CBT 620
Infectious Disease

Worms, Germs, and Gloves
A Common-Sense Approach to Infectious Disease

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2004 CBT 620 Infectious Disease

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INTRODUCTION

We live in an age acutely aware of infectious disease. From smallpox and anthrax to “mad cow disease” and “flesh-eating bacteria,” it is hard to open the newspaper without reading an account of how infectious disease of one sort or another has affected our lives.

As health care providers, we are obligated to learn about infectious disease. Why?

- First, and most obviously, knowledge helps us take better care of our patients. Can you recognize a patient with meningitis? Do you understand that a patient with bacterial sepsis is like a trauma patient, needing immediate medical care in the “golden hour”?

- No less important, understanding infectious disease helps us protect ourselves by taking appropriate precautions. It also helps prevent us from taking precautions that may be unnecessary, dehumanizing to the patient, or needlessly cumbersome.

- Finally, an understanding of infectious disease should be considered basic knowledge for every adult. We are living in a rapidly evolving world in which climactic changes, farming and livestock husbandry practices, and societal pressures create fertile ground for new and emerging infections with unprecedented potential for harm. Knowledge and awareness are our first lines of defense.

The information presented here may go beyond what you will use on an average aid call. It is hoped that the knowledge you gain in this course will help you think critically about infectious disease both at work and at home.

OBJECTIVES

Performance Based: This curriculum does not include any performance-based tests.

Cognitive Based: After studying the material in CBT620, the EMT will verify cognitive learning by successfully passing a ten question written test with a minimum score of 70%. A practice exam is provided at the end of the curriculum.

HISTORY

Sickness and disease were mysteries to early people. They attempted to explain sickness with a variety of causes, ranging from the anger of the gods to an imbalance in essential body “humors.” Not understanding the cause of disease, people were also at a loss to affect a cure. Indeed, in many cases, the cure was worse than the disease. Documented “treatment” for illnesses ranged from bleeding the patient, opening the skull with a sharp tool, enemas, and emetics (Figure 620.1).

Figure 620.1
Sometimes the cure — in this case, bleeding the patient — was worse than the disease.

One of the first rational treatments of an infectious disease occurred in the 18th century, when Edward Jenner discovered that injecting a person with a mild form of a virus ("cowpox") could prevent the development of more serious disease (smallpox). Although the physiology of this response was not understood, the implications were far-reaching. At that time, smallpox was one of the most devastating diseases. (Read more about how vaccination works on page 620.13.)

In the 19th century there was a revolution in knowledge about infectious disease. Cholera is a diarrheal disease that we now know is spread by drinking water contaminated by fecal matter. At that time, the prevailing theory attributed it to "miasma" (bad air that came from cesspools, swamps, and dumps). In 1854, physician John Snow discovered that most of the cholera deaths in a particular neighborhood occurred among people who drank water from one pump. Further investigation determined that this well was contaminated by a leaking cesspool. Feces infected with cholera were getting into the drinking water. He proved his case by removing the handle from the suspect pump; the cases of cholera in that area decreased dramatically.

But what was the organism or agent that actually transmitted the disease?

Enter three scientists: Louis Pasteur, Joseph Lister, and Robert Koch. Pasteur discovered that the agent (bacteria) causing milk to sour or wine to spoil was alive, and that it could be killed by heating (pasteurization). Lister, a surgeon, realized that infection in his patients was caused by a similar agent, and that infection could be prevented by excluding such agents from the field of operation (although a different chemical, the brand "Listerine" pays tribute to this man). Finally, Koch, using a microscope and special stains, identified many bacteria, including the bacteria that cause anthrax, cholera, and tuberculosis. These discoveries set the stage for our modern view of infectious disease.

OVERVIEW OF PATHOGENS

Infections are diseases caused by biological agents. Infections are the result of the interaction between the host (the person), the agent (virus, bacteria, or other pathogen), and the environment (food, water, air).

Many different biological agents cause infections. They range from prions, which are tiny bits of protein so small that they are barely visible even with the most powerful microscope, to intestinal parasites which may grow to nearly 50 feet in length!

Let's take a quick trip through the rogue's gallery of infectious agents …

- Bacteria
- Viruses
- Fungi
- Parasites
- Prions

Bacteria

Bacteria are simple, one-celled organisms (Figure 2). Most range in size from 1 to 10 micrometers – several thousand would sit on the eraser of your pencil. Reproduction is simple: one bacterium simply divides into two, and those divide into two, and so on. This is very efficient – given adequate food and the right temperature, one bacteria can produce hundreds or thousands of descendents in just a day!

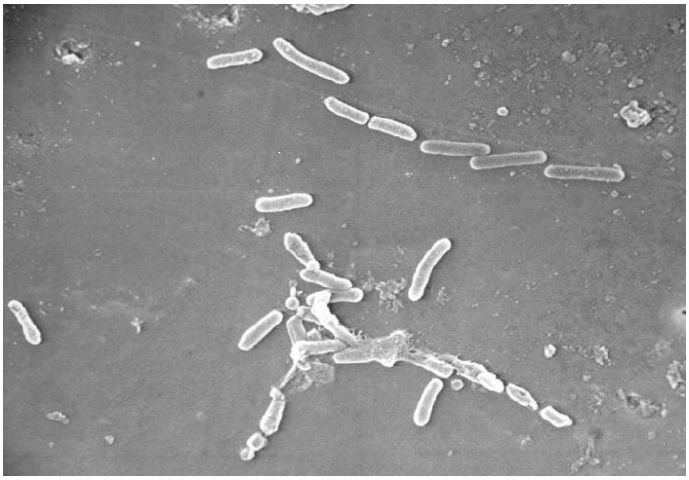

Figure 620.2
Rod-shaped bacteria swarm around in a culture.

Most bacteria are harmless, and many are actually beneficial. In fact, you have many bacteria living in your body – on your skin, in your nose and nasopharynx, in your mouth, and in your large intestine. In most cases, if these bacteria stay put, they cause no problems; rarely, a bacteria will migrate elsewhere and cause trouble. For example, the bacteria *Hemophilus* and *Neisseria* live in the nasopharynx of some people, and occasionally travel up into the nervous system and cause meningitis.

How do bacteria do their damage? As part of their normal metabolism, bacteria release enzymes and other chemicals. Some of these are harmful to our cells. In some diseases, bacteria die, and their disintegrating cell bodies cause a harmful reaction among our cells.

Bacterial infections are treated with antibiotics. Antibiotics such as penicillin and streptomycin are prepared from fungi, and kill bacteria or prevent them from reproducing. Antibiotic-resistant bacterial infections are an increasingly severe problem.

Bacteria cause many well-known diseases. Here are a few:

- Tetanus
- Botulism
- Gas gangrene
- Diphtheria
- Dysentery
- Cholera
- Tuberculosis
- Leprosy
- Syphilis
- "Strep" throat
- Plague
- Tularemia
- Anthrax
- Meningitis

Bacterial diseases can be spread in a variety of ways:

- Feces (cholera, dysentery)
- Dirt (tetanus)
- Droplets (tuberculosis)
- Arthropods (fleas) (plague)

Most of us have had bacterial infections of one sort or another. Some of the more common are the infections caused by *Streptococcus* ("strep") and *Staphylococcus* ("staph"). Cocci refers to the shape of the bacteria, which are round. These bacteria cause a reaction in the body, which produces pus.

- Staph in the skin causes pimples; staph on the eyelid causes a stye. Some staph produce toxins. In the 1980s, deaths of several young women from "toxic shock syndrome" were linked to their use of super-absorbent tampons; subsequent testing showed the presence of a toxin associated with a strain of staph.

- Strep causes sore throats ("strep throat"), scarlet fever, and impetigo, a local and highly infectious skin infection, usually of children. Why is it important to treat strep infections? Rarely, a hypersensitivity response to the bacteria causes swelling in the joints and the heart's valves, some of which may cause damage months or even years after the initial infection.

- *Neisseria meningitidis* is a bacteria that is a normal resident of the nasopharynx of many in the population (estimates range as high as 30%, increasing to 90% in cases of overcrowding). For reasons that are unknown, the bacteria may occasionally leave its cozy confines and cause meningitis, septicemia, or both. Infections are most common in children, who are usually treated successfully. Although rarer in adults, the mortality rate is also higher, often 50% in the first 48 hours.

Other common bacteria are those that inhabit the gut. In fact, most bacteria in the gut serve a useful purpose. For example, they synthesize vitamin K and members of the B vitamin complex.

- Occasionally bacteria that invade or live in the gut cause problems, usually diarrhea. How do they do this? Some bacteria (*Salmonella*, *Shigella*, some *E. coli*) invade and damage the bowel wall. Diarrhea caused by these bacteria may contain blood or pus. Others (cholera) produce a toxin that causes the epithelial cells in the gut to secrete massive amounts of water and electrolytes. These bacteria cause profuse, watery diarrhea, but usually no pus or inflammatory cells. A patient with cholera can lose 20%

of their body weight in just 24 hours, and literally die of profound dehydration. Thanks to good sanitation, it is unlikely that the EMT will ever encounter a case of cholera!

- Most EMTs, however, have responded to a call for food poisoning. What is “food poisoning”? Food poisoning is a generic term describing acute gastroenteritis usually characterized by nausea, vomiting, and diarrhea. Infectious food poisoning occurs when the bacteria in the food produce their toxins in the gut, causing symptoms 24 hours or so after ingestion. Examples of such bacteria include *Shigella* and *E. coli*. Toxin food poisoning occurs when the bacteria reproduce and produce toxins in the food before ingestion; in this case, symptoms such as violent vomiting and diarrhea may begin as little as an hour after eating, and usually last less than 6 hours. An example of toxin food poisoning is *Staphyloccocus*, which produces “staph enterotoxin” in contaminated custards, milk, and processed meats.

- Another bacteria worth knowing is *Hemophilus influenza*. This bacteria grows nicely in blood (hemo: blood; philus: love). Despite its name, it does not cause the flu (we now know that the flu is caused by a virus). The bacteria got its name because it was mistakenly suspected of causing the influenza epidemic of 1890*. H. influenza* is an important cause of sore throats and ear infections in children. It also causes epiglottitis and pneumonia.

- In fact, pneumonia can be caused by many different bacteria, including strep, staph, *Hemophilus*, *Klebsiella*, and others. Symptoms vary somewhat depending on the disease-causing agent, but pneumonia generally presents with fever and chills, productive cough, dyspnea, and pleuritic chest pain. About 2 million people get pneumonia each year. Of these approximately 50,000 die, making pneumonia the most common lethal infection especially for the elderly and those who are immunosuppressed.

Far less common but featured in the recent news is anthrax, an infection caused by a bacillus (rod-shaped bacteria). This bacillus forms spores when not inside a warm body. These spores can live for years in soil, and are very resistant to destruction. When they re-enter a body, the bacilli emerge from the spores.

- Anthrax is an animal disease, found mostly among cattle, sheep, and other hoofed mammals. There are two major forms: that found on the skin and that which invades the lungs (other body systems, such as the GI tract, are more rarely affected). Humans can acquire the disease from handling infected animal hides, or as recent events demonstrated, from anthrax spores that have been weaponized. Anthrax does not represent a threat of contagion. In other words, if you treat a patient with anthrax, you are not at risk of acquiring the disease.

- *Mycobacteria tuberculosis* is a thin, curved rod responsible for one of the most devastating diseases in history — tuberculosis. The old name, consumption, reflects how victims were “consumed” by the disease. As recently as 100 years ago, tuberculosis was the leading cause of death in the U.S.

- The bacteria that causes tuberculosis is spread by droplets in the air. The organism must invade the small airways to actually cause disease. Interestingly, only 5 to 10% of people infected with tuberculosis actually become sick from it; the immune system is

quite effective at preventing disease. However, once infected, always infected. The organisms simply retreats, usually inside a cell, always ready to begin reproducing again in the case of immunosupression, malnutrition, or some other stress.

- The PPD test given to most EMS personnel tests only for INFECTION, not active disease. Again, only 5 to 10% of those infected will ever develop symptomatic disease. Active disease is identified by chest X-ray or isolation of the organism from sputum or other material.

Lastly, consider tetanus. Patients who have been in an accident or with a break in the skin are at risk of acquiring tetanus and need a tetanus shot unless they have had one in the last five years. Tetanus is a rod-shaped bacteria which lives in the intestines of horses and is found in soil that has been in contact with manure. The tetanus bacteria produces a toxin more powerful than that of the deadliest snake. The toxin moves from the area of the injury along the nerves to the spinal cord. It binds irreversibly to nerve cells and damages them, causing muscle stimulation and contraction, often beginning in the jaw (hence the old term for the disease, “lockjaw.”).

Antibiotic resistance: What is it and why you should care?
Imagine that you have 10,000 bacteria living in a small wound on your arm. Your immune system is preparing to do battle. But you are impatient and go to the doctor, who gives you a prescription for antibiotics. You take antibiotics and over several days, most of the bacteria are killed and your arm starts to heal. However even though bacteria reproduce in a very simple way, by dividing, occasional mutations occur, so there are some slight variations among the bacteria in the sore on your arm. One of those slight variations includes a change in the cell wall that allows the bacteria to better survive an onslaught from antibiotics. After 4 days of taking the antibiotics, your arm is so much better that you decide to stop, even though your prescription has another week’s worth of pills.

What have you done? You’ve killed off 99% of the bacteria in the sore on your arm. But the 1% left are a little different. They’re tougher, harder to kill. Now, without competition from all those other bacteria, and without antibiotics to disturb them, they begin to multiply. Lo and behold, your skin infection flares up again. But this time, that antibiotic won’t work …

That dramatization illustrates two important points:

- If you are prescribed an antibiotic, take the full amount. This decreases the chance of allowing a few bacteria to survive and become resistant.
- Don’t take antibiotics for every bump, bruise, cough or cold (see the section Viruses to find out what really causes colds). Widespread use of antibiotics destroys helpful bacteria and reduces competition, potentially allowing resistant strains to multiply.

