of the liver. Hepatitis B and C are forms of infectious hepatitis. However similar damage to the liver can occur from long-term drinking (alcoholic hepatitis) or from other causes, such as damage to the liver from medications or chemotherapy. While the presentation may be similar, the causes are very different.

AIRBORNE DISEASES

Tuberculosis

Tuberculosis (TB) is an infectious bacterial disease, transmitted person to person through droplets expelled from the throat and lungs. The disease usually affects the lungs but can also attack the spine and other parts of the body.

From a treatment point of view, tuberculosis remains a challenge. Unlike most bacteria, it enters the cells of the body where it can remain dormant for many years. The tuberculin skin test looks for the presence of TB infection, not active disease. While most people who are infected by TB remain asymptomatic, there is a 10% lifetime risk of developing active disease, especially if the person becomes immunosuppressed or otherwise challenged. Treatment consists of two or more antibiotics that must be taken over a long period of time, typically over a period of at least six months. Multi-drug resistant TB is an increasing and difficult problem.

Influenza

In 1918, an unknown disease swept the globe. It infected 500 million people, about a third of the world population, and killed 30 to 50 million, mostly young, healthy adults. It swept the globe, ranging from remote islands to the arctic. It is considered the most devastating epidemic in recorded world history. It was the flu.
Contrary to what the pharmaceutical industry, makers of “cold and flu therapy,” might have us believe, cold and flu are NOT the same, nor even closely related. Flu, or influenza, is a systemic viral illness that infects the respiratory tract, spreading through droplets in the air or on surfaces. Even today, influenza is a killer. In the United States, as many as 200,000 people are hospitalized with the flu, and 20,000 die from it. However, while influenza can sicken anyone, most people with severe disease are older, debilitated, or immunosuppressed.

So what happened in 1918? Scientists believe that the strain causing the 1918 epidemic had an unusual trait. In addition to being very transmissible from person to person, as flu is today, it was also extremely virulent. It caused very serious and often life-threatening symptoms.

In 1918, people had no idea what caused their illness. We now know that influenza is a zoonotic disease (a disease that spreads from animals to humans) that circulates in birds such as chickens and ducks. There are many strains, identified by the letters H and N (which refer to proteins on the surface of the virus). You may have heard of H5N1, the bird flu of 2004 which caused some concerning human deaths. H1N2 is a common circulating variety.

When different strains both infect the same animal, for example a pig which is also susceptible to flu, genes from the different strains can reassert themselves into new combinations. This, plus the high mutation rate, means that the virus is frequently changing. This is why we need a new flu shot every year.

Most flu strains have high transmissibility (very contagious person-to-person) and low mortality. The bird flu of 2004 had a high mortality, but was not contagious person to person. The flu of 1918 was the perfect storm – high transmissibility and high mortality. It is exactly that combination that would create the next influenza pandemic, and for which we must always be vigilant.

**Meningitis**

*Meningitis* is a general term meaning “inflammation of the meninges” or membranes of the brain. Meningitis can be viral, bacterial, fungal, or even parasitic. Most types of meningitis are not transmissible.

The most common, viral meningitis, occurs when a virus already in the person’s body, such as flu, enterovirus, or herpes virus, enters the meninges and causes inflammation. Viral meningitis is not transmissible. To clarify, the virus that caused the meningitis, such as influenza, may be transmissible, but it will not cause meningitis in the person who acquires the virus. Treatment for viral meningitis is mostly symptomatic.

Bacterial meningitis is much less common, but is potentially transmissible to family members, health care providers, and other close contacts. The bacteria that cause meningitis are often friendly
residents in the nose and throats of healthy people; what causes them to leave their normal abode and enter the nervous system is often a mystery. Bacterial meningitis can cause seizures, altered mental status, and sepsis. It is a rare but extremely serious disease.

OTHER DISEASES

Methicillin-resistant Staphylococcus aureus (MRSA)

One in every four people in the general population is colonized by Staphylococcus. An even higher number are intermittently colonized. That’s because Staphylococcus is one of many bacteria that reside on the surface of the skin and part of the respiratory tract. If you have ever had a pimple, boil, stye, or abscess, it is very likely that you have had a staph infection. Most are not serious and most get better on their own.

Staph is not always this well-behaved. Occasionally staph migrates from the skin into the lungs, nervous system, or blood, causing a variety of illnesses from meningitis to sepsis. Breaks in the skin increase this risk. Patients who are hospitalized may have IVs, urinary catheters, and other possible conduits. Staph is one of the most common causes of hospital-acquired infections and often the cause of surgical wound infections.

