CHAPTER 2

COMMUNICABLE DISEASE PREVENTION

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INTRODUCTION

The practice of medicine includes the prevention of disease and injury as well as the treatment of illness. Prevention is the preferred method for maintaining good health. Aboard ship, maintenance of the health of passengers, crew, and staff is essential for a successful journey. Specific measures can be taken to prevent, control, or remove threats to the health of those aboard ship. Such measures may be aimed at preventing injury, chemical or other toxic exposure, or infectious diseases. Measures that prevent infectious disease include avoiding risky behaviors; proper sanitation and food hygiene; control of animals and insects that carry disease; and, when indicated, chemoprophylaxis (use of medication or other chemicals to prevent disease), immunization, and quarantine. Presenting educational talks and distributing pamphlets on how to minimize disease risk are also helpful. Those in command of the vessel are ultimately responsible for ensuring that effective preventive measures are in place.

COMMUNICABLE DISEASES

A communicable (or infectious) disease is an illness caused by a specific infectious agent (such as a bacterium, virus, or fungus) or by a substance the infectious agent produces (toxin). The infectious agent or its toxic product may be transmitted directly from an infected person, animal, or the environment to a susceptible host patient, or it may be transmitted indirectly through an intermediate plant or animal host or a vector (often an insect).

Life aboard ship is a unique environment; one that has duties, routines, and activities that can increase a person's chances of acquiring a communicable disease. These elements include:

- **crowding** (easier to pass a cold to other crew in the bunkroom);
- **physical stress** (irregular sleep patterns, changes in diet, weather extremes, noise);
- **self-contained food and water systems** (susceptible to lapses in proper maintenance and cross-contamination with infectious agents);

- **exposure to cargos** (animals and animal products such as hides and wool);
- **travel to other countries** (exposure to diseases such as malaria, typhoid fever and cholera through contaminated food or water).

What influences the occurrence and spread of a communicable (infectious) disease? Three factors: **the agent** (e.g., a type of bacteria); **the host** (the individual or groups who are exposed to the agent); **the environment (route of transmission)**. Disease transmission requires an agent that is capable of causing a disease, a host that is susceptible to the agent, and an environment that permits the agent and host to come together. For an infectious disease to circulate within a population there must be a **chain of transmission** from one infected host to another and a suitable route of spread.

Why is it essential to understand the principles of preventing and controlling communicable diseases? The answer: to ensure safety aboard the ship. If most of the crew are ill (an outbreak), fewer will be able to operate the ship safely; medical supplies may run low and care may become inadequate. To prevent disease, one can direct efforts at the specific agent (e.g., *Staphylococcus aureus*), the host (vaccination to prevent measles) and/or the environment (sanitation improvements to prevent *Salmonella*). One can also target a specific point in the chain of transmission (e.g., *Escherichia coli* and adequately cooked hamburgers). Thus, it is important to know how various diseases are spread, what can be done to prevent their spread, and what can be done to control them once they appear.

Infectious Agents

An **infectious agent** or its toxic product causes communicable disease in a susceptible host. Organisms that can *produce* disease in humans range in size from submicroscopic viruses to the fish tapeworm, a parasite that can attain a length of more than 30 feet. Several groups of **infectious agents** and toxins (and some examples of the diseases they cause) may be classified as follows:

- **Bacteria:** bacillary dysentery, cholera, plague, syphilis, tuberculosis;
- **Bacterial toxins:** botulism, staphylococcal food poisoning;
- **Viruses:** acquired immune deficiency syndrome (AIDS), hepatitis A, B and C, influenza, measles, common cold;
- **Rickettsiae**: Rocky Mountain spotted fever, typhus fever;
- **Parasites:** malaria, hookworm, African sleeping sickness;
- **Fungi:** histoplasmosis, ringworm, athlete's foot.

Some illnesses may be caused by many agents. For example, infection with many different respiratory viruses can result in a common cold, and infectious diarrhea can be caused by many bacteria and viruses. Other diseases, such as tuberculosis or polio, occur only after infection with the specific infectious agent.

Disease Incidence (Occurrence)

Infection with an organism may be inapparent (symptom-free or asymptomatic) or it may result in disease. The likelihood of disease occurring depends on the following factors:

- **Pathogenicity:** the organism's ability to cause disease. The bacterial agent of spinal meningitis, *N. meningitidis*, has high pathogenicity, because infection with this bacteria is likely to lead to severe disease. Other organisms, such as those found normally on human skin, have low pathogenicity because they rarely cause disease.
- **Infectious dose:** the number of organisms to which the person is exposed.
- **Susceptibility:** of the host's ability to resist infection. Factors influencing host susceptibility are discussed later in this chapter.