Sepsis.
An out-of-control bacterial infection, such as one in the bloodstream, can cause a patient to die chillingly quickly. Most EMTs can recount stories of patients who presented with vague symptoms of nausea and malaise accompanied by hypotension and an odd rash. They were astounded to find that the patient was dead less than 24 hours later! Because bacteria reproduce by dividing in half, bacterial growth can be exponential, putting the patient in grave danger. Every moment counts, and the emphasis is on rapid transport to a facility where the patient can be immediately started on IV antibiotics. Many patient with overwhelming sepsis die in spite of aggressive treatment. Sometimes the bacteria is resistant to the antibiotics. Other times, the antibiotic does its job, but the death of bacterial cells causes leakage of their enzymes and toxins into the body, a stress that sometimes cannot be overcome. Figure 620.3 shows a patient with meningococcal disease (a bacterial infection); note the characteristic rash.

Figure 620.3
Characteristic rash of meningococcemia (meningococcal disease), sepsis caused by a bacteria.

Summary: Key Points About Bacteria:

- Bacteria are large. Compared to some other disease-causing organisms such as viruses, bacteria are large and can be targeted directly by the cells of the immune system.
- Not all bacteria are bad! Many bacteria live peacefully inside the body and, in fact, are helpful for various tasks.
- Most (but not all) bacteria stay outside cells. With a few exceptions (notably, the bacteria that causes TB), bacteria do their damage from outside the body's cells.
- Disease-causing bacteria produce toxins or directly damage cells of the body. The types of cells that are damaged determine the signs and symptoms that the patient will exhibit (for example, neurological symptoms vs. diarrhea).
- Bacterial infections are treated with antibiotics. Antibiotics such as penicillin and streptomycin are prepared from fungi, and kill bacteria or prevent them from reproducing.
- Overuse of antibiotics destroys "good" bacteria and also enables bacteria to develop resistance.
- Bacterial infections are exceedingly common. The body's immune system takes care of most infections. Others are treated with antibiotics. How do you recognize an infection that is out of control and needs immediate, emergent treatment?
    - Altered LOC
    - Fever (may not always be present, particularly in the elderly)
    - Hypo tension, tachycardia
    - Unusual rash. Some bacterial toxins damage capillary beds, causing them to leak. This leakage accounts for a characteristic rash consisting of small purple or red dots on the skin.

Viruses

In 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 only appeared to reproduce in living things, not on the culture plates on which scientists grew bacteria.

By the early 1900s, the mystery was solved with the discovery of viruses.

If bacteria are small, viruses are truly TINY. Some are just 20 nanometers in diameter – literally millions could fit on a pinhead. Even our most powerful microscopes do not do them justice.

Unlike bacteria, which are real, although primitive, cells, viruses are not cells. They consist of genetic information (DNA or RNA) surrounded by a protein coat. Many also have hooks or suction cups that they use to attach themselves to a host cell (Figure. 620.4)

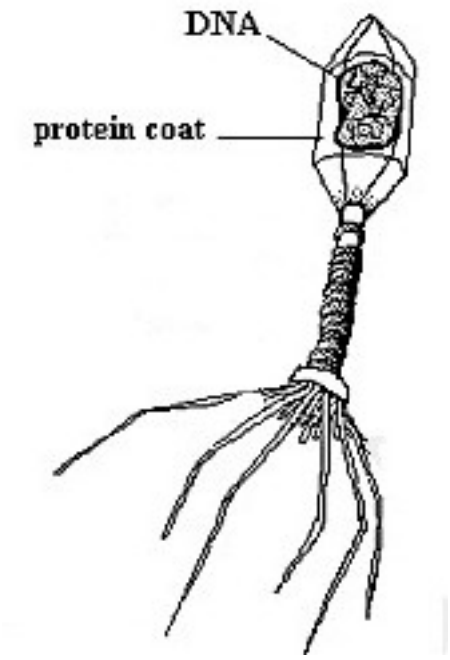

Figure 620.4
This schematic of a virus shows the genetic information, the protein coat, and the hooks by which the virus attaches to a cell membrane.

When a virus enters the body, it immediately begins searching for a host cell, and more specifically, for a particular attachment site on that cell. Once it attaches, it enters 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 virus's instructions. Those instructions direct the cell to construct new viral particles, and so it does. The cell has been turned, for all practical purposes, into a virus-producing factory (Figure 620.5). As time goes on, the dying cell's membrane breaks down, and the newly constructed viral particles are released, to search out new cells to infect (Figure 620.6). Figure 620.7 shows the complete schematic of a virus at work, from entry into the host cell, to replication (duplication) to budding and release of new viral particles.

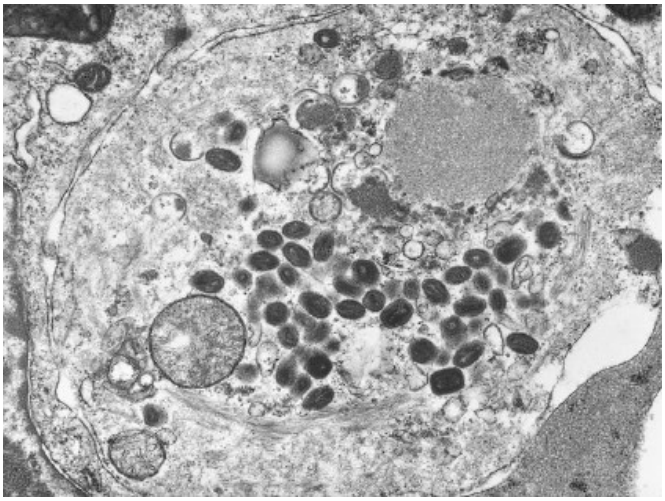

Figure 620.5
This cell, the outline of which is lightly visible in this micrograph, is full of dark viral particles.

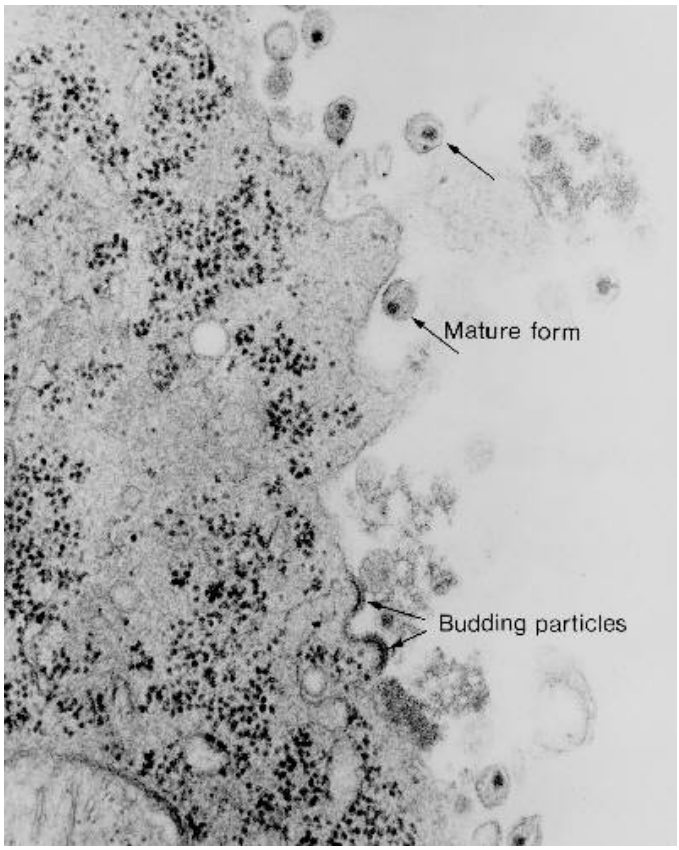

Figure 620.6
Viral particles bud off cells and then go on to infect new cells.

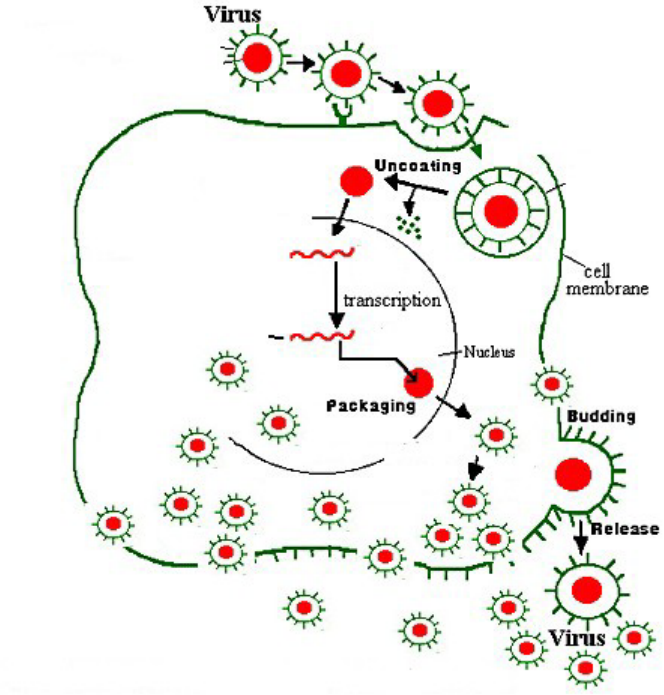

Figure 620.7
This schematic shows how viral replication occurs: a virus binds to a cell membrane and then enters the cell. Once inside, the virus uses the host cell's machinery and materials to make more copies of itself. The many viral copies make their way to the outside of the cell where they bud off and escape.

This oversimplification assumes that all viral infections cause cell death. This isn't necessarily the case. Here are the different things that can happen when a viral disease is acquired:

1. Overwhelming infection occurs, and the host (organism) dies. An example is rabies, which is virtually 100% fatal once symptoms begin.

2. The virus causes a carrier state. The virus enters a cell but replicates exceedingly slowly and without damage to the cell. This is an uncertain relationship, however. If immunosuppression or other stress occurs, the latent infection may turn to an active one, and the virus may then cause active disease. A good example is herpes simplex, the virus that causes cold sores. As many as 50 to 90% of people (depending on the population studied) have a latent infection with this virus, which generally only causes a flare-up of symptoms when the person has another infection, or is under stress.

3. The virus is destroyed by the immune system. This is the case in common viral diseases such as cold and flu (this is why you don't have a cold forever!). Cells infected by viruses send out chemical distress signals that are detected by the immune system. Cells from the immune system recognize, engulf, and destroy infected cells (Figure 620.8). Under a massive assault from the immune system, the virus may be eradicated. Interestingly, many of the symptoms you experience when you have a viral disease result from the body's attempts to defend itself (fever, swollen glands, inflammation).

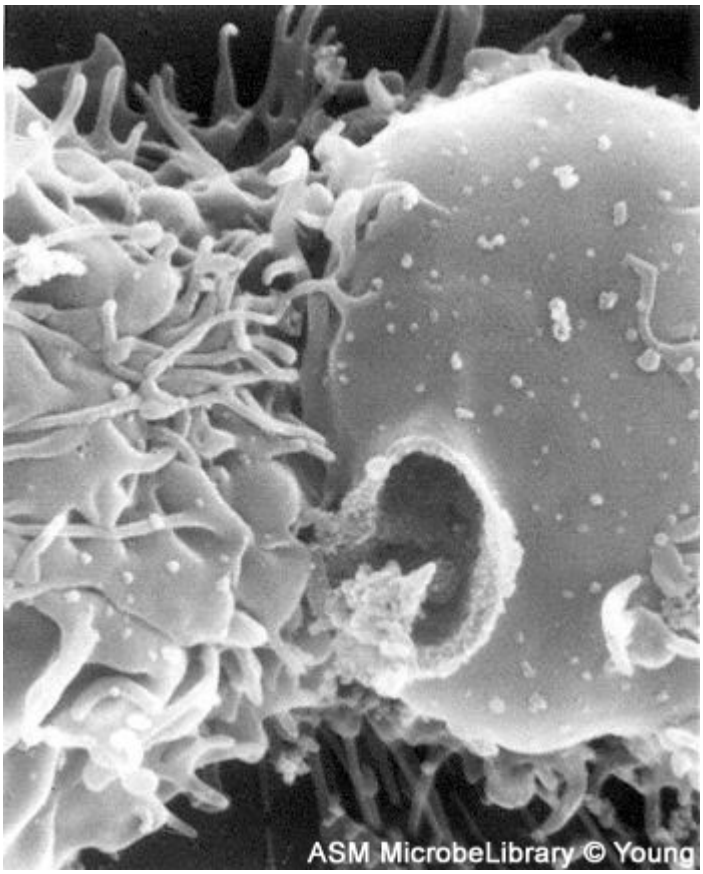

Figure 620.8
The immune cell on the left has identified and is attacking a virus-infected cell. The infected cell is dying; the cell membrane is already beginning to disintegrate (note the large hole).

Viruses cause many familiar and well-known diseases. Some of these are:

- Chickenpox
- Smallpox
- AIDS (acquired immunodeficiency syndrome)
- Parvo
- Rubella
- Yellow fever
- Measles

- Hepatitis
- Rabies
- Ebola
- Influenza (flu)
- Common cold
- Hanta
- RSV (respiratory syncytial virus disease)
- Herpes
- Polio
- West Nile disease
- Mononucleosis

Viral diseases present with many different signs and symptoms depending on which body systems are affected.

Viral diseases can be spread in a variety of ways:

- Blood (HIV, Hep B, Hep C)
- Insects (West Nile virus)
- Droplets or direct contact (flu, cold)
- Saliva (rabies)
- Fecal-oral (Hep A)

<u>How are viral diseases treated?</u>

Not very well!