Staph infections are treated with antibiotics, but this is a double-edged sword. The more we treat infections, the more likely it is that the bacteria will develop resistance to the treatment. This has happened with staph. The antibiotic penicillin was introduced in 1943. By 1950, 40% of hospital staph was resistant, and by 1960, it had risen to 80%. Accordingly, we’ve had to develop newer and more powerful antibiotics.

Methicillin-resistant Staphylococcus aureus is staph that has become resistant to a class of antibiotics called beta-lactams, which includes antibiotics such as methicillin (the M in MRSA) and penicillin. Other antibiotics can be used to treat these infections, but the treatment is often more difficult and less successful, and the bacteria may then develop resistance to additional antibiotics.

MRSA and other antibiotic resistant bacteria are a significant problem in hospitals, prisons, and nursing homes (abbreviated HA-MRSA, for hospital-acquired MRSA). Recently MRSA has become more widespread in the community (this is CA-MRSA). Anyone is at risk. Most people who get MRSA in the
Community get infections of the skin. Factors associated with the spread of MRSA skin infections include: close skin-to-skin contact, openings in the skin such as cuts or abrasions, contaminated items and surfaces, crowded living conditions, and poor hygiene. People may be more at risk in locations where these factors are common, including athletic facilities, dormitories, military barracks, correctional facilities, and daycare centers.

**Norovirus**

When is the flu, not the flu? When it’s the stomach flu! The general public, and even prehospital healthcare providers, frequently use the term “stomach flu” or “flu-like symptoms” to describe a GI illness with nausea, vomiting, and diarrhea. This is not the flu. Flu *(influenza)* is a systemic illness that causes fever, headache, and body aches. Since we should always be aware of the possibility that a pandemic flu might arise, we should be careful about our evaluation of patients with infectious illnesses and precise about our terminology.

If not the flu, what causes nausea, vomiting, diarrhea, stomach cramps? These symptoms can be the unfortunate result of many different conditions, such as food poisoning, a parasitic infection such as Giardia, a bacterial infection like *E. coli*, or a virus like norovirus. As a prehospital healthcare provider, it’s impossible to tell the difference between these.

Many of these GI infections are caused by pathogens that are highly transmissible, which explains why there are often widespread outbreaks of diseases such as norovirus on cruise ships, in daycare centers, and in nursing facilities. It only takes a few viral particles to infect a person with minimal contact. For this reason, strict attention to personal protective equipment is critical to avoid infection.

It’s also important to note that pathogens like norovirus are tough customers – they need to survive the transit through the mucous membranes and the stomach before settling in the small intestine. They are less susceptible than many other pathogens to deactivation by the alcohol wipes or sprays commonly used by EMS and in hospitals. It seems old-fashioned, but vigorous hand washing with soap and water, combined with treatment of contaminated surfaces, is the best way to prevent transmission.

**Ebola**

Outbreaks of Ebola virus disease in Africa have been documented since 1976, and were probably occurring long before that. Prior outbreaks have been mostly in rural areas, small in scale, and self-limited. There are several reasons for the size of the 2014 outbreak, including the fact that it originated in an area initially unfamiliar with the disease, and it entered a more urban setting where it could spread more quickly.
Infectious disease specialist shown reinforcing proper hand washing, Guinea
CDC worker demonstrating how one goes about cleaning up infected body fluids, Guinea

Ebola virus is transmitted through direct contact of infectious fluids onto skin or mucous membranes. These fluids may be vomit, feces, blood, sweat, and saliva, even if they are not visibly contaminated with blood.

Symptoms of Ebola include fever, headache, muscle aches, vomiting, diarrhea, and occasionally significant internal and external bleeding. Case fatality rates average 50% or higher. There is no vaccine and no cure, although research is ongoing and there have been some promising leads. Symptomatic treatment can decrease the mortality rate slightly. Cause of death from Ebola ranges from simple dehydration to “cytokine storm,” where the immune system in trying to defend the body mistakenly produces an overabundance of chemicals that have deleterious effects.

The overwhelming majority of people currently infected with Ebola live in West Africa. By the end of December 2014, there had been just a handful of people who either came to the US with Ebola or who developed the disease here. The likelihood of a widespread Ebola outbreak in the US is exceedingly low.