Thus, an individual infected with an organism may or may not "get sick" or have symptoms.

Chain of Transmission

The concept of the **chain of transmission** is basic to understanding the prevention and control of disease. When the **chain of transmission** is understood, ways to break the chain can be identified. If the chain is broken, then the disease will be controlled and future cases prevented.

A **chain of transmission or infection** contains the following links:

- **Reservoir:** or source of the agent;
- **Portal of exit:** or mode of escape of the agent from the reservoir or source;
- **Mode of transmission:** of the agent from the source to the new host;
- **Portal of entry:** into the new host;
- Susceptible **new host:** (who may become the source for additional transmission).

Reservoirs or Sources of Infection

The **reservoir of infection** is where the organism is normally found. The **source of infection** is the location from which the organism is transmitted to the host (either directly or indirectly through a vehicle such as air or water). For example, the **reservoir** of the organism causing botulism, *Clostridium botulinum*, is the soil. The **source** of the toxin produced by this agent is often improperly processed food contaminated by soil. The **reservoir** and the **source** of an infectious agent may have different locations. Eliminating the **source** of the organism may not prevent further spread of infection if the **reservoir** remains intact.

Reservoirs and sources of infection may be human, animal, or environmental. Most of the infectious diseases harmful to man have a human source or reservoir, which means that the infection is transmitted directly or indirectly from a person with the disease. Examples of such diseases include: AIDS, measles, travelers' diarrhea, pertussis, and typhoid fever. An infection with an organism may lead to consequences ranging from no symptoms and signs, to mild or moderate illness, to serious disease or death.

A **carrier** is a person who harbors an infectious agent but may show no signs of illness. The period of carriage of an organism may occur during the incubation period (the time between infection with the agent and when the patient actually shows symptoms of illness), during an infection (whether apparent or inapparent), or following recovery from illness. Carriage of an infectious agent may be transient, lasting from the onset of infection through a portion of convalescence. It may be chronic lasting many months or years, or even a lifetime. **Asymptomatic** carriers serve as reservoirs of infection and play an important role in the spread of some diseases.

Diseases of animals (*zoonoses*) generally affect humans only accidentally. In such cases, humans are not the natural host for the infectious agent. However, for other zoonotic diseases, both man and another animal or animals are essential to the normal life cycle of the infecting agent. Thus an infectious agent may require two or more hosts for its development during different stages in its life cycle. The agent that causes malaria (a parasite that must live in two different hosts--mosquitoes and man--at different periods of its life cycle) is an example of such an organism. For some infectious agents, either man or another animal can serve as reservoirs of infection.

Animal species serving as reservoirs for infectious agents that affect humans (and examples of their associated diseases) include:

ANIMAL	DISEASE
Snails	Schistosomiasis
Mosquitos	West Nile Virus, Yellow Fever, Malaria
Ticks	Rocky Mountain Spotted Fever, Lyme Disease
Raccoons, skunks, bats, dogs	Rabies
Wild rodents	Plague, Hantavirus Disease, Murine Typhus Fever, Lyme Disease
Cattle, swine, goat, sheep	Brucellosis

Some infectious agents live in the soil; which becomes the reservoir of infection. Fungi (such as those causing coccidioidomycosis, histoplasmosis, and blastomycosis) and molds are found in soil and dust or on vegetation grown in endemic areas (places where the diseases are common). Certain species of bacteria that form spores also are found in the soil, but only if the soil has been

contaminated previously with the spores. Tetanus (lockjaw) and anthrax are examples of diseases that may be acquired through exposure to the environment.

Portals of Entry and Exit

Portals of entry and **exit** are the routes through which the infectious agent enters and exits the body of the host. Often the portal of entry is the same as the portal of exit. **Portals of entry** and **exit** in the human body include the respiratory, digestive, and urinary systems, as well as the skin (including mucous surfaces such as the eye), wounds, and blood.

Often the causative organism enters and exits the body through the part of the body primarily involved in the disease process. This is true, for example, for illnesses such as the common cold as well as other respiratory and digestive system diseases. Conversely, the portal of entry may have no relation to the organ system involved in the disease. For example, the infectious agents for malaria and yellow fever, transmitted by mosquitoes, enter and leave the host through the skin, but involve other areas of the body (such as the liver and brain) in the disease process.