Viruses do their damage by going inside living cells. As such, they are difficult to target for eradication. There *are* anti-viral drugs, but they do not usually cure the patient of his or her disease. Some of these drugs are designed to be brought into the cell, where they then interfere with some stage of viral replication (reproduction). Other medications interfere with the virus's binding to the cell's receptors.

However MOST treatment of viral diseases is symptomatic: support the patient while waiting for the immune system to gear up.

Antibiotics have NO effect on viral infections, other than to prevent or treat a secondary bacterial infection.

<u>Prevention of viral diseases: the story of natural immunity</u>

YES, many viral diseases can be prevented! A glance at the list of viral diseases above shows that we have vaccines for many of them. How do vaccines work, and how do we make them?

First, it is necessary to understand how natural immunity works – in other words, why you only get chickenpox once. This concept is illustrated in Figure 620.9a and Figure 620.9b.

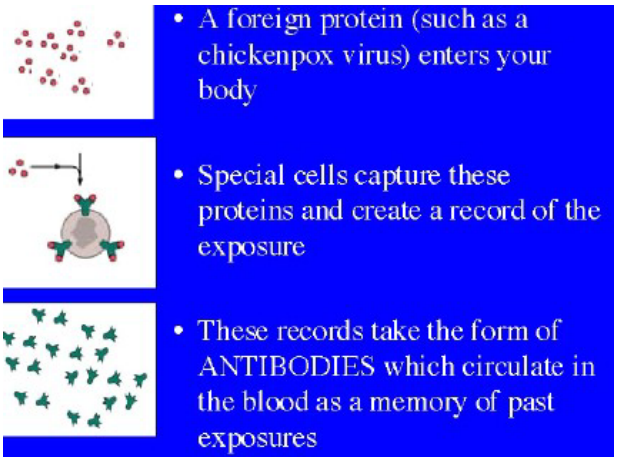

Figure 620.9a

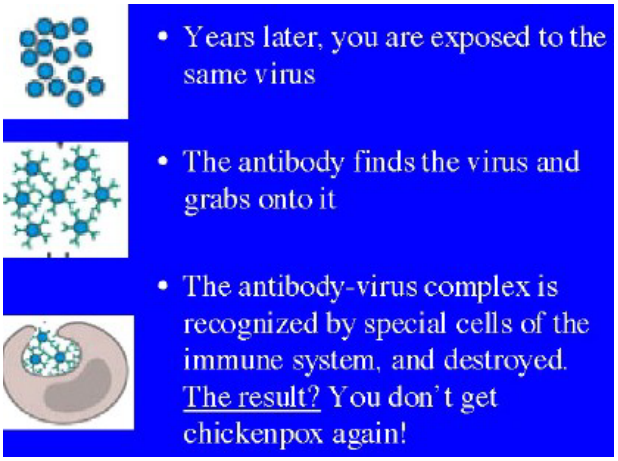

Figure 620.9b

Steps in the acquisition of natural immunity to a viral disease (for example chickenpox).

When you are invaded by a foreign protein (in this case a virus), your body takes a snapshot of the invader, and translates that snapshot to a "memory" of viral infection. This memory takes the form of small circulating agents called ANTIBODIES. If you had chickenpox as a child, you undoubtedly have chickenpox antibodies circulating in your blood.

If you are exposed to chickenpox at a later time, for example while caring for a patient with chickenpox, your antibodies are ready to go into high gear. If a chickenpox virus makes it into your body, lots of antibodies are manufactured by the immune system; they bind to the virus and prevent it from invading cells. The antibody-virus complex can be easily recognized and destroyed by the immune system.

With the antibodies on guard, viruses have no chance!

Turning natural immunity to our favor: how to make a vaccine

Our body creates antibodies when it is exposed to a virus. How, then, can we create antibodies without exposing the body to a dangerous virus (for example, hepatitis B)?

One way is by disabling the virus or reducing its virulence so that it can no longer cause disease. This is done in a variety of ways, for example by using chemicals that damage the pathogen. The disabled virus is then made into a vaccine, and injected into a person or animal. The disabled virus is similar enough to the real virus that the immune system can't tell the difference. Not knowing that the virus is disabled, the immune system dutifully makes antibodies to the vaccine, just as it would do to an active virus.

Now skip ahead ten years … you have an exposure to blood that is contaminated with hepatitis B. The virus is circulating in your blood. Enter the antibodies. Although they were made from a disabled form of the virus, they still recognize the real virus — the two copies are that similar. Just as they did in the example of chickenpox, the antibodies grab onto the virus and create a complex that can be recognized by the immune system and destroyed.

Thus, as Figure 620.10a, Figure 620.10b, and Figure 620.10c illustrate, vaccination takes advantage of the body's natural ability to create a memory of previous exposures, and use that memory to mount a quick, effective immune response to a second exposure.

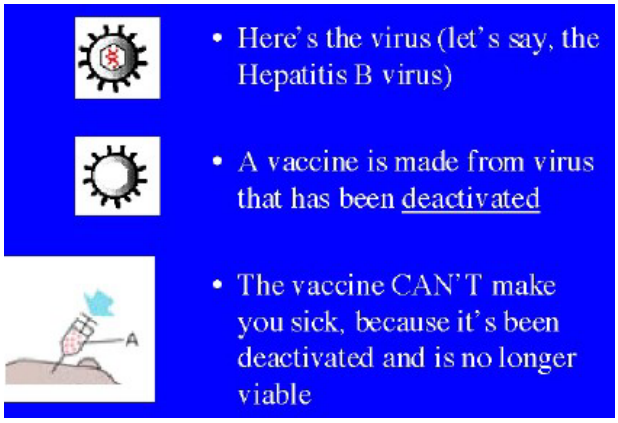

Figure 620.10a

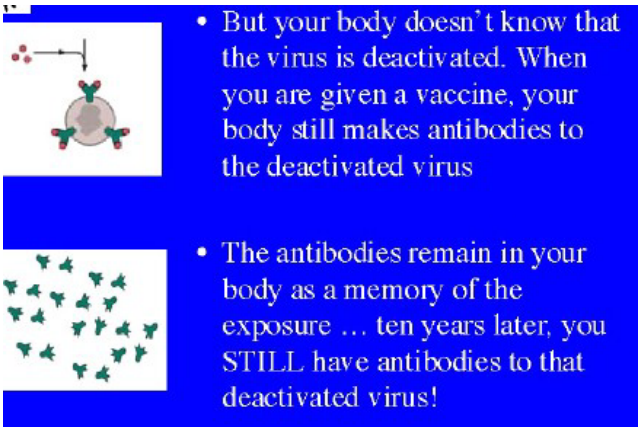

Figure 620.10b

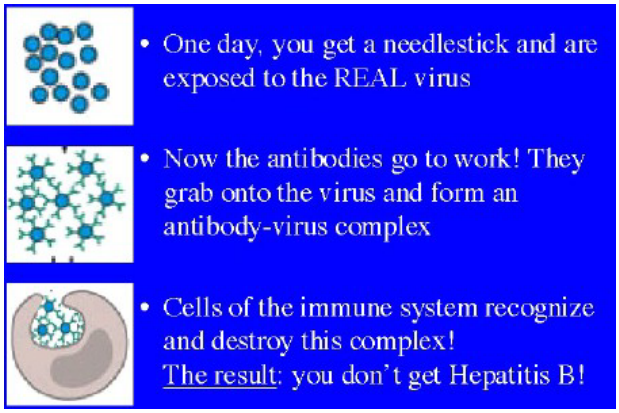

Figure 620.10c

Figure 620.10a, Figure 620.10b, and Figure 620.10c
Steps in the vaccination of a person against a viral disease (for example Hepatitis B)

If vaccination is so effective, why don't we have a vaccination for HIV yet? The answer is that the protein coat of this virus is exceedingly variable due to frequent mutations. So far scientists haven't been able to identify any portion of this protein coat that is consistent enough to make a suitable vaccine. But research continues.

Flu Shots
Have you ever heard this?

"I won't get the flu shot anymore. Last year it gave me the flu!"

Now the facts: this isn't possible. The flu vaccine is made from deactivated flu virus, so it CANNOT cause you to get the flu. So why might you get the flu or flu-like symptoms after you get a flu shot? There are several reasons:

First, it takes a few days to a week after you get a flu shot for your body to develop antibodies to the vaccine. It's possible that you were exposed to the flu BEFORE you got vaccinated, in which case your body didn't have time to build an adequate immune response before the virus began to make you sick.

Second, there are many different strains of flu. Each year, before the start of flu season, scientists travel around the world to try to determine which strains are likely to be the most common. They make their vaccine based on their best guess. Some years, they guess wrong, and a different strain becomes more common by the time the flu reaches this country. Or you may be unlucky enough to be exposed to a strain of flu that was not included in the vaccine.

Third, you may not have the flu! There are lots of other viruses that cause flu-like symptoms.

Lastly, if you feel sick right after you get a flu shot, chances are you don't have the flu but are experiencing a mild reaction to the flu shot itself. The flu shot, like other vaccines, fools the body into thinking it's been exposed to a virus. Your immune system gears up to fight this foreign invader, often causing symptoms that we attribute to being sick: fever, chills, and that generally icky feeling. These symptoms don't generally last more than a day.

Does the flu shot protect you from the flu? YES! Statistically, you're better off getting that shot!

Summary: Key Points About Viruses:

- Viruses are TINY; most are many times smaller than the smallest cell.
- Most viruses do their damage by going inside cells, where they take over the machinery of the cell and turn the cell into a virus-producing factory.
- Viral diseases can cause: death of the host (e.g. rabies), carrier state (e.g. herpes) or eventual recovery due to destruction of the virus and infected cells by the immune system (e.g. flu or cold).
- Most viral diseases are not effectively treated, due to the logistical problems of trying to reach viruses, which are hiding inside living cells.
- Viral diseases can be prevented in some cases by making a vaccine from a disabled version of the virus. The vaccine fools the body into thinking it's been exposed to the virus, causing it to be make antibodies which will defend against future attacks of that virus.

Fungi

Fungi are unique organisms. They aren't animals. They aren't plants. Rather, they exist in a biological kingdom all their own. Examples of fungi include mushrooms, molds, and yeasts. Most have complicated lifecycles and exist in many different forms.

Though a few cause disease, fungi as a whole are incredibly beneficial organisms. Fungi are responsible for the breakdown of dead animal and vegetable matter. In other words, they cause decay. Were it not for fungus, we would be overwhelmed with dead organic matter. In addition, some fungi (mold) produce powerful antibiotics.

It is rare to encounter a patient who has called 911 for a raging fungal infection; healthy immune systems keep most fungal infections at bay. People who are immunosuppressed (for example patients with HIV infection or patients taking chemotherapy) are at risk for acquiring fungal diseases. Such diseases include cryptococcal meningitis, a fungal disease of the brain, and candidiasis (commonly known as "thrush"), a fungal infection of the mouth, genitals, and GI tract. Less serious and far more common 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, taking antibiotics increases the incidence of fungal diseases, such as yeast infections. Why? Many beneficial bacteria live in the body in symbiosis (cooperation) with fungi; their presence helps restrict fungal growth. If these beneficial bacteria are eliminated, for example by taking an antibiotic, fungal growth can increase to the point where it becomes harmful.

Fungal diseases are treated with anti-fungal medications such as clotrimazole, amphotericin B, and nystatin.

Fungal diseases can be spread in a variety of ways:
- Bird feces (histoplasmosis)
- Dusty soil (coccidiomycosis)
- Direct contact ("athlete's foot")

<u>Summary: Key Points About Fungal Diseases</u>

- Fungi are incredibly diverse and useful organisms that are responsible for decay in nature.
- Serious fungal diseases in humans are rare; most occur in people who are immunosupressed or otherwise debilitated.
- Less serious fungal infections such as yeast infections occur due to the destruction of beneficial bacteria that normally keep the fungi in check (for example, in a person taking antibiotics).
- Fungal diseases are treated with specific anti-fungal medications.

Parasites

Parasites are members of the animal kingdom which live in or on the body of a human or another animal. They may be small, consisting of just one cell, or may be large, multi-cellular organisms (Figure 620.11). Many have complicated life cycles, where they live part of the time in a human host, and part of the time in another animal or in water or soil. Some

are very specialized: the tapeworm *Echinococcus* must go through part of its life cycle in a dog or wolf, with the other stage being in a human being. Another worm, *Angiostrongylus costaricensis*, invades the intestinal wall and then arteries of a human, after passing through intermediate life cycle stages in the cotton rat and the slug.

Figure 620.11
Close-up of a tapeworm. Note the hooks by which it attaches to the intestinal wall of its host.

A “good parasite” lives without compromising its host too much. After all, being parasites, if the host dies, the parasite will also. In many developing countries, infection with parasites is virtually universal and causes general debilitation and discomfort.

The smallest parasites are the one-celled protozoa. Most protozoa are harmless creatures that live out their lives in ponds, oceans, and even the little drops of water that collect on plant leaves. But some protozoa cause disease.

- One well-known protozoal parasite found in Washington State is *Giardia*, which causes cramps and diarrhea. *Giardia* is acquired by drinking water that has been contaminated with *Giardia*-infected feces. Animals may be intermediate hosts of *Giardia*. *Giardia* is also a common cause of diarrhea in day care centers.

- Malaria is also caused by a single-celled parasite. Part of the lifecycle of this organism is spent in the *Anopheles* mosquito. When an infected mosquito bites a person, thousands of the tiny parasites enter the bloodstream, make their way INSIDE red blood cells, and proceed to multiply inside the red blood cells and eventually destroy them. When the red blood cells finally burst, these tiny parasites escape and search out new red blood cells to infect. Since the parasites mature at the same time, this massive destruction of red blood cells and discharge of parasites into the blood stream occurs all at once, causing a sudden high fever and attack of chills that is the hallmark of this disease.

