

## **INFECTIOUS DISEASES, FACTORS THAT SPREAD THEM**

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**Abstract:** Infectious disease, in medicine, a process caused by an agent, often a type of microorganism, that impairs a person's health. In many cases, infectious disease can be spread from person to person, either directly (e.g., via skin contact) or indirectly (e.g., via contaminated food or water).

**Keywords:** bacteria, viruses, pneumococci, staphylococcus, rickettsia, meningococci, mycoplasma, ureaplasma.

An infectious disease can differ from simple infection, which is the invasion of and replication in the body by any of various agents—including bacteria, viruses, fungi, protozoans, and worms—as well as the reaction of tissues to their presence or to the toxins that they produce. When health is not altered, the process is called a subclinical infection. Thus, a person may be infected but not have an infectious disease. This principle is illustrated by the use of vaccines for the prevention of infectious diseases. For example, a virus such as that which causes measles may be attenuated (weakened) and used as an immunizing agent. The immunization is designed to produce a measles infection in the recipient but generally causes no discernible alteration in the state of health. It produces immunity to measles without producing a clinical illness (an infectious disease). The most important barriers to invasion of the human host by infectious agents are the skin and mucous membranes (the tissues that line the nose, mouth, and upper respiratory tract). When these tissues have been broken or affected by earlier disease, invasion by infectious agents may occur. These infectious agents may produce a local infectious disease, such as boils, or may invade the bloodstream and be carried throughout the body, producing generalized bloodstream infection (septicemia) or localized infection at a distant site, such as meningitis (an infection of the coverings of the brain and spinal cord). Infectious agents swallowed in food and drink can attack the wall of the intestinal tract and cause local or general disease. The conjunctiva, which covers the front of the eye, may be penetrated by viruses that cause a local inflammation of the eye or that pass into the bloodstream and cause a severe general disease, such as

smallpox. Infectious agents can enter the body through the genital tract, causing the acute inflammatory reaction of gonorrhoea in the genital and pelvic organs or spreading out to attack almost any organ of the body with the more chronic and destructive lesions of syphilis. Even before birth, viruses and other infectious agents can pass through the placenta and attack developing cells, so that an infant may be diseased or deformed at birth. From conception to death, humans are targets for attack by multitudes of other living organisms, all of them competing for a place in the common environment. The air people breathe, the soil they walk on, the waters and vegetation around them, the buildings they inhabit and work in, all can be populated with forms of life that are potentially dangerous. Domestic animals may harbour organisms that are a threat, and wildlife teems with agents of