Severe Acute Respiratory Syndrome (SARS)

In 2002, an unidentified respiratory virus later called SARS infected almost 10,000 people, beginning in China, and killed a tenth of them (10% mortality). In the summer of 2003, a woman infected with the virus arrived in Toronto, beginning a Canadian outbreak that infected over 400 people, and killed 44 of them (10% mortality). Health care workers made up almost half of the cases.

Where did the virus come from? Scientists believe that, like Ebola, the natural host of the virus is a bat. However the fact that antibodies were found in other animals, namely civet-cats, a small mammal raised for food, suggests that they may have served to amplify the virus to the point where it became transmissible to humans.
**Middle East Respiratory Syndrome (MERS)**

The latest emerging infectious disease is MERS. Like SARS, MERS is airborne, and like SARS, it causes fever, cough, and shortness of breath. It has a mortality rate approaching 30%.

Where does the MERS virus originate? Antibodies to MERS have been found in camels, and it is possible that the disease “spilled over” from camels to humans. a person who has the disease.

**SUMMARY**

Ebola, SARS, MERS ... what is the next emerging infectious disease of concern? A new hemorrhagic fever from China? A neurologic illness from Australia? An influenza that has mutated to become both highly virulent and highly transmissible?

No one can predict with any certainty, but the next serious global disease is likely to be a zoonosis. And, while the disease may originate in fruit bats in Africa or civet cats in China, it is not a huge leap for the virus to arrive here. A person infected with the next bad disease could hop on a plane and be anywhere in the world in a short time spreading the disease.

Theoretically, that person’s first entry into the health care system might be a call to 911. Therefore it is reasonable that each of us should stay informed about pathogens, the immune system, and infectious disease. Research on these topics is ongoing and may change what we think we know. Accordingly we should commit to keeping up to date on the latest information, and follow the recommended guidelines and precautions so that we can continue to provide quality patient care while ensuring our own safety.
APPENDIX A: INFECTIOUS DISEASES