  Malaria is considered by many to be the greatest public health problem in the world. In some tropical areas nearly everyone is infected, often from infancy until death, causing fever, chills, anemia, and malaise. According to one author: “Such persons never know for a single day the feeling of perfect health.” (Desowitz, 1981). Although we may think of malaria as a disease of tropical, developing countries, there have been several accounts and outbreaks of malaria in the southeastern United States.

- Larger parasites include roundworms (nematodes), tapeworms (cestodes), and flukes (trematodes). Some can be quite long (up to 50 feet in length!). Others are tiny (the pinworm that commonly infects children measures less than an inch). Like other

parasites, the parasitic worms have evolved fascinating life cycles. Consider the hookworm, one of the most common parasites in the world, infecting an estimated 100,000,000 people yearly. The worm embryo lives in warm, moist soil, and enters a human body by boring through bare skin. Once inside the body, the worm enters a vein and is carried via the blood to the lung. From the lung, it makes its way to the trachea, which it climbs until it reaches the junction of the esophagus. It then descends down the esophagus and passes through the stomach, eventually reaching the duodenum, where it attaches with small hooks. An infected person may have hundreds or thousands of worms, each of which can lay 10,000,000 eggs at a time; these are shed in the feces where they start the cycle anew.

Treatment of parasitic diseases depends on the particular organism that is causing the infection. Examples of medications for treating parasitic diseases are albendazole, mebendazole, and metronidazole. More than treating the individual patient, reduction in the incidence of parasitic diseases requires an epidemiological approach – understand the life cycle of the parasite and try to control it through one or more of the pathways in the life cycle. For example, many parasites have been brought under control by treating water (flukes), educating people to cook their food (tapeworms), or removing the intermediate hosts (mosquito control).

Parasitic disease can be spread in a variety of ways:

- Feces-contaminated water (*Giardia*, *Cryptosporidia*)
- Feces-contaminated soil or vegetables (tapeworms)
- Meat or fish (tapeworms)
- Insects (malaria)

Where does the caduceus symbol on your patch or EMT card originate?
Some think that the caduceus represents a snake on a staff. Others believe that the snake is actually a worm, and the staff is really a small stick.

And to be more specific, the worm would be a guinea worm, once a common parasite of India, Africa, and the Middle East. This parasite has a fascinating life history. Guinea worm larvae are discharged by the parent worm into fresh water, where they are eaten by crustacean copepods (small swimming invertebrates). These copepods are so tiny that they are swallowed unknowingly by people who drink untreated water. In the person's body, the guinea worm larvae escape from the copepods, migrate from the stomach into the viscera, become adults, and mate. The female then makes her way through the body to the subcutaneous tissues, where she begins to emerge.

At this point, a small boil develops on the outside of the person's skin as the worm makes its way out (Figure 620.12a). To pull at the worm or otherwise kill it would not solve the problem; the tissue of the dead worm inside the body would set up an inflammatory response. Neither can the worm be allowed to simply hang as it gradually emerges since this process may take several days. (Also, worms can emerge from anywhere on the body — sometimes from very inconvenient locations.) The solution is to carefully and gently wind the worm, as it emerges, around a small stick (Figure 620.12b). Hence the caduceus metaphor – something to think about the next time you look at the symbol painted on the side of the aid car.

Figure 620.12a

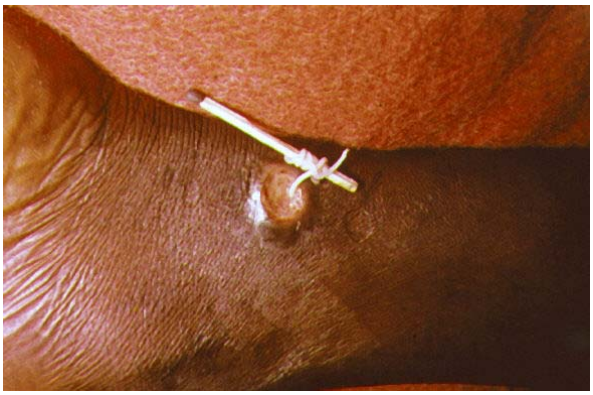

Figure 620.12b

The guinea worm, once inside a person's body, eventually burrows its way to the surface, where it forms a small boil and gradually emerges over a period of several days. The worm is often wound around a small stick until it completely emerges.

Summary: Key Points About Parasitic Diseases

- Parasites can be unicellular (such as *Giardia*) or multicellular (such as tapeworms).
- Parasites require one or more hosts to survive.
- Most parasites are very specialized and have complex life cycles.
- Many people in developing countries live their entire lives with multiple parasites, which cause malaise, anemia, malnutrition, and increased susceptibility to other diseases.
- Parasites are best controlled by understanding their life cycle and intervening at one of these stages.

Prions

As small as viruses are, there is something even smaller: prions. Once called “slow viruses” because they usually take years to cause disease, prions are actually small misshapen pieces of protein that touch other proteins and, in turn, cause those proteins to become misshapen and dysfunctional. In the nervous system, accumulating damage to proteins eventually causes neurologic problems, brain damage, and death.

The prototype prion disease is kuru, known from the Fore tribes people of the New Guinea highlands. Carleton Gajdusek, an anthropologist who studied this culture, described the slow onset, progressive neurologic decline, dementia, and eventually – universally – death. He noted that this disease was most prevalent among the women – who also, incidentally, practiced ritual cannibalism as part of their care of their dead (many of whom, it turned out, died of kuru).

As cannibalism was phased out in the 1950s, kuru become less common and has now virtually disappeared – cementing the theory of an infectious agent transmitted in the flesh of those who had died of the disease.

So why would a rare disease of New Guinea natives be important to us today?

As it turns out, diseases like kuru (the general term is “spongiform encephalopathy,” for the sponge-like appearance of the brain) are also seen in animals. In sheep, the disease is called scrapie, and in cows the disease is called bovine spongiform encephalopathy (BSE).

New Guinea natives got the disease by practicing cannibalism – but how do cows and sheep get this transmissible agent? Investigation shows that the normally vegetarian ruminants had been turned into carnivores by modern farming practices that strove to increase the protein ratio of feed. All manner of offal – livestock that died in the field, bones and organs from slaughterhouses, aborted calf fetuses – were collected, ground up, dried, mixed with feed, and given back to livestock. The prions – difficult to destroy because they are not truly living things – went right into the feed and caused new infections.

In the last ten years, there has been a significant increase in the number of cases of BSE. All of this would be of veterinary interest only, except that it soon became apparent that prions could cross the species barrier, and that people could be infected. The press named BSE “mad cow disease,” for the behavior it caused in cows. People who ate infected beef developed a disease called (variant) Creutzfeldt-Jakob disease, named after the people who first described it.

Though there is still much to be learned about prions, it is now accepted that the infectious agent can be transmitted from tissue – usually nervous system tissue – of a cow to a person who eats it. The prion’s misshapen proteins begin to accumulate, causing other proteins around them to be damaged, and eventually causing symptoms and then death.

Mad cow disease in the US?

Maybe we're just lucky. Farmers and ranchers in the US practiced the same animal husbandry as in the UK. Fortunately for us, mad cow disease has not been found in cattle in this country – yet. Significant changes in animal feeding have now been made to prevent the transmission of disease causing agents. Scientists continue to monitor the situation to keep our food supply safe. But prions remain a threat. They are tiny, insidious, and may take years to cause symptoms, making it very difficult to track them. There is no easy test, no X ray or blood analysis, which will betray their presence. Scientists and lawmakers are extra-cautious. Realizing how infectious it is, and not understanding all the details of its transmission, new guidelines have been put in place. For example, people who have lived or spent time in Europe are asked not to donate blood on the slim chance that their blood contains the agents of this disease. A cure? There is none. The disease is universally fatal although it may take months or years for the person to die once symptoms appear.

INFECTIOUS DISEASE IN THE PREHOSPITAL ENVIRONMENT

Emerging Infections

The world is a different place than it was two years ago. The events of September 11 have brought a global awareness of infectious diseases as agents of terrorism and war. In addition to the threat of terrorism, we are changing the natural world more quickly than ever in our history. Global warming, habitat destruction, even the widespread use of pesticides and herbicides are eliminating some species, favoring others. The result? Diseases like malaria, a mosquito-borne illness, are moving northward into areas where they have never been found before. Association of some animals, such as scavenger crows, rats, and others, with human populations increases the chances of disease transmission from one species to another. Historically, diseases like bubonic plague were linked to the close association between rats and people; today, a disease like West Nile Virus, is found naturally in birds, but mosquitoes can transmit it to people. Ebola hemorrhagic fever, which probably has a reservoir in wild mammals, is manifested in periodic outbreaks. What we view as progress may in fact make areas more suitable for certain diseases. The building of dams to provide irrigation water provided large stretches of habitat suitable for the colonization by a variety of parasites such as the nematode worm that causes river blindness.

Given this worldwide concern about infectious diseases, how can you – as an EMT and a citizen – recognize infectious disease, treat your patients properly, and keep yourself safe? This final section in the curriculum deals with these topics.

Prehospital Presentation

Writing about the presentation of a patient with an infectious disease is a bit like trying to describe a 60-year-old patient who has just called 911 – the presentation could be almost anything!

Like other diseases, an infectious disease may be chronic and may or may not cause any significant problems. For example, the person with COPD may always be slightly short of breath. If he exerts himself or develops a cold, however, that dyspnea may worsen, resulting in a call to 911. Similarly, a person with HIV infection may never feel completely well. However he may not call 911 until he develops some exacerbation of his symptoms – hypotension secondary to diarrhea, dyspnea due to pneumonia, and so on.

Those of us who are healthy may not appreciate the burden of most of the world's population, who live with one or more infectious diseases <u>for their lifetimes</u>. These diseases may cause symptoms such as weakness, visual difficulty, low-grade fever, and chronic diarrhea. One scientist, studying the parasites of people in a very poor area of Thailand, asked for stool samples. He noted the liquidy samples sloshing in the collection cups and asked: "How long have you had diarrhea?" "Diarrhea?" the person would reply curiously, "I don't have diarrhea. My stools are always like this." (Desowitz, 1981)

Even in our society, people with infectious diseases, like people with other chronic medical problems, live under the burden of their disease. Accordingly, when evaluating new symptoms, it is important to ask:

- What is your usual state of health? (How do you feel now compared to the way you normally feel?)
- What is new today? (Why did you call 911?)
- What has been the progression of your illness? (getting better, getting worse, staying the same?)
- How are you being treated?
- How often do you take your medicines? (Is this the way they've been prescribed?)

(You may find out that the reason the person has called 911 has nothing to do with their underlying disease. The person may, for example, have tripped and fallen down the stairs.)

Many new-onset infectious diseases are rarely seen by prehospital care providers. Unless it is very severe, most people do not call 911 for a cold, flu, or sore throat.

Rarely, a new infection may present with dangerous or even life-threatening signs or symptoms, which may prompt a call to 911. Typically these fall into one of four categories:
- CNS symptoms: altered mental status, seizures, and severe headache
- Unstable vital signs: hypotension, tachycardia
- Respiratory distress
- Pain

Occasionally, a call to 911 may be made for signs in a child that are frightening to the parents, such as an unusual rash.

Signs and symptoms often attributable to infectious disease include:
- Fever and chills
- General malaise
- Swollen glands
- Rash
- Nausea, vomiting, diarrhea
- Pain

Signs or symptoms that appear quickly are of more concern than signs or symptoms that take days to develop. For example, a person who developed weakness and nausea two hours ago, and now has a heart rate of 130 and an unusual rash may have a bacterial infection. Bacteria multiply by dividing and can rapidly overwhelm the body's defenses. This is more of an immediate concern than a person who has had a general feeling of malaise, fever, and headache for a week.

As part of your history, make sure to ask:
- What symptoms are you having?
- When did the symptoms start?
- How were you feeling before these symptoms started? (Any minor symptoms before the call?)
- Is anyone else in the family sick?

Be sure to check and document:
- Vitals, including pulse oximetry if available
- Extent and appearance of rash, if present (note location as it may change over time)
- Appearance of emesis or bowel movements
- Lung sounds

It is difficult to diagnose an infectious disease in the field; in fact, in many cases it is difficult even in a hospital. Rather than spending time trying to figure out which bacteria might be responsible for this patient's sepsis, recognize that the patient has an overwhelming infection and needs immediate treatment and transport!

Treatment Guidelines

Since you treat patients based primarily on their presentation, most treatment guidelines are the same whether or not the patient has an infectious disease. You may not know the cause of the person's symptoms; only further investigation at the hospital reveals that they have an infectious disease. For example, if a person presents with shortness of breath, field treatment is the same whether they have a viral, bacterial, or parasitic pneumonia.

Remember that people with infectious diseases can also have problems unrelated to their infection. A person with HIV infection can also have an MI, asthma, or COPD. A person with tuberculosis can also be involved in an auto accident.

How much can you write on a run report? For many years, it was considered taboo to write "HIV" or "AIDS" on a prehospital run report. The prejudice against people with HIV infection, particularly in the early years of the epidemic, encouraged the passage of laws that protected people against discrimination. The intent of the law, however, was never to stop the dissemination of medical information that might help the patient. If the patient's HIV status is pertinent to his or her medical problem, it is acceptable to document it on the run report, in the same way that one might document a history of asthma. Two examples show this more clearly. The first is a patient who is walking down the street, trips, falls, and sprains her ankle. She tells you that she has recently been diagnosed as being HIV-positive, but is on no medication and at this time is completely asymptomatic. Her HIV status probably has no bearing on her injury; therefore it is unnecessary to document it on the run report.

The second example is a patient who calls you because he feels lightheaded; you find him with a blood pressure of 70/50 and a heart rate of 140. He tells you that has AIDS and has had severe diarrhea for several days. In this case, he has probably acquired an opportunistic disease or parasite that causes diarrhea, a common problem for people with AIDS. The patient's AIDS history IS relevant to his current complaint. It is potentially beneficial to document this information on the run report.