Modes Of Transmission

The main modes of transmission of communicable diseases are person-to-person, common vehicle, airborne, vector-borne, sexual contact, and blood-borne spread. The chain of transmission of an illness can be broken by interrupting the route of transmission.

- **Person-to-person spread** occurs when the source and the host come in direct physical contact. This includes fecal-oral spread, in which fecal material from an infected person is transferred to the mouth of an uninfected person, usually by unwashed hands. The hands are often contaminated by touching an item, such as soiled clothing, and then touching the hands to the mouth. Examples of diseases spread from person-to-person include giardiasis, hepatitis A, rotavirus, and shigellosis.
- **Common vehicle spread** results when a single inanimate vehicle serves as the source of transmission of the infectious agent to multiple persons. Food and water are the most common causes of common vehicle outbreaks. Diseases transmitted through contaminated food and water include botulism, salmonellosis, campylobacteriosis, cholera, and *Escherichia coli* O157:H7.
- **Airborne spread** of disease consists of transmission of the infectious agent by droplets or dust. Droplets are produced whenever someone breathes out; these may be projected greater distances by a cough or a sneeze. These droplets remain suspended in the air. Once the moisture in the droplets evaporates, bacteria and viruses form *droplet nuclei* (tiny particles that can float in the air) that may subsequently be inhaled by susceptible hosts. Diseases spread by the airborne route include tuberculosis, legionellosis, pertussis, measles, rubella, and chickenpox.

- **Vector-borne disease spread** occurs through insects, either externally or internally. *Mechanical* transmission occurs when the contaminated mouth or feet of an insect vector physically transfers the infectious organism to the host or to food. For example, houseflies can carry diarrhea-causing bacteria from human waste to human food. Eating this food can cause subsequent illness. With *biologic transmission*, the vector (for example, the mosquito) carries the infectious agent within its body, and the agent passes through the skin via an insect bite. Examples of vector-borne diseases include Lyme disease, plague, and Rocky Mountain spotted fever.
- **Sexually transmitted diseases** are spread through sexual contact, either heterosexual or homosexual. Sexually transmitted diseases include AIDS, chlamydia, hepatitis B, syphilis, and gonorrhea.
- **Blood-borne diseases** are transmitted by contact with blood from an infected patient. This mode of transmission usually occurs in the health-care setting, with infusion of contaminated blood products or by skin puncture with a contaminated syringe. Sharing of needles among injecting drug users also transmits blood-borne diseases. Examples of blood-borne diseases include AIDS, hepatitis B, and hepatitis C. Malaria can also be a blood-borne disease.

Even when the source of an outbreak is unknown, understanding and interrupting the most likely route of transmission can prevent further disease.

Host Immunity and Resistance

The host is the person or organism susceptible to the effect of the infectious agent. The general health status of the host, his/her genetic makeup, as well as other factors determine susceptibility to disease. Host defenses that contribute to resistance to infection include:

- **Mechanical barriers** (i.e., the skin and mucous surfaces of the respiratory, digestive, and urinary systems) and the action of coughing.
- **Bodily discharges** that either destroy, trap, or wash away infecting organisms. Tears, urine, digestive juices, perspiration, and respiratory mucus contain enzymes, acid, and nonspecific *antibodies* (a type of protein produced by the immune system) that combat infection.
- **Certain cells of the immune system**, found throughout the body, that remove infecting organisms from the body by engulfing and destroying them, in a process known as *phagocytosis*.
- **Competition between normal**, non-disease-causing (*commensal*) microorganisms normally found in the gut or on the skin and *pathogenic* (disease-causing) organisms to which the host is exposed.

These defenses may be overcome by exposure to a large number of organisms or repeated exposure over an extended period of time. Defense mechanisms may

diminish when another disease-causing infection is occurring at the same time, following previous treatment with antibiotics (which wipes out commensal organisms), or when a breakdown in a barrier exists (such as a skin wound).

Individuals can also develop a specific immune response to an infectious agent. This immunity may be acquired through natural infection (i.e. a host becomes immune after recovery from the illness or infection), by active vaccination with the agent, or by passive immunization with antibodies from other persons who have been infected with the agent. Natural immunity follows the natural occurrence of disease. This type of immunity usually lasts the longest period of time, often for the life of the host. Vaccination with weakened or killed infectious agents leads to active, induced immunity. In this case the body develops antibodies specific to the vaccine agent. Measles and polio vaccines are examples of active immunization. Injection of antibodies or antitoxin leads to a passive, temporary immunity to an agent. Use of gamma globulin to protect against chicken pox is an example of passive immunity.