This appendix lists a number of diseases that may be of interest to EMS providers, either because we are potentially at risk for developing the disease (MRSA, Hepatitis C) or because the risk is minimal but the disease has been in the news lately (Ebola, MERS). A great reference site for infectious diseases of all types is the Centers for Disease Control website, www.cdc.gov.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Transmission</th>
<th>Presentation</th>
<th>Prevention</th>
<th>Treatment</th>
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</thead>
<tbody>
<tr>
<td>AIDS (acquired immunodeficiency syndrome)</td>
<td>Blood, semen, or vaginal fluid that enters the body through a vein or small tears in the skin or genital area</td>
<td>Depends on the opportunistic disease or infection. May include diarrhea, dyspnea, neurologic problems, wasting syndrome</td>
<td>Practice “safe sex,” don’t use IV drugs; get tested if you are at risk. Avoid contact with blood, especially via needle sticks.</td>
<td>Antiviral medications to attack the virus; other treatments specific to the opportunistic disease or infection. Post-exposure prophylaxis (antiviral) as soon as possible after a needle stick or other significant exposure</td>
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<tr>
<td>Anthrax</td>
<td>Contact with skins of infected animals; ingestion of meat from infected animals; inhalation of anthrax spores</td>
<td>Fever, cough, difficulty breathing. Cutaneous anthrax may form a blister with a black center</td>
<td>Animal husbandry and utilizing care in handling animal products.</td>
<td>In the unlikely event of an exposure, possibly to weaponized anthrax, an antibiotic.</td>
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<tr>
<td>Avian influenza (“bird flu”)</td>
<td>Historically, avian flu cases in humans have been acquired through direct contact with infected birds. Human-to-human transmission is negligible. Pandemic concern if the virus mutates to cause human-human transmission.</td>
<td>Fever, headaches, body aches, malaise, dry cough, sometimes diarrhea</td>
<td>Caution in handling infected birds. Awareness if the disease mutates and becomes human-human transmissible.</td>
<td>Antiviral medications (oseltamivir and zanamivir) and supportive care including airway management if needed.</td>
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<tr>
<td>Chickenpox</td>
<td>Direct contact with secretions, or through the air via coughing and sneezing</td>
<td>Characteristic itchy rash (“pox”) which forms blisters that dry and become scabs in 4 to 5 days</td>
<td>Vaccination</td>
<td>Mostly supportive.</td>
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<tr>
<td>Ebola virus disease</td>
<td>Initial cases probably involved contact with infected bats or primates. Human to human transmission is through direct</td>
<td>Initially, fever, malaise, muscle pain, headache, followed by vomiting, diarrhea, hypotension, and sometimes internal and external</td>
<td>In Africa, avoid contact with bats and primates. In a human outbreak, full body protection is recommended due to the mode of</td>
<td>Mostly symptomatic. Experimental treatments and vaccines are being studied.</td>
</tr>
<tr>
<td>Disease</td>
<td>Pathogen</td>
<td>Transmission and clinical presentation</td>
<td>Prevention/Management</td>
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<tr>
<td><strong>Hanta pulmonary syndrome</strong></td>
<td><strong>Pathogen:</strong> Hantavirus</td>
<td>Saliva, urine, feces of the deer mouse and some other rodents (dry, dusty environments facilitate infection)</td>
<td>Avoid contact with wild rodents. Symptomatic, including ventilator support if needed.</td>
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<tr>
<td><strong>Hepatitis B</strong></td>
<td><strong>Pathogen:</strong> Hepatitis B virus</td>
<td>Blood and bodily fluids, sharing of injection drug equipment, occupational needle sticks</td>
<td>Practice &quot;safe sex,&quot; don't use IV drugs, get tested if you are at risk. Avoid contact with blood, especially via needle sticks. Hep B vaccine is safe and effective.</td>
<td>Symptomatic, also antivirals and interferon. Post-exposure prophylaxis: Hep B immune globin.</td>
</tr>
<tr>
<td><strong>Hepatitis C</strong></td>
<td><strong>Pathogen:</strong> Hepatitis C virus</td>
<td>Blood and bodily fluids, sharing of injection drug equipment, occupational needle sticks</td>
<td>Practice &quot;safe sex,&quot; don't use IV drugs, get tested if you are at risk. Avoid contact with blood, especially via needle sticks. No Hep C vaccine is available.</td>
<td>Symptomatic, plus antivirals and interferon. New medications can now cure many people of hep C but are extremely expensive.</td>
</tr>
<tr>
<td><strong>Influenza</strong></td>
<td><strong>Pathogen:</strong> Influenza virus (many types)</td>
<td>Droplets, either on surfaces or through aerosols, expelled when the person coughs or sneezes</td>
<td>Mask on patients and caregivers. Hand washing. Disinfection of contaminated surfaces.</td>
<td>Antiviral medications (oseltamivir and zanamivir) and supportive care including airway management if needed.</td>
</tr>
<tr>
<td><strong>Meningococcal disease, meningococcal meningitis</strong></td>
<td><strong>Pathogen:</strong> Meningococcal bacteria Neisseria meningitidis</td>
<td>Droplets spread through coughing, sneezing, nasal discharge, and saliva from infected people</td>
<td>Sudden high fever, chills, severe headache, stiff neck (highly suggestive, but many with meningitis do not have); ultimately seizures, altered mental status, hypotension, petechial rash.</td>
<td>Wear a mask and put a mask on the patient. Vaccination is available and recommended in some living situations</td>
</tr>
<tr>
<td><strong>Methicillin-resistant Staph aureus (MRSA)</strong></td>
<td><strong>Pathogen:</strong> Staph bacteria that is resistant to some antibiotics</td>
<td>Direct skin-to-skin contact with an infected person; can also be spread on surfaces contaminated with the bacteria</td>
<td>Can range from minor (pimple, boil, styte) to life-threatening (sepsis, encephalitis)</td>
<td>Gloves and other barriers, hand washing, decontamination</td>
</tr>
<tr>
<td>Pathogen</td>
<td>Clinical Features</td>
<td>Precautions</td>
<td>Notes</td>
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<tr>
<td>Middle East Respiratory Syndrome (MERS)</td>
<td>Many cases have occurred in people with close contact with camels; antibodies to the virus have been found in camels. Person-to-person transmission is less common but has occurred, probably through small/aerosolized droplets.</td>
<td>Avoid camels and camel products (milk, meat). To prevent human-human transmission, use airborne precautions. There is no vaccine.</td>
<td>No specific treatment is available. Supportive care, including ventilator support, may be needed.</td>
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<tr>
<td>Norovirus</td>
<td>Highly transmissible. Spread through close contact with an infected person, on contaminated food and on surfaces. Fecal-oral route.</td>
<td>Contact precautions, careful hand washing, surface decontamination. Consider a mask and glasses/goggles due to the explosive nature of the symptoms and the possible aerosolization of small particles of vomit.</td>
<td>Mostly symptomatic, including intravenous rehydration if necessary. Antibiotics are useless since the pathogen is a virus.</td>
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<tr>
<td>Pertussis (whooping cough)</td>
<td>Airborne transmission of bacteria sprayed into the air by an infected person</td>
<td>Vaccination (usually given in childhood, may need to be repeated in adults). Mask and other airborne precautions.</td>
<td>Treatment is with antibiotics. Post-exposure prophylaxis: antibiotics, on a case by case basis</td>
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<tr>
<td>Severe acute respiratory syndrome (SARS)</td>
<td>Initial cases involved contact with infected palm civets in China. Subsequent cases involved human-to-human transmission, probably through droplets and respiratory secretions</td>
<td>Avoid civet cats. To prevent human-human transmission, use airborne precautions. There is no vaccine.</td>
<td>No specific treatment is available. Supportive care, including ventilator support, may be needed.</td>
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</tr>
<tr>
<td>Tuberculosis</td>
<td>Inhalation of bacteria aerosolized by coughing or sneezing. Infectious droplets can be</td>
<td>Wear a mask (ideally the patient will wear a mask also). Reduce contact in an</td>
<td>Antibiotics, usually two or three (the more common include rifampin, isoniazide,</td>
<td></td>
</tr>
<tr>
<td>Pathogen: MERS-CoV, a coronavirus</td>
<td>Fever, cough, shortness of breath, malaise, possibly progressing to respiratory failure.</td>
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<tr>
<td>Pathogen: West Nile fever, meningitis, encephalitis</td>
<td>West Nile virus</td>
<td>Bite of a mosquito. Not spread human-to-human</td>
<td>Most are asymptomatic of have very mild symptoms. Some have fever, muscle aches, headaches, joint pain. Rarely, patients may develop meningitis with high fever, stiff neck, confusion, seizures, altered mental status</td>
<td>Reduce chances of being bitten by a mosquito</td>
</tr>
</tbody>
</table>
APPENDIX B: PERSONAL PROTECTIVE EQUIPMENT (PPE)