Finally, people with infectious diseases over the course of history have been the object of fear, ignorance, prejudice, and hostility. There is no excuse for this behavior, especially among health care workers, who should be well educated about these diseases. Whether a person has CHF, COPD, or AIDS, he or she should be treated with dignity, compassion, and respect.

Keeping Yourself Safe

Your department will have specific guidelines for the use of PPE (personal protective equipment). The guidelines listed below include recommendations by the CDC (Centers for Disease Control). Your department's specific guidelines may vary.

- The term “scene safety” should be expanded in our minds to include a quick assessment of risk and necessary PPE. This PPE may range from none, to gloves, to gowns and goggles. Some questions you may want to consider:
  - Is there anything about the overall scene that suggests a possible infectious disease (for example, a person who is homeless or has poor access to medical care is at higher risk for tuberculosis)?
  - Is blood or other bodily fluid present now (trauma) or likely to be present in the future (childbirth)?
  - What is the extent of the bleeding (arterial vs. venous)?
  - Is the patient controllable (consider a combative vs. a cooperative patient)?

- Wear gloves for contact with blood or other bodily fluids. Recognize that most bodily fluids, such as vomit or urine, while aesthetically unappealing, do not typically carry blood borne viruses. Others, such as feces, may harbor bacteria or parasites that could make you sick. These are not transmitted through the skin or via inhalation, but through the so-called fecal-oral route. Therefore …

- Wash your hands! The importance of hand washing cannot be over-estimated. The use of gloves actually <u>increases</u> the incidence of bacteria on your hands, since it provides a warm, protected environment for these pathogens. Wash your hands after all patient contact, even if you wore gloves.

- Wear goggles and a mask if there is a splash potential of blood, vomit, or other fluids. While the chance of contracting a blood borne disease through this route is very remote, this is a reasonable precaution to take in a situation where there is a splash potential.

- Be exceedingly careful around needles! Needlesticks represent by far the greatest risk of occupational blood borne transmission.
  - Depending on your level of training and your department’s policies, you may be occasionally expected to handle sharps such as scalpels in an OB kit, epi-pen needles for anaphylaxis, 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).
  - HOWEVER, as an EMT, you will be intimately involved in scenes where paramedics will be using needles, scalpels, or other “sharps.” Many “exposures” among EMTs involve cases in which EMTs inadvertently stuck themselves with used needles! Therefore …
  - Be CAUTIOUS, be AWARE, and be DELIBERATE, when you are working around sharps. Keep an eye on the paramedics and needles, and watch where you put your hands. Your greatest risk of acquiring a blood borne disease will come from a needlestick***, NOT from getting blood on intact skin.***

- Wipe down surfaces after patient contact. Strip sheets from the cot. Consider equipment such as the BP cuff and stethoscope. Use red bags for disposal of contaminated waste per your department’s protocols.

- If you suspect an airborne disease such as tuberculosis, put a mask on the patient (if tolerated), and wear a mask yourself. HEPA masks, as provided by your department, provide the highest level of protection.

- Ask the patient about his or her disease. Sometimes this will determine whether or not the patient is infectious. People with tuberculosis, for example, are not infectious shortly after they start antibiotic treatment, even though they may need to continue the treatment for many more months.

- Follow-up! Diseases such as *Neisseria* meningitis may require treatment of exposed contacts. If you suspect a transmissible disease such as tuberculosis or meningitis, follow-up with the hospital to determine the final diagnosis and any treatment for people who were exposed. Even if the patient doesn't end up having an infectious disease, you'll learn a bit more about the patient's condition. Patient follow-up is a great way to learn more about medicine.

Exposure: What To Do If It Happens To You

We are exposed to infectious diseases at all times, not just when we work as EMTs or paramedics. The viruses that cause the common cold or the flu can be transmitted at the grocery store or the bank as well as in the back of the aid car. Your best protection against such exposures is to keep yourself healthy, allowing the immune system to do its job protecting you from potential invaders. You can help by taking such common sense steps as washing your hands after each patient contact and before eating (even if you aren't at work!). Interestingly, hand-to-hand (or hand-to-eye or –mouth) contact is a more efficient way to transfer germs than even mouth-to-mouth contact. In one study, healthy volunteers were paired with partners who were sick with a cold. Half were asked to kiss the infected person for one minute, while the other half were asked to shake the sick person's hand. Kissing was a relatively inefficient way to transmit the virus, compared to hand shaking!

<u>Blood borne exposure:</u>
Needlestick
- Wash the area well with soap and water.
- There is no evidence to suggest that the use of antiseptics or expressing blood from the wound limits the chance of seroconversion, but they aren't harmful.
- Do NOT use bleach or other harsh chemicals (these may damage the skin, making it more likely for the virus to enter the body)
- Report to your officer for testing and possible post-exposure prophylaxis (see your department's guidelines)

Skin exposure
- Wash with soap and water
- Report to your officer for testing and possible post-exposure prophylaxis (see your department's guidelines)

Mucus membrane exposure
- Flush liberally with water
- Report to your officer for testing and possible post-exposure prophylaxis (see your department's guidelines)

<u>Exposure to airborne diseases:</u>
Follow-up with the local hospital and with your exposure control officer. Some diseases (bacterial meningitis) may require automatic and immediate post-exposure prophylaxis, while others (tuberculosis) may require post-exposure testing and then treatment only if you become positive.

AN ASSESSMENT OF RISK

It is worth noting that the attention given to a disease in the popular press or even around the beanery table may be distinctly out of proportion to the risk it presents to you as an EMT or to the population as a whole. An early example of this was the AIDS epidemic. In the last 25 years, an estimated 57 health care workers in the United States have contracted HIV from a documented occupational exposure. Yet, in spite of this relatively low risk, we take many precautions to protect ourselves from this virus – gloves, masks, and so on. It is ironic that, prior to the development of the Hepatitis B vaccine, thousands of health care workers EVERY YEAR contracted Hepatitis B from an occupational exposure, and it is estimated that as many as 200 per year died! It was *known* that Hepatitis B was a blood borne disease, yet in spite of this knowledge, widespread glove use and other precautions against blood borne diseases did not occur until HIV came on the scene. The combination of fear, prejudice, and ignorance associated with this disease compelled the health care community to take precautions that we probably should have been taking all along.

The recent anthrax scare is another good example of misplaced fear. People from Arkansas to Wyoming found powdered sugar in their cupboards, worried that it might be weaponized anthrax, and convinced their physicians to prescribe Cipro, the prophylactic drug given to prevent anthrax. While this is a slight exaggeration, the reality is that Cipro was prescribed so widely and with so little rationale in many cases that epidemiologists now worry that the drug has lost some of its power as a wide-spectrum antibiotic.

Also consider the recent publicity about West Nile Virus (WNV). This virus is primarily an avian (bird) virus, which occasionally makes the species jump and infects mammals including people. Extensive coverage in the press, particularly on the east coast, suggests that you have a reasonable risk of acquiring the disease. The statistics, however, show otherwise. Most people infected with WNV are completely asymptomatic; those that have symptoms often feel as though they have the flu. Only 1% of the people infected go on to develop more severe presentations such as meningitis or encephalitis. In 2001, 9 people died of WNV (the numbers will undoubtedly increase as the disease spreads westward). This is still a tiny number from a statistical viewpoint. By comparison, an average of 70 people are killed by lighting each year! And other, much more common diseases, pose a greater risk, yet are neglected in the press. Each year, for example, 114,000 people are hospitalized for complications of the flu, and 20,000 DIE.

Why does all of this matter? Why is an assessment of risk important to an EMT?

Life is risky. We take calculated risks every day, whether we go for a hike, take care of a patient in an auto accident, or drive to the post office to pick up the mail. A rational and scientific understanding of risk allows us to make educated decisions. Viewing EVERYTHING as equally risky blunts our appreciation for those things that are truly dangerous. For example, many health care providers wear gloves at all times, and go to great lengths to avoid getting blood on their skin. Yet blood on intact skin poses a vanishingly small risk, compared to the hazard of getting a needlestick – and wearing gloves provides little protection against a needlestick. Statistical data supports the assertion that the emphasis on keeping ourselves safe against blood borne diseases should be on preventing needlesticks rather than religious wearing of gloves for all patients. Yet the casual attitude of some health care providers towards “sharps,” and the incidence of

needlesticks among prehospital care providers, shows that we still have a way to go to meet this goal.

To take this concept a step farther, we spend much time dwelling on our risk of acquiring an infectious disease, yet often don't consider other risks associated with the job (many of which can be mitigated). For example, in the last 10 years, between 20 and 25% of all firefighter fatalities occurred while responding to or from a fire or EMS incident. Approximately 30% of the fatalities were due to ejection from the vehicle; of these, only 20% were wearing seatbelts at the time! EMT and paramedic injuries and fatalities from motor vehicles accidents run into the hundreds per year (but are harder to track due to the lack of a central reporting agency.) It is probably safe to say that if you are dispatched to an ill person with HIV infection, the most dangerous part of the call is simply GETTING THERE.

As with most things in life, the antidote to ignorance about disease is knowledge. The goal of this curriculum has been to provide a starting point for you to increase your knowledge. At the end of this text is a list of books and web pages that provide additional information. It is our hope that this information will help keep you safe, help you provide better care to your patients, and help you be a better-educated citizen in this changing world.

APPENDIX 1: SPOTLIGHT ON DISEASE

A few conditions of interest to EMTs

The diseases presented here – AIDS, Hep B, Hep C, and TB are of considerable concern to many prehospital care providers, not only because these are transmissible diseases which carry a high risk of serious disease and death, but because many EMTs view their risk of acquiring such diseases as significant. These diseases are also given considerable attention in most courses of infectious disease. In fact, as the section on transmission emphasizes, our risk may not be as high as we perceive it to be. Additional information on these and other diseases may be found in Appendix 2, Matrix of Infectious Diseases. The web pages listed in Appendix 2 can be used as a source of additional information.

AIDS (Acquired Immunodeficiency Syndrome)

AIDS is caused by the virus HIV (human immunodeficiency virus). HIV attacks the cells of the immune system. These cells, called T cells, are responsible, in a healthy person, for orchestrating many aspects of the immune response to a variety of pathogens – bacterial, viral, fungal, and parasitic. As the T cells are destroyed, the suppressed immune system can no longer fight off these pathogens. The person then becomes susceptible to a wide variety of diseases and infections. You may have heard these called "opportunistic diseases" or "opportunistic infections," because they take opportunity of – take advantage of – the body's suppressed immune system. Ironically, when we treat a person who is sick with HIV/AIDS, we are more likely to be treating him or her for one of these opportunistic diseases than for symptoms caused by the virus itself.

Although HIV, the virus that causes AIDS, was isolated in 1983, there is evidence from examining old blood samples that the virus may have been present in the US as early as the 1970s. The virus probably originated in Africa in the 1940s or later, possibly as a mutation of a primate virus.

<u>Current status</u>

Worldwide: Approximately 42 million people are estimated to be living with HIV/AIDS worldwide. It is estimated that over 5 million new cases occur yearly. In 2001, an estimated 3 million people died of AIDS. Ninety-five percent of the people infected with HIV/AIDS live in the developing world. Worldwide, the male-female sex ratio is virtually 1:1.

Nationwide: Approximately 40,000 new cases occur in the US every year. Of these, 70% occur in men, 30% in women.

**Most of these are 2001 statistics.

<u>Transmission</u>

HIV may be transmitted by:

- Unprotected sex with an infected partner
- Infected blood given during a transfusion (extremely rare in developed countries today due to testing of the blood supply)
- Sharing of needles by IV drug users
- An infected mother to her baby
- Occupational transmission usually by a needlestick of infected blood

HIV is NOT transmitted by:
- Kissing
- Sharing of utensils, swimming pools, toilet seats, etc.
- Casual contact
- Mosquitoes or other biting insects
- Air, food, or water
- Vomit, feces, urine, or saliva, unless they contain visible blood

Diagnosis

When a person is infected with HIV, the body makes antibodies to the virus. These antibodies can be detected several weeks to several months after exposure. Two of the most common antibody tests are the ELISA test and the Western blot. It is also possible (though more expensive) to test for the presence of the virus itself.

Progression

Initial infection with HIV may present like influenza (the flu), with swollen glands, low-grade fever, headache, and fatigue. (This corresponds to the body mounting what will turn out to be an ineffective defense against the invading virus.) These symptoms resolve and are often not severe enough to cause the person to seek medical attention. Then begins a period in which a person may be either completely asymptomatic (without symptoms) or have very mild symptoms. This may last as long as 10 years if the person is otherwise healthy. However during this time, the T cells of the immune system are being destroyed. Eventually, enough are destroyed to affect the body's ability to fight disease. A person is considered to have progressed from HIV infection to AIDS when a) the T cell count falls below 200 (normal is 1000 or more), or b) when the person acquires any one of a number of diseases or infections which are not normally found in people with healthy immune systems (*Pneumocystis* pneumonia or Kaposi's sarcoma, to name just two).

Prehospital presentation

Unlike many diseases, which present in a predictable way, HIV/AIDS varies in its presentation depending on which opportunistic disease or infection is acquired. As a prehospital care provider, you may encounter:
- Dehydration and hypotension secondary to diarrheal diseases (*Giardia*, *Cryptosporidia*)
- Seizures or altered mental status secondary to a nervous system infection (Cryptococcal meningitis, viral meningitis)
- Dyspnea secondary to a respiratory infection (pneumonia, tuberculosis, etc.)
- Medication reactions (which may range from nausea and vomiting to a rash to hypoglycemia)
- End of life issues

Treatment

Treatment for a person who is infected with HIV consists of:
- Antivirals such as AZT, and newer medications which interfere with the virus's ability to reproduce (protease inhibitors)
- Medications which prevent or treat the opportunistic infections (antibiotics, antifungals, etc.)
- Supportive care and palliative care (medications, which address the patient's symptoms, pain, etc.)

Occupational Risk
The occupational risk of acquiring AIDS is VERY LOW. In the last 25 years, the Centers for Disease Control have been tracking health care workers who acquired HIV from documented, on-the-job exposures. During this time, there have been 57 documented cases – none of them among prehospital care providers.

HIV is transmitted most efficiently by blood-to-blood contact. Virtually all health care workers who acquired HIV occupationally did so by getting needlesticks of infected blood.

The CDC estimates that the risk of acquiring HIV infection after a needlestick with infected blood is 0.3% (i.e., approximately 1 in 300). The risk of acquiring HIV infection after mucus membrane exposure to infected blood is .09% (less than 1 in 1000).

Prevention of Occupational Exposure
The CDC statistics support the claim that HIV is transmitted most effectively through blood, particularly via a needlestick or other blood-blood contact. Prevention should therefore be focused on preventing significant blood exposures, specifically (in our business) *needlesticks*. If a significant exposure does occur, post-exposure prophylaxis may be recommended.

Vaccination: there is currently no effective vaccine to prevent infection with HIV.

Post-exposure prophylaxis: A health care worker who has a significant exposure to HIV may take "post-exposure prophylaxis" (PEP) – medications that are taken AFTER an exposure to reduce the chance of acquiring the disease. Post-exposure prophylaxis reduces the already very low risk of acquiring the disease, although it does not guarantee that no disease transmission will occur. An exhaustive review of PEP is beyond the scope of this curriculum; the CDC's website provides complete, up-to-date information. A few points about PEP:

- The medications taken for PEP are 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!
- If PEP is started, it should be started SOON! Animal studies suggest that PEP is most effective if started IMMEDIATELY after exposure, if at all possible within two hours.
- As soon as possible after the exposure, determine whether the person from whom the exposure occurred is HIV negative or positive. If the patient is determined to be HIV-negative, the PEP medications can be stopped.

Hepatitis B

This disease is caused by the hepatitis B virus (HBV), which damages the liver. Vaccination against HBV has been available since 1982. The disease is spread by contact with the blood of a person infected with the disease, or by sexual transmission.

Current status
The number of new infections with HBV in this country has declined from an average of 260,000 in the 1980s to about 78,000 in 2001. The highest rate of disease occurs in those

20 to 49; children and adolescents have shown the greatest decline due to routine vaccination.
An estimated 1.2 million Americans are chronically infected with Hepatitis B.

Transmission
- Blood and other bodily fluids.
- Sex with an infected person
- Sharing needles with an infected person
- From a woman to her baby during birth
- Hepatitis B is not spread by food, water, or casual contact.

Diagnosis
A blood test checks for the presence of HBV antibodies.

Progression
Over 90% of infants, 50% of children, and 5% of adults with acute hepatitis B will develop chronic or long-term infection. About 30% of infected people have no signs or symptoms. In the remainder, the person may develop jaundice, fatigue, abdominal pain, nausea and vomiting. HBV can cause lifelong infection, cirrhosis (scarring) of the liver, and liver cancer.

Prehospital presentation
Because most of the signs and symptoms of Hep B are mild, it is unlikely that you will be called to respond to an acute illness caused by this virus. However you may on occasion see a patient with end stage liver cancer or other complication from the disease.

Treatment
Treatment: adefovir dipivoxil, alpha interferon, and lamivudine are used for the treatment of patients with chronic Hepatitis B.

Occupational Risk
The occupational risk for acquiring HBV for an unvaccinated person is significant. Studies of unvaccinated health care workers who sustained a needlestick with HBV infected blood showed that up to 30 percent developed clinical disease. Widespread studies of health care workers before vaccination found that the incidence of HBV was ten times higher than in the general population. It has been claimed that prior to the introduction of Hep B vaccination, approximately 200 health care workers died yearly as a result of their occupational exposures to HBV.

Prevention of Occupational Exposure:
The best way to prevent an occupational exposure to HBV, in addition to taking care to protect yourself from blood exposure, is to be vaccinated against the disease. This vaccine is extremely effective at preventing infection.
Vaccination is currently recommended for:
- Children 0 to 18 who have never been vaccinated
- Anyone whose behavior puts them at risk of acquiring HBV
- Anyone whose job exposes them to human blood

Vaccination is very effective at preventing acquisition of Hep B and has been shown to be very safe.

Post-exposure prophylaxis: Even if you are vaccinated, you may be advised to take post-exposure prophylaxis (PEP) after a significant exposure to infected blood. This may consist of immune globulin and/or vaccination, depending on your vaccination status.

Hepatitis C

Hepatitis C is a liver disease caused by the hepatitis C virus (HCV). The disease is spread by contact with the blood of a person infected with the disease.

Current status
Number of new infections per year has declined from an average of 240,000 in the 1980s to about 25,000 in 2001. An estimated 3.9 million (1.8%) Americans have been infected with HCV, of whom 2.7 million are chronically infected.

Transmission
- Transmission of Hep C is primarily through blood. Most current infections are due to sharing of illicit injection drug equipment. Previous infections occurred through transfusions and through dialysis equipment prior to screening and other precautions. Mothers who are infected with Hep C can pass the virus on to their babies.
- Transmission does not occur through coughing, sneezing, sharing utensils or drinking glasses, or other casual contact. It is also rare for HCV to be transmitted via sexual contact, although it can occur.

Diagnosis
An antibody test can determine whether the body has been exposed (made antibodies) to the HCV virus. A viral test shows if there is actually virus present in the body.

Progression
On average, of every 100 persons infected with HCV about:
- 75 to 85 persons may develop long-term infection
- 70 persons may develop chronic liver disease
- 15 persons may develop cirrhosis over a period of 20 to 30 years
- Less than 3% of persons die from the consequences of long term infection (liver cancer or cirrhosis)

Prehospital presentation
80% of people with Hep C are asymptomatic. Others may have mild signs and symptoms such as nausea, loss of appetite, abdominal pain, jaundice, and fatigue. It is unlikely that you will be called to respond to an acute illness caused by hepatitis C, although you may on occasion see a patient with end stage liver cancer, liver disease, cirrhosis, or other complication from the disease.

Treatment/vaccination/post-exposure prophylaxis
- Two drugs used to treat Hep C are interferon and ribavirin. Otherwise, most treatment is symptomatic. There is no vaccine for HCV.
- There is no post-exposure prophylaxis for HCV.

Occupational Risk
After needlestick or sharps exposure to HCV positive blood, about two healthcare workers out of 100 (1.8%) will get infected with HCV (different studies have found different rates of infection). Like HIV, this is a relatively low risk; according to the CDC, “HCV is not

transmitted efficiently through occupational exposures to blood." Furthermore, HCV is even less likely to be transmitted through exposure to other fluids, and there have been no cases of HCV being transmitted through exposure to either intact or non-intact skin.

Prevention of Occupational Exposure
The CDC statistics support the claim that HCV is transmitted most effectively through large-scale exposure to blood, such as via a transfusion. While your risk is minimal, HCV *can* be transmitted through needlesticks. Prevention should be focused on preventing these significant blood exposures.

Tuberculosis

Tuberculosis (TB) is a disease caused by small bacteria that travels from the small airways to the cells of the lung. Less than 10% of people infected with TB will develop active disease; in the others, the bacteria hides, causing no disease until the host (patient) becomes immunocompromised or otherwise debilitated.

History
TB was once the leading cause of death in this country. However beginning in the 1940s, drugs used to treat TB caused a dramatic decline in cases until the mid 80s. There are many theories about the recent resurgence of TB in this country, including resistance of the bacteria to the drugs, globalization and world travel, and the HIV/AIDS epidemic. 16,000 cases were reported in the US in the year 2000.

Current status
Eight million new tuberculosis (TB) cases occur each year in the world and 3 million people die of the disease. An estimated 10 to 15 million persons in the U.S. are infected with the bacteria. Without intervention, about 10 percent of these persons will develop TB disease at some point in life. About 100 cases per year of active TB are reported in King County.

People at risk for TB include foreign-born people from areas with a high prevalence of TB; residents and employees of long-term institutional settings (such as nursing homes and correctional facilities); and medically under-served populations, such as the poor, the homeless, and injection drug users. Other people at risk include immunocompromised people (especially those with HIV infection and on chemotherapy) and people with other medical risk factors (such as diabetes or end-stage renal disease).

Transmission
The bacteria is spread through the air from one person to another. This bacteria can be spread during the process of breathing, coughing, speaking or using a nebulizer.
TB is NOT spread by handshakes, sitting on toilet seats, or sharing dishes and utensils with someone who has TB.

Diagnosis
The PPD ("purified protein derivative") consists of injecting a small amount of testing fluid (called tuberculin) under the skin. A raised bump, read by a health care worker two to three days later, indicates a positive test. However this test does not distinguish between latent and active infection.

Active infection may be diagnosed by a positive sputum culture or smear, or by a chest X ray.

TB reporting is required by law in every state! This means that a physician who identifies a case of TB must report it to the local health department. When this occurs, all close contacts are notified. This may include the prehospital care providers if they transported or had close contact with a person with TB.

Progression

TB bacteria in the body can cause two types of infection: latent and active. A person with latent infection usually has a healthy immune system, which keeps the bacteria from multiplying and causing illness. A person with *latent infection*:

- May have a positive PPD (TB skin test)
- Is asymptomatic
- Is not infectious
- May develop active disease in the future if the immune system is suppressed.

A person with *active disease*:

- Has a positive PPD
- Feels sick and has symptoms of TB
- Can spread the disease to others

Prehospital presentation:

A person with *active disease* may have the following signs and symptoms:

- Cough, often productive of blood-tinged sputum
- Fatigue and weakness
- Night sweats
- Low-grade fever
- Loss of appetite and weight loss

Most of these signs and symptoms are not life-threatening and often come on gradually, so the person will not necessarily seek help from EMS for this condition. Rather, a person may call 911 for another reason, and the EMT may note the presence of these signs and symptoms.

Treatment/vaccination/post-exposure prophylaxis

People who develop new infections (as opposed to those who have been infected for years) are at greatest *risk* of developing active disease — that is, becoming sick with TB. Therefore they may be given TB prophylaxis in the form of isoniazid (INH), for 6 to 9 months (occasionally longer). People with *active TB disease* are given several different medications (among them rifampin, pyrazinamide, ethambutol, and streptomycin), which they must take for at least six months. However note that in most cases, the patient will no longer be infectious after 2 to 3 weeks of taking the medications.

Vaccination: A vaccine called BCG (named after two scientists who developed it) is given in some countries. The vaccine is rarely used in the US and has been found to be relatively ineffective at preventing the disease.

Occupational Risk

Occupational risk is low but has been very difficult to quantify. Risk increases with time spent with the patient and type of exposure. Although the timeframe is short, exposure to a patient with active disease in the back of an aid car does pose a small risk of infection,

particularly if an invasive airway technique such as intubation is performed. Among family members and other close contacts of a person with active disease, estimates of infection range from 10% to 20%, with 1% of these contacts developing active disease if untreated.

Prevention

You can minimize your chance of acquiring TB by maintaining a high index of suspicion among patients who are at risk of having TB, and then taking precautions if patients present with suspicions signs and symptoms. Precautions include wearing a mask and putting a mask on the patient (if the patient's condition permits). Even a simple step such as asking the patient to cough into a tissue will reduce the number of bacteria dispersed.

SARS (Severe Acute Respiratory Syndrome)

In February 2003, a new and virulent respiratory infection was reported in Asia. Over the next few months, before effective steps could be taken to contain the disease, it had spread to over 20 countries through North America, South America, Europe, and Asia – a testament to the effect of global commerce, enterprise and travel.

The SARS outbreak of 2003 was contained by the summer. However before it disappeared, it sickened over 8,000 people worldwide, of whom 700 died. In the United States, there were 192 possible cases (of these, only 33 were considered "probable"), and there were no deaths. However, worldwide, the disease was unusual and frightening in that it had a relatively high case fatality rate among young, healthy people.

What caused SARS? Where did it come from? Could it return?

SARS is caused by a coronavirus. This family of viruses has also been implicated in the common cold (note: there are multiple causes of the "common cold"). It is possible that the coronavirus causing SARS has a reservoir in animals. A virus appearing identical to human SARS has recently been discovered in the civet, a small carnivore related to the mongoose. The civet is a culinary delicacy in parts of Asia and thousands are kept in captivity prior to being eaten.

SARS begins with a high fever, headache, malaise (overall poor feeling), and body aches. There may be mild respiratory symptoms and there may be diarrhea. Most patients develop pneumonia – ultimately the most serious complication of the disease. The resulting hypoxia may require ventilatory assistance and supplemental oxygen.

Like many respiratory viruses, SARS is spread through close person-to-person contact. Droplets spewed from the cough or sneeze of an infected person are an effective way to transmit the disease. However the disease can also be spread on surfaces – if the infectious droplets land on an object, a healthy person can then touch that object and touch his or her mouth, nose or eyes, spreading the virus.

Treatment is largely supportive and symptomatic, and is similar to the treatment that would be given to a person with serious pneumonia. Antiviral drugs were tested but were not been found to be very effective.

The SARS outbreak was officially contained in July 2003. Until recently there were no additional community-acquired cases (though there were several cases as a result of laboratory exposures). In December 2003 in southern China, a case of SARS was reported which was potentially acquired from the animal reservoir (civets). This case has been contained and there have been no additional outbreaks. Nevertheless, there is uncertainty surrounding this disease. We can't predict if or when SARS will return, whether it will make its way to North America, and if it does, what form the disease will take. Epidemiologists will be continuing to monitor the global disease situation. Updates and guidelines will be provided through our local health department, the CDC, and the WHO (links below):

www.metrokc.gov
www.cdc.gov
www.who.org

SARS: Important points

- Viral respiratory illness caused by a coronavirus
- Possible animal reservoir (civets)
- Global outbreak of 2003 contained
- S&S: fever, headache, malaise, body aches, cough, diarrhea, pneumonia
- Spread by close person-to-person contact and on surfaces
- Prevention (prehospital):
  - Standard precautions: wash hands, wash surfaces
  - Contact precautions: gown, gloves, and protective eyewear
- Currently minimal risk due to lack of recent cases – follow local and CDC guidelines for identification of high-risk patients if the disease returns

Influenza

In 1918 to 1919, a pandemic swept the globe. Twenty to 40 million people died. Up to a third of the world's population became ill, with the highest mortality suffered by those between 20 and 40 years of age. It wasn't the Black Death, or yellow fever, or cholera, or any number of other horrific diseases that we have come to associate with widespread death and destruction. It was a disease that most of us have experienced in our lifetimes, a disease that resurfaces every year, a disease that we regard casually and even cavalierly. It was the flu.

The flu, more correctly known as influenza, is caused by the influenza virus, which attacks the respiratory system. Flu occurs seasonally, generally from November to April in the northern hemisphere. The structure of the virus changes slightly but frequently over time; this accounts for the appearance of different strains each year. The natural reservoir of Type A influenza (the strain that has the potential to cause pandemics) is wild birds, but the virus can also affect pigs and horses. The virus can mutate in these hosts. In the 1918-1919 flu pandemic, the strain was unusually virulent – not only was it very infectious but it also had a high mortality rate. That event is considered to have been the worst epidemic in recorded history, and is the main reason that we should not underestimate the flu.

The flu as we know it today is an respiratory disease characterized by a relatively sudden onset of high fever, headache, extreme fatigue, muscle aches, dry cough, and sore throat.

(Although GI symptoms may occur, there is really no such thing as the “stomach flu” – influenza is a respiratory not a gastrointestinal disease. Illnesses whose predominant symptoms are vomiting and diarrhea are probably caused by other viruses or by a bacterial infection.) Although anyone can get the flu, the disease is more severe in people who are older or who have significant medical history. Yearly, from 10 to 20% of the US population gets the flu – and an estimated 36,000 people die from it. This is of course fewer than died in 1918, but statistically this is a far greater threat than diseases like West Nile virus, mad cow disease, or SARS.

The flu is transmitted via respiratory droplets that are present when an infected person coughs or sneezes. The disease can also be spread, less commonly, by virus that is present on surfaces. Prevention takes the form of proper handwashing, cleaning contaminated surfaces, and asking coughing patients to cover their mouth or even wear a mask.

Treatment of the flu is mainly supportive and symptomatic. Antibiotics are useless against viruses, although they may occasionally be prescribed to prevent a possible secondary bacterial infection. There are several anti-viral medications that may reduce the duration and severity of the flu. In general flu resolves on its own in about a week.

Fortunately a vaccine is available which is highly successful in preventing the flu. It is necessary to be vaccinated yearly, since the viral strains mutate. Sometimes, the predominant virus strain changes from the time the vaccine is made to the time the disease arrives in late fall. In that case, the vaccine may not provide complete protection. The flu vaccine is a killed vaccine; it cannot give a person the flu.

Important information and updates about the flu and flu vaccinations can be found on the CDC’s webpage:

www.cdc.gov

Influenza: important points

- Viral illness caused by the influenza virus
- Animal reservoir probably in wild birds (pigs may mix strains)
- S&S: sudden onset of high fever, malaise, headache, dry cough, body aches
- Spread by coughed droplets and less commonly on surfaces
- Prevention: handwashing, clean surfaces, mask on patient or ask patient to cover mouth when coughing
- Best prevention is the flu vaccine, which must be taken yearly

APPENDIX 2: INFECTIOUS DISEASE REFERENCE INFORMATION

This Appendix lists a number of diseases that may be of interest to EMS personnel, either because we are potentially at risk of acquiring the disease or because the disease has been in the news lately (even though the risk may be minimal). If your favorite disease isn't listed, we apologize! A great reference site for infectious diseases of all types is the Centers for Disease Control website, at **www.cdc.gov**

Every attempt has been made to bring the information in this chart up to date. Some variation may occur in some of the statistics depending on the reference material used.

Disease	Pathogen	Occurrence	Mode of Transmission	Signs and Symptoms	Methods of Control, Prevention, Treatment, and PEP	Prehospital Risk	Internet reference
AIDS	HIV (human immunode-ficiency virus), a retrovirus that infects cells with CD4 receptors (specifically cells of the immune system, GI tract, and nervous system)	40 million people infected worldwide. In 2001, an estimated 3 million people died of AIDS.	Blood, semen, vaginal fluid, or breast milk that enters the body through a vein or through small tears in the skin or genital area.	Primary disease (flu-like symptoms, diarrhea, fever) several weeks after infection. Latent period follows, lasting up to ten years or more. HIV infection → AIDS c/ development of specific opportunistic infections or T4 count below 200. Immunosuppression leaves a person susceptible many disease e.g.: fungal infections of mouth, esophagus, lungs, and brain; parasitic diseases causing severe diarrhea or pneumonia; recurrent bacterial infections; carcinomas and lymphomas; mycobacterial infections; wasting disease	Control and prevention: practice "safe sex," don't use IV drugs, or use clean needles, get tested if you are at risk. Avoid contact with blood, especially via needlesticks. Prevention: no vaccine. Treatment: anti-virals and treatment of opportunistic diseases/infections. PEP: Yes, ASAP after an occupational exposure.	Greatest risk is from a needlestick with contaminated blood, and is approximately .3% (one in 300). Mucus membrane exposures are approximately .1% (one in 1000). Blood on intact skin or contact with other non-bloody bodily fluids are virtually without risk.	http://www.cdc.gov/hiv/pubs/facts.htm http://www.metrokc.gov/health/apu/ Prevention and PEP for health care workers: http://www.cdc.gov/hiv/pubs/facts/hcwprev.htm

Anthrax	*Bacillus anthracis*, a bacteria	Worldwide, thousands of cases occur in countries where people have direct contact with animals (the main reservoirs). Normally there are about 5 cases per year in the US. Last year's cases were due to intentional contamination of mail and other items with anthrax spores.	Cutaneous (most common): contact with hides or skin of an infected animal. Inhalational: inhalation of anthrax spores Intestinal: ingestion of meat or other produce from an animal infected with anthrax	Inhalation: fever, headache, cough, difficulty breathing, chills, weakness, and chest discomfort. Cutaneous: raised, itchy bump, becoming a small blister, which then becomes a painless sore with a black center. Intestinal: nausea, vomiting, fever, pain in the abdomen, and diarrhea.	Prevention: Elsewhere in the world, animal control consists of vaccination and utilizing care in handing hides and animal products. Treatment and PEP: in the unlikely event of exposure to anthrax, possibly used as a weapon, an antibiotic taken for 30 to 60 days is used for both prevention and treatment of anthrax.	Minimal, even if caring for a person with anthrax. Anthrax is NOT transmitted person-to-person.	http://www.bt.cdc.gov/agent/anthrax/index.asp and http://www.metrokc.gov/health/prevcont/anthraxfacts.htm
Botulism	Toxin formed by the bacteria *Clostridium botulinum*	Approximately 100 cases per year in the US. Most are from improper canning.	Ingestion of contaminated food. Potential of botulina as an agent of bioterrorism	Blurred vision, dry mouth, and paralysis of the muscles, especially those of face, swallowing, and breathing. Vomiting, constipation or diarrhea may also occur.	Prevention: proper canning Treatment: anti-toxin and supportive care	None. Not transmitted person-to-person.	Basic info: http://www.cdc.gov/health/botulism.htm Botulina as a possible agent of bioterrorism: http://www.hopkins-biodefense.org/pages/agents/agentbotox.html
Chicken-pox	*Varicella* virus which also causes herpes zoster and shingles	4 million cases per year in the US. Most occur in children and are mild in nature. The disease is more severe in adults	Direct contact with secretions (e.g. saliva) from an infected individual or through the air from secretions (coughing, sneezing, etc.)	Characteristic itchy rash, the "pox", which form blisters that dry and become scabs in 4 to 5 days.	Prevention: vaccination. Treatment: mostly supportive	Highly contagious. Consider vaccination if you haven't had chickenpox as a child. An antibody test can determine whether you've been exposed in the past.	Basic info: http://www.metrokc.gov/health/prevcont/chickenpox.htm#What and http://www.cdc.gov/nip/diseases/varicella/

Creutzfeldt-Jakob disease (CJD) and "new variant" Creutzfeldt-Jakob disease (nvCJD)	Prion, a deformed protein which causes changes in the proteins around it, particularly in nervous system tissue	Approximately 120 cases of nvCJD in the UK since 1995.	Kuru, a related disease, is known from the Fore people of New Guinea, where it was transmitted by cannibalism. CJD occurs sporadically worldwide and has been transmitted person-to-person by organ transplants. nvCJD is thought to be spread by the consumption of infected beef	Progressive neuromuscular decline with symptoms of muscular weakness, lack of coordination, and dementia.	Control: destroy animals and animal carcasses known to be infected. Prevention: avoid eating nervous tissue, or to be safer, avoid eating meat. Treatment: symptomatic. CJD is 100% fatal. PEP: none	None. The only known person-to-person transmission is via transplants. (A closely related disease, kuru, is spread by cannibalism)	Basic info: http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm and http://www.mad-cow.org/ and http://www.pbs.org/wgbh/nova/madcow/
Food poisoning	Usually bacterial (*Campylobacter, Salmonella, E. coli*	Estimated to cause 76 million illnesses, 325,000 hospitalizations, and 5,200 deaths in the US yearly.	Ingestion of contaminated food or water.	Nausea, vomiting, diarrhea, abdominal cramps. Depending on the bacteria, diarrhea may be bloody or watery. Fever may or may not be present.	Control, prevention: sanitation, a clean water supply, washing of food prior to eating, washing hands prior to eating Treatment: Most people recover without treatment, or with symptomatic treatment only. Rarely, antibiotics may be prescribed.	Use care in handling material soiled with feces. Wear gloves and wash hands well with soap and water after contact.	http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodborneinfections_t.htm
Giardia	Parasite *Giardia lamblia*	Unknown. A large percentage of infected people are asymptomatic; up to 30% of some populations are infected.	Ingestion of contaminated water; accidental ingestion of fecal material on food or via pets.	Abdominal cramps, diarrhea, gas, rarely vomiting.	Control/prevention: Filter water prior to drinking if source is unknown. Wash or remove skins from vegetables. Wash hands after cleaning up after pets or people with diarrhea.	Use care in handling material soiled with feces. Wear gloves and wash hands well with soap and water after contact.	http://www.cdc.gov/ncidod/dpd/parasites/giardiasis/factsht_giardia.htm
Hanta-virus Pulmonary Syndrome	Hantavirus	Although a newly described syndrome (1993), the disease probably existed unrecognized prior to this date. Approximately 20 cases have been reported in Washington state.	Virus is transmitted through the saliva, urine, and feces of the deer mouse and some other rodents.	Fever, chills, muscle aches, nausea, vomiting, and abdominal pain. Coughing and shortness of breath develop within a few days. Death may result from profound hypoxia or from hypotension.	Control/prevention: avoid contact with wild rodents. Treatment: mainly symptomatic, including ventilatory support if needed.	None. Hantavirus is not transmitted from person to person.	http://www.metrokc.gov/health/prevcont/hanta.htm#hantavirus and http://www.cdc.gov/ncidod/diseases/hanta/hantvrus.htm

Hep A	Hepatitis A virus	Prior to widespread vaccination, there were 35,000 cases of Hep A per year. Current caseload is significantly lower. One-third of Americans have evidence of past infection (immunity).	Contaminated food, water, or shellfish. Sexual contact.	Nausea, vomiting, fatigue, fever, and abdominal cramps. Jaundice (yellow eyes or skin) may also be present but does not occur in all cases.	Control/prevention: care in food handling. Treatment: rest, symptomatic treatment. Most cases resolve spontaneously. Vaccination: available for those at risk (such as travelers to foreign countries) PEP: Immune globulin provides 80 to 90% immunity if an exposure to Hep A occurs.	Use care in handling material soiled with feces. Wear gloves and wash hands well with soap and water after contact.	http://www.cdc.gov/ncidod/diseases/hepatitis/index.htm
Hep B	Hep B virus	Prior to vaccination in the 1980s, there were as many as 260,000 new infections per year. In 2001, there were only 78,000. There are an estimated 1.25 million chronically infected Americans, of whom 20-30% acquired their infection in childhood.	Blood and bodily fluids, sexual contact, sharing of injection drug equipment, during childbirth	Nausea, loss of appetite, vomiting, fatigue, and abdominal cramps. Dark urine, pale or stools, and jaundice (yellow eyes or skin) may also occur. Chronic hepatitis B may lead to liver disease including cirrhosis and liver cancer.	Control/prevention: Exercise caution in handling blood/bodily fluids. Vaccination: an effective vaccine exists and is recommended for virtually everyone. Treatment: mostly symptomatic (anti-virals such as adefovir dipivoxil, alpha interferon, and lamivudine are available but have limited efficacy) PEP: Vaccination (if not already done) and Hep B immune globulin (HBIG)	Significant risk with blood contact IF the person is not vaccinated. Vaccination provides almost complete protection. A significant exposure (i.e. needlestick) may still dictate PEP (HBIG).	Basic info: http://www.cdc.gov/ncidod/diseases/hepatitis/b/index.htm PEP guidelines: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5011a1.htm
Hep C	Hep C virus (previously known as non-A, non-B)	3.5 million people in the US are chronically infected. Up to 20% of people with chronic Hep C will develop liver problems 30 years after infection. 80% of persons with chronic hepatitis C suffer only mild injury to their liver over time and have minimal or no symptoms.	Transfusion recipients (prior to 1992), hemodialysis patients, injection drug users, babies born to infected mothers. Sexual transmission and transmission via blood is rare.	Jaundice, fatigue, dark urine, abdominal pain, loss of appetite, nausea. Up to 80% of people with Hep C infection are asymptomatic.	Control/prevention: testing of the blood supply (currently being done). Counseling of injection drug users. Treatment: Interferon, ribavirin, and a number of experimental treatments are given. Much treatment is symptomatic. Vaccination: none PEP: none	Very low. Health care workers are not considered at increased risk unless they sustain a needlestick. After an unintentional needlestick from a HCV positive source, the average risk of HCV infection is 1.8%. Transmission is very rare after mucus membrane exposures, and no transmission has been documented from intact or non-intact skin exposures to blood.	Basic info: http://www.cdc.gov/ncidod/diseases/hepatitis/c/index.htm Hep C virus infection among firefighters, paramedics, and EMTs from 1991 to 2000: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4929a3.htm