PREVENTION OF COMMUNICABLE DISEASES

Preventing communicable disease requires understanding the relationship between the agent with its reservoir, the susceptible host, and the route of transmission. To find ways to break the chain of disease transmission communicable diseases are prevented by

- increasing host resistance (through vaccinations);
- modifying the environment (to eliminate reservoirs or to interrupt transmission);
- inactivating the infectious agent.

Vaccination

Seagoing persons should be appropriately vaccinated against all diseases traditionally occurring during childhood (diphtheria, tetanus, poliomyelitis, measles, mumps, rubella, and chicken pox) and should consider vaccination to prevent hepatitis A and B. Though vaccines have reduced the occurrence of many of these diseases worldwide, susceptible travelers may still acquire these diseases.

Diphtheria and tetanus boosters are recommended every 10 years. Adults born after 1957 should either have received two doses of MMR (measles, mumps, and rubella-containing vaccine) or show evidence of immunity when their blood is tested for antibodies against these viruses. Vaccination against chicken pox is only necessary if there is no history of childhood infection. Vaccination against both hepatitis A and B and an inactivated poliomyelitis vaccine booster should be considered for adults who plan to travel and work in areas where these diseases are more common. Hepatitis A is contacted by the oral fecal route, such as from contaminated food or water. Hepatitis B may be acquired by direct or indirect contact with body fluids from an infected person. Certain personal practices, such as avoiding contaminated

needles (e.g., tattoo and syringe needles) and using condoms, help to prevent infection.

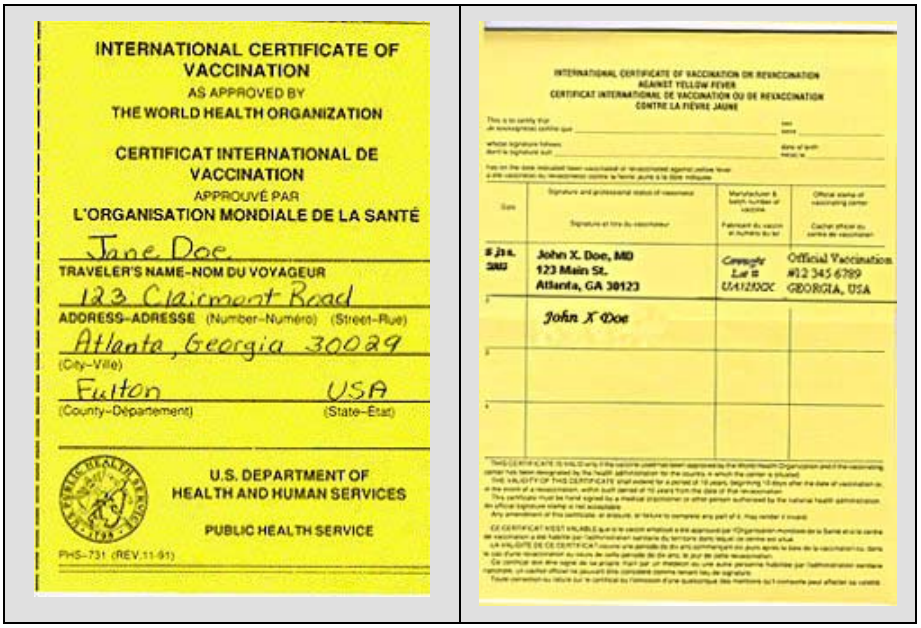
Travelers to endemic areas should consider vaccination for hepatitis A, typhoid fever, and cholera. Hepatitis A and/or typhoid vaccines are indicated for persons who travel regularly to less-developed countries and who anticipate eating locally prepared foods or drinking water. Travelers to less-developed countries are advised to avoid eating uncooked food, especially fish and shellfish, and to peel fruits themselves to minimize the risk of acquiring typhoid fever, cholera, hepatitis A, and other gastrointestinal diseases. Currently, no country or territory requires cholera vaccination as a condition for entry. Local authorities, however, may require documentation of cholera vaccination when coming from endemic or epidemic areas; in such cases, a single dose of vaccine is sufficient to satisfy local requirements. Otherwise, the risk of cholera to U.S. travelers is so low and the vaccine of so little efficacy that it is not currently recommended.