Infectious diseases are becoming more prevalent in the daily activities of all EMS providers. To help avoid infection from fluids and airborne particles, you need to wear personal protective equipment or PPE, decontaminate equipment and surfaces after use, and wash your hands frequently.

Personal protective equipment is any type of specialized clothing, barrier product or breathing device used to protect workers from serious injuries or illnesses while doing their jobs.

PPE includes fit-tested masks (such as N95 and N100 masks), eye protection (such as glasses, face shields and goggles), gowns (or suits) and gloves. Use the patient’s presentation and history, as well as your good judgment, to determine the level of protection that you need. A patient with an infected hand but no other symptoms might require only gloves. A patient with a fever, cough, and respiratory distress suggests the use of a mask, eye protection, and gloves.

Donning PPE

If there is a potential for splash of blood, vomit or other fluids, the minimum PPE should include eye protection, gown and gloves. If there is a potential for airborne transmission, don a mask. Put on your PPE before you enter the patient area. The sequence for donning a complete set of PPE is MEGG:

1. Mask
2. Eye protection
3. Gown
4. Gloves

Doffing PPE

Remove your PPE once you have completed a call and left the patient area. Be careful not to contaminate yourself while taking it off. To remove PPE, reverse the order that you put it on:

1. Gloves
2. Gown – hand washing min 20 sec
3. Eye protection
4. Mask – hand washing min 20 sec
Hand Washing

Hand washing is vital. Washing your hands is the single most effective way to prevent the spread of disease. Wash your hands with soap and water for at least 20 seconds. If you don’t have access to soap and water, you can use a waterless alcohol gel hand cleaner.

Equipment Decontamination

Cleaning and decontaminating equipment is an important step in protecting yourself and others from infectious diseases; cleaning means removing visible contamination such as blood, disinfecting means wiping a clean surface with a disinfecting solution. You should clean first and then disinfect.

After completing a call involving a patient with an infectious disease, you must decontaminate everything you touched including:

- Equipment that was exposed or cross-contaminated
- Outside of kits
- Stethoscope
- Radios
- AEDs, etc.

After you transport a patient, decontaminate the inside of your rig before putting it back in service. Be sure to decontaminate the steering wheel, door handles, radio handset, clipboard, headsets, gurney, etc. When you return to your station carry out a more thorough decontamination as needed or as directed by department policy.