Meningococcal disease	Meningococcal bacteria *Neisseria meningiditis*. This bacteria can cause meningitis (swelling of the brain), bacteremia (bacteria in the blood), and pneumonia (infection of the lungs)	May be present in 5% of more of the US population without causing disease. 10%-15% of cases are fatal. Of patients who recover 10%-15% have permanent hearing loss or other serious sequelae.	This bacteria is often found in the noses and throats of healthy people. However, they as well as sick people can spread the disease through coughing, sneezing, nasal discharge, and saliva.	Sudden high fever (102° F or more), chills, severe headache, stiff neck, nausea and vomiting, decreased LOC, seizures, rash or bluish/purple splotches. Not all symptoms will be present in every patient!	Prevention: wear a mask and put a mask on the patient. Treatment: Rifampin Vaccination: available and recommended for people living in close quarters (such as college students) PEP: Rifampin recommended for close contacts.	Unknown, probably dependent on type of exposure and time exposed. Wear a mask to reduce risk. Consider PEP if patient is found to test positive for meningococcal disease.	http://www.metrokc.gov/health/prevcont/menin.htm http://www.cdc.gov/ncidod/dbmd/diseaseinfo/meningococcal_g.htm#What%20is%20meningitis
MRSA (methicillin-resistant Staph A)	Staph bacteria, which is resistant to standard antibiotics.	"Staph" is commonly found in the noses and on the skins of healthy people. MRSA infection usually develops in elderly or sick hospital patients, or those who have an open wound (such as a bedsore) or a tube (such as a urinary catheter. Healthy people rarely get MRSA.	Naturally occurring bacteria found in most people, which causes disease and develops resistance to antibiotics in debilitated patients. MRSA can be spread from one patient to another, primarily by physical contact.	A staph infection can be minor, such as a pimple or boil, or major such as life-threatening bacteremia.	Treatment: other antibiotics (it may take several trials to determine an antibiotic that works on this infection). PEP: not necessary.	Minimal for people who are healthy. Family members of people with MRSA are not advised to take special precautions other than to wash hands after contact. Casual contact, hugging, kissing, etc. are permitted. Wear gloves if contact with bodily fluids is expected.	http://www.cdc.gov/ncidod/hip/aresist/visa.htm
Nectorizing fasciitis ("flesh-eating bacteria")	Group A Strap or a mixture of bacteria including anaerobic bacteria.	Relatively rare (several cases in King County per year). Mortality rate up to 30%.	Trauma to the area, often minor, with contamination by bacteria. It often occurs among injection drug users who use unclean needles to inject.	Tender, red, hot swollen skin at the site of the infection. System symptoms may progress to include fever, tachycardia, altered mental status, and hypotension.	Prevention: use of clean needles by injection drug users. Treatment: antibiotic (depending on gram stain of pus), supportive care, extensive incision and debridement, up to and including amputation.	None. Not typically transmissible from person-to-person.	http://www.metrokc.gov/health/prevcont/necrofasci.htm

Pertussis	Bacteria *Bordetalla pertussis*	Common worldwide. Over 200,000 cases were reported in the US prior to vaccination, which began in the 1940s. Now about 4,000 cases occur yearly. In countries where vaccination is not done, pertussis kills about 300,000 children yearly.	Aspiration of the bacteria which are sprayed in the air by an infected person.	Sneezing, lacrimation (tearing), listlessness. This is followed by paroxysm of coughs culminating in a deep inspiratory whoop. The patient may vomit due to these paroxysms or due to gagging on thick mucus.	Control: vaccination (usually given in childhood) Treatment: antibiotics PEP: antibiotics, on a case-by-case basis	Pertussis is highly contagious, but adults develop only a mild upper respiratory infection.	http://www.cdc.gov/nip/publications/pink/pert.pdf
Smallpox	Variola virus.	The last case of naturally occurring smallpox in the US was in 1949; the last case of naturally occurring smallpox in the world was in 1977 in Somalia.	In most cases, direct and fairly prolonged face-to-face contact is required for transmission. Smallpox also can be spread through direct contact with infected bodily fluids or contaminated objects such as bedding or clothing.	First symptoms: fever, malaise, head and body aches, vomiting. The fever is high, 101 to 104 degrees. Then a rash appears on the skin, starting on the face, spreading to arms, legs, hands, and feet (usually within 24 hrs). The bumps become raised, round, hard pustules, which then become scabs. The disease most commonly confused with smallpox is chickenpox. Differentiation: smallpox lesions develop at the same pace and appear identical. Chickenpox lesions are more superficial and develop in crops. With chickenpox, scabs, vesicles, and pustules may be seen simultaneously on adjacent areas of skin. Moreover, the rash in chickenpox is denser over the trunk (the reverse of smallpox), and chickenpox lesions are almost never found on the palms or soles.	Prevention: Vaccination was stopped due to the assumed extinction of the virus. The possible return of the virus as an agent of bioterrorism has raised concerns about wide-scale vaccination. Smallpox vaccination is with a LIVE virus (vaccinia). The approximate incidence of complications is: -- 3 cases of encephalitis per million vaccinations (40% fatality) -- Progressive vaccinia (growth of the virus with which the person was vaccinated). -- Many cases of more minor complications (fever, rash, malaise) Treatment: mostly symptomatic. Prevention: wear gloves and mask; do not re-use bedding or other contaminated items. PEP: Vaccination is probably effective 4 or 5 days AFTER exposure.	In a smallpox outbreak, almost all citizens are at risk. Health care providers are more likely to be exposed if a sick person seeks help. The desire for vaccination needs to be balanced with the side effects of the vaccination. Fortunately, in the event of an outbreak, it appears that vaccination is probably effective 4 or 5 days AFTER exposure.	http://www.bt.cdc.gov/agent/smallpox/basics/index.asp

Tuberculosis	Mycobacterium (usually *M. tuberculosis*, but other species, e.g. *M. Boris* and *M. Africans* are also seen).	TB at one time was a major cause of death in the US. Today there are about 30,000 cases in the US yearly. The HIV epidemic, as well as an increase in homeless and a decrease in some aspects of the public health system, has caused a resurgence in TB cases.	Usually inhalation of organisms present in droplets. Droplets can hang suspended in the air for several hours.	Initial complaints are general malaise, night sweats, productive cough, and dyspnea. Later in the disease course, hemoptysis may be present. People who are infected have a 10 percent lifetime chance of developing active disease. Those with HIV infection are at much greater risk, running a 10% per year chance of developing active disease.	Wear TB masks (ideally, the patient should also be masked). Reduce contact in an enclosed environment. Reduce sputum-producing activities, such as using a nebulizer. Open the windows in the aid car. Treatment: Anti-tuberculosis drugs (usually at least two drugs are given). These may include Isoniazid (INH), rifampin, streptomycin, ethambutol, and others. PEP: Recent conversion after an exposure may warrant prophylaxis on a case-by-case basis.	Unknown, probably dependent on type of exposure and time exposed. Some statistics suggest that 20% of people with close contact of an infected person (i.e. family members or others living with the person) will develop infection, and 1% of these will go on to develop active disease.	Transmission prevention in health care setting: http://wonder.cdc.gov/wonder/prevguid/m0035909/m0035909.asp
West Nile fever, meningitis, and encephalitis	West Nile virus	Previously found in Africa, Asia, and the Middle East. Discovered in the US in 1999.	Bite of a mosquito	Most have no symptoms or a mild illness with fever, muscle aches, fatigue, headache, and joint pain (West Nile fever). No medical care is required. A smaller number of people develop encephalitis or meningitis with signs and symptoms of high fever, stiff neck, confusion, coma, and seizures.	Prevention and control: reduce chance of being bitten by a mosquito (wear long sleeves, use repellent) Treatment: mostly symptomatic Vaccine: being developed PEP: none	None. This disease is not transmitted from person to person (except possibly, rarely, in a transfusion setting)	http://www.metrokc.gov/health/westnile/faq.htm www.cdc.gov/ncidod/dvbid/westnile/q&a.htm

Appendix 3: Recommended Reading

Desowitz, R., New Guinea Tapeworms and Jewish Grandmothers. 1981. The American Museum of Natural History, NY.
Entertaining short stories dealing with parasitic diseases ranging from malaria to African sleeping sickness.

Garrett, L. The Coming Plague – Newly Emerging Diseases in a World Out of Balance. 1994. Penguin Books, NY. A lengthy, detailed, very complete but readable analysis of a variety of infectious diseases that are making the news – from HIV/AIDS to Ebola to Hantavirus.

Kolata, G. Flu – The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus that Caused It. 2000. Farrar, Straus and Giroux, NY.
A fascinating account of a forgotten pandemic that killed more soldiers during WWI than the war; further, it details current attempts to identify and study the virus that caused the disease.

Shiltz, R. And The Band Played On. 1988. Penguin Books, NY.
A detective story of the early years of the AIDS epidemic – how the disease spread, how the virus was identified, and the attempts to stop its spread. A movie of the same name can be rented at local video stores.

Rhodes, R. Deadly Feasts. 1998. Simon and Schuster, NY.
A chilling book that starts by describing a cannibalistic feast in which the prion disease Kuru is potentially transmitted from the dead person to the diners. The book continues by describing other prion diseases, up to and including “mad cow disease.” Hard to put down, and hard to eat a hamburger after reading it.

Preston, R. The Hot Zone. 1994. Random House, NY.
Beginning with a man on a plane who dies of exsanguinating Ebola, this book continues by describing a “close call” with monkeys near Washington DC who were infected with a related, but airborne, virus.

INFECTIOUS DISEASE PRACTICE EXAM

1. Name two differences between viruses and bacteria.

2. Name two viral diseases and two bacterial diseases.

3. How does a virus replicate (reproduce) itself?

4. Which of the following do antibiotics treat?
   a. Viral disease
   b. Bacterial disease

5. How does antibiotic resistance occur? How can you, as a patient, prevent this from happening?

6. How is HIV transmitted? How is it NOT transmitted?

7. What is the most important thing you can do to protect yourself from occupational exposure to HIV?

8. True or false: Vaccination protects you against all forms of hepatitis

9. What signs and symptoms may suggest that a patient has tuberculosis?

10. What signs and symptoms may suggest that a patient has meningitis?

Infectious Disease Practice Exam
ANSWERS

1. **Name two differences between a virus and a bacteria.**
   Viruses are far smaller than bacteria and are not really living things; they need living cells in order to reproduce. They do their damage from INSIDE cells, and cannot be destroyed by antibiotics. Bacterial are simple, one-celled organisms that produce toxins that damage living cells. Bacteria are susceptible to treatment with antibiotics.

2. **Name two viral diseases and two bacterial diseases.**
   Virus: Smallpox, rabies, hanta virus, Ebola, hepatitis, HIV, flu, common cold
   Bacteria: Anthrax, E. coli, Strep, Staph, TB

3. **How does a virus replicate (reproduce) itself?**
   A virus attaches to the outside of a cell via "hooks." It then enters or injects its genetic information, which serves as a template by which the cell is forced to produce new viral particles. The cell, in effect, is turned into a virus-producing factory. When the cell is full of viral particles, it bursts, spewing new virus that goes out to infect new cells.

4. **Which of the following do antibiotics treat?**
   a. Viral disease NO
   b. Bacterial disease YES

5. **How does antibiotic resistance occur? How can you, as a patient, prevent this from happening?**
   Antibiotic resistance can occur when an antibiotic is taken inappropriately – taken when not needed, or taken for a short time and then stopped (which allows resistant bacteria to survive). To prevent this: only take antibiotics when necessary, and then take the full course as prescribed.

6. **How is HIV transmitted? How is it NOT transmitted?**
   Sexual contact, IV drug use, and occupational exposure via contact with blood or bloody fluids. Saliva, feces, and vomitus (unless bloody) have not been implicated in HIV transmission. HIV is NOT transmitted through casual contact, through contact with intact skin, or via airborne exposure.

7. **What is the most important thing you can do to protect yourself from occupational exposure to HIV?**
   Percutaneous (through the skin) exposure to infected blood is by far the biggest risk. BE EXCEEDINGLY careful with sharps (needles, scalpels, etc.). BE AWARE, BE OBSERVANT, and BE CAREFUL when you are at a scene! (Wear gloves when appropriate but don't be deceived – this will not protect you from a needlestick.) Always wash hands after patient care.

8. **True or false: Vaccination protects you against all forms of hepatitis**
   False. There is no vaccination for Hepatitis C.

9. **What signs and symptoms may suggest that a patient has tuberculosis?**
   History of weight loss, fatigue, productive cough (perhaps with blood-tinged sputum), and shortness of breath. Groups at highest risk are the homeless, people with reduced access to medical care, people who are immunosuppressed, and recent immigrants from countries where TB is endemic.

10. **What signs and symptoms may suggest that a patient has meningitis?**
    Fever, unusual rash, headache, photophobia (light sensitivity), stiff neck, seizures (not all symptoms will be present in all patients!)