Certain diseases transmitted by mosquitos, such as yellow fever and Japanese encephalitis (a disease that occurs throughout eastern and southern Asia) may be prevented through vaccination and by avoiding mosquito bites by wearing appropriate clothing and using repellents and mosquito netting. Yellow fever vaccination is required at 10-year intervals for travel to many tropical American and African countries. Animal-borne disease such as plague and rabies may be prevented by vaccine and avoidance of unknown animals. Meningococcal disease may be prevented with vaccination when traveling to regions of higher risk: the sub-Saharan east-west belt of Africa, the Middle East, and the Asian subcontinent.

Every seaman should keep with his or her passport and other papers, written evidence of the vaccines and prophylaxis received. The World Health Organization publishes vaccine cards, which are recommended in order to keep an accurate record of all vaccinations (Fig 2-1). Up-to-date records will prevent repeated and unnecessary vaccinations when entering an infected port or one that requires vaccination documents. Some ports may require documentation of prior vaccination for yellow fever or cholera when traveling from areas with high disease activity.

NOTE: An International Certificate of Vaccination must be complete in every detail; if incomplete or inaccurate, it is not valid. This certificate is revised periodically, but older forms are usually acceptable. A copy of the International Certificate of Vaccination, (PHS-731) is available from most health departments and many medical practitioners. It may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, telephone 1-202-512-1800. The stock number is 017-001-00483-9.

Figure 2-1



Although some vaccinations require single dose administration, others require two or three doses given over a period of 2 weeks to 6 months. Without adequate planning, this may present a problem to merchant seamen. If no medical officer is available and qualified to administer vaccinations, it is recommended that seamen arrange for multi-dose vaccinations during layovers ashore. Seamen should consult medical authorities at least 6 weeks before departure to obtain current health information on the countries that will be visited. Information on requirements and recommendations for the international traveler is available via the Centers for Disease Control and Prevention (CDC) website at http://www.cdc.gov/.

Reservoir Eradication

Exposure to infection can be prevented by eradicating the reservoir of infection, closing the portals of exit from the sources, and eliminating the modes of transmission. For example, outbreaks of bubonic plague have been controlled by destroying rats and other rodents that can carry the plague bacteria. Providing proper environmental controls of air, dust, and dirt (which may harbor infectious agents) aboard ship may decrease the risk of communicable diseases among crew. Similarly, insect control may eliminate reservoirs for certain vector-borne diseases.

Interrupting Disease Transmission

Disease transmission can often be interrupted by the following:

- rapid diagnosis and treatment of infectious diseases; isolation of patients from other crew members (when appropriate);
- chemoprophylaxis before exposure (i.e. medication prophylaxis to prevent malaria);
- practicing good personal hygiene (i.e. using insect repellents and wearing appropriate clothing).

Inactivating Infectious Agent

Infectious agents can be inactivated to reduce the spread of disease. Chemical methods include chlorinating water supplies and sewage effluents. Proper disinfection and maintenance of potable water systems can prevent waterborne diseases caused by bacteria and viruses. Disinfectants and fungicides are useful. Physical methods for inactivating infectious agents include use of heat (proper cooking of foods) and cold (refrigeration of foods). Proper food handling, preparation, and storage help to prevent outbreaks of food borne and diarrhea diseases. These simple yet essential practices should be carried out by staff and crew members of the ship.

Personal Hygiene

Personal hygiene is necessary to prevent infectious diseases. Many diseases are transmitted by the oral fecal route. Hands are often contaminated when urinating or defecating. This contamination can spread disease to the individual and to the entire crew. REGULAR HANDWASHING BY EVERY CREW MEMBER is critical to the health of the entire crew. If crewmembers frequently develop diarrhea, the source of contamination should be aggressively sought and corrected. Each head must be kept clean, so that handwashing is effective.

Hands should also be washed before touching food and before meals. Cigarettes can become contaminated in the same way, and spread disease. Always wash your hands before touching anything that will go into your mouth.

Food service workers should be especially cautious. They should be free of infectious disease when preparing food. Routine health screening is important. Further, they must use the recommended sanitation procedures for food purchase, storage and preparation. Handwashing is critical. They should wear gloves when handling food.

Safe Food Practices

The basics of food safety are the same on land and on sea. However, because so many people share the same environment, the same water, and the same meals on board a ship, a break in sanitation may allow diseases to spread quickly to many people or the entire crew. General principles include:

- Maintain the potability (safety) of the water;
- Use reliable food suppliers;
- Keep the room temperature preparation times short;
- Keep raw and cooked foods entirely separate; also separate meat and fish, and fruit and vegetable prep areas; (including equipment, wiping cloths, storage areas, etc.);
- Keep hot food items hot and cold food items cold;
- Rapidly chill cooked foods (to 41° F/5° C or less) if they are not to be eaten immediately;
- Persons with diarrhea, vomiting, or open sores on their hands should not prepare food until they have fully recovered;
- All food handlers should wash hands frequently, especially after handling raw meat and fish;
- Protect food from insects, rodents, and other animals.