Masks

If you suspect you may encounter an airborne disease such as tuberculosis, don a fit-tested mask before entering the scene. Also place a mask on the patient, if tolerated. Fitted masks, as provided by your department, provide the highest level of protection.

To be effective, a mask must be fit tested to your face. You must apply the mask as soon as a hazard is known or suspected. In addition, you must remove and dispose of the mask without contaminating yourself. Disposable masks are for single use only and should be discarded after use. Do not re-use, share or hang masks around your neck. Change a mask that has been splashed and is wet.

Emergency medical dispatchers in some jurisdictions may provide you with premise information if they know that a patient or location is an infectious disease risk.

Eye Protection

Wear eye protection on all calls. This helps protect you from unanticipated splashes such as:

- Vomiting or spit
- Blood or bodily fluids
- Violent cough or sneeze
**Gloves**

Wear medical gloves on all calls. Most bodily fluids, such as vomit or feces, while aesthetically unappealing, do not typically carry bloodborne viruses like HIV. However, feces and vomit may harbor other viruses, bacteria, or parasites that could make you sick.

You should wear nitrile gloves if you are sensitive to latex or if you are treating a latex-sensitive patient. Usually, a patient knows and will inform you about latex sensitivity. Also, nitrile gloves provide more protection from chemicals. While working in a rescue or extrication environment where the risk of both cut and body substance exposure are present, consider wearing latex or nitrile inner gloves and other protective outer gloves.

Gloves are for use during patient contact. Remove gloves when you are done with patient contact, before getting into your rig, talking on the radio or driving. Decontaminate any items that you may have touched.

Remember that gloves will not protect you from sharp objects such as needles. You still need to remain vigilant of sharps while on the scene.

**Sharps**

Be exceedingly careful around needles and other “sharps.” Needle sticks represent by far the greatest risk of occupational bloodborne disease transmission.

You may be occasionally expected to handle sharps such as scalpels in an OB kit, syringes for epinephrine, and lancets for glucometry.

You should not be asked to handle sharps or manipulate sharps if you were not trained to do so (for example, transferring blood to blood tubes).

Many "exposures" among EMS providers involve cases in which EMS providers inadvertently stuck themselves with used needles!
APPENDIX C: EXPOSURES

Note: Please consult your department’s guidelines for details on exposures and post-exposure prophylaxis.

Percutaneous Exposures

A percutaneous exposure is one where the barrier of the skin has been breached, usually through a needle stick or a cut from a sharp object. If this occurs, wash the area well with soap and water. Do NOT use bleach or other harsh chemicals. These may damage the skin, making it more likely for a bloodborne virus to enter the body.

Report the exposure immediately to your supervisor for testing and possible post-exposure prophylaxis.

Skin or Mucus Membrane Exposures

Blood on intact skin is not considered a significant exposure. Non-intact skin includes abrasions and cuts. For exposures to non-intact skin you should:

- Wash with soap and water
- Report the exposure immediately to your officer for testing and possible post-exposure prophylaxis

For exposures to mucus membranes you should:

- Flush liberally with water
- Report the exposure immediately to your officer for testing and possible post-exposure prophylaxis

Post Exposure Prophylaxis (PEP) for Bloodborne Diseases

You must immediately report any possible exposure to a bloodborne disease to your company officer. Your department’s SOPs will give guidance that may include taking post-exposure prophylaxis (PEP). The intent of post-exposure prophylaxis for HIV is to reduce your risk of developing this disease if the source patient was infected. Post-exposure prophylaxis reduces the already very low risk of acquiring the disease, although it does not guarantee that no disease transmission will occur.

The medications taken for PEP are highly toxic. Most people who take them experience significant side effects ranging from fatigue to nausea and vomiting; in fact, as many as 30% of health care workers who start PEP stop taking the drugs because of the side effects. PEP also carries with it a chance of serious permanent consequences such as liver damage. This is not a decision to be taken lightly!

Part of the plan for PEP includes testing of the blood source. If the patient is determined to be HIV-negative, the PEP medications can be stopped.

Post Exposure Prophylaxis (PEP) for Airborne Diseases

For exposure to an airborne disease such as tuberculosis or bacterial meningitis, contact your company officer. In some cases the hospital may notify exposed responders if the patient is diagnosed with a reportable disease (such as tuberculosis).