The ship's management should assure all food service workers understand and implement safe food practices.

Shellfish: Items containing seafood accounted for more than half of shipboard food-borne disease outbreaks investigated by CDC. Shellfish, especially scallops, accounted for four of the six seafood-related outbreaks on cruise ships. The more recent outbreaks showed that neither blanching nor marinating alone will make contaminated raw shellfish safe to eat. Steaming for at least 15 minutes may reduce the risk, if the entire product reaches a uniformly high temperature.

Crustaceans, such as lobster, crab, and shrimp, should also be cooked thoroughly. The U.S. Food and Drug Administration (FDA) Food Code recommends cooking crustaceans such that the internal temperature reaches 145° Fahrenheit/63° Celsius for at least 15 seconds.

Eggs: Salmonella with raw eggs has long been recognized. It had been believed that the Salmonella was due to unclean eggs or eggs contaminated internally through cracks in the shells, and that the contents of an intact egg were sterile. However, research suggests that a worldwide epidemic of salmonella (Salmonella serotype enteritidis (SE)) is infecting the egg-forming organs of hens and is transmitted to the egg yolks as the eggs are formed inside the chickens. As a result, a perfectly normal-looking egg can harbor large numbers of SE organisms.

Each year, about 80 outbreaks of SE infections are reported in the U.S., with a few resulting in death. Eggs are implicated as the vehicle of infection in many of these outbreaks. Two outbreaks of SE infection have recently occurred on cruise ships which have been attributable to eggs. To prevent these outbreaks, the FDA and the CDC published the following guidelines:

- Shell eggs should be maintained at an internal product temperature of 41° F/5° C or below until used;
- Commercially pasteurized egg and egg products should be substituted for raw shell eggs in the preparation of uncooked, ready-to-eat menu items such as Caesar salad, uncooked hollandaise or bearnaise sauce, ice cream, etc.;
- Pasteurized egg product should be substituted for shell eggs in recipes calling for pooled eggs;
- Eggs should be cooked to heat all parts to at least 145° F/63° C for 15 seconds or more;
- Cooked eggs requiring holding before service should be held at an internal temperature of 140° F/60° C or above.

The third guideline is especially important. Large outbreaks have been related to the use of bulk pooled eggs held for periods of time before cooking, or held on a steam table or buffet bar after partial cooking. Any recipe that calls for a large pool of eggs that are cracked ahead of time and held in a large container before cooking is of particular concern. A single infected egg can contaminate the entire pool. No outbreaks have been caused by pasteurized egg products.

Ground beef: While no food borne disease outbreaks aboard cruise ships have yet implicated ground beef as the source, this item could serve as a source of infection with *Escherichia coli* O157:H7 if not cooked properly. The food borne bacterial organism E. coli O157:H7 is an emerging cause of food borne illness. Infection often leads to bloody diarrhea and occasionally to kidney failure and death. Most illness has been associated with eating undercooked, contaminated ground beef. E. coli O157:H7 lives in the intestines of some healthy cattle; meat can become contaminated during slaughter, and organisms can be thoroughly mixed into beef when it is ground. Infection can be prevented by thoroughly cooking ground beef to at least 155° F/68° C for at least 15 seconds, as recommended in the FDA Food Code (available through the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, 703-487-4650, or Internet address: http://www.ntis.gov/products/families/military.asp?loc=4-3-4.

RECOMMENDED REFERENCES

1. Chin J., editor. Control of Communicable Diseases Manual. Seventeenth edition. Washington, DC: American Public Health Association, most recent edition.
2. Osterholm MT, Hedberg CW, Moore KA, Chapter 11, Epidemiologic Principles, in: Mandell GL, Bennett JE, and Dolin R, editors. Principles and Practice of Infectious Diseases, fifth edition. New York: Churchill Livingstone, 2000.
3. Wenzel RP, editor. Section 2, Control of Communicable Diseases, in: Wallace RB, Last JM, Doebbeling BN, editors, Maxcy-Rosenau-Last Public Health and Preventive Medicine, 14th edition. Norwalk CT: Appleton and Lange, most recent edition.
4. U.S. Department of Health and Human Services, Public Health Service. Food Code 2001. Washington, DC: Food and Drug Administration, 2001 or most recent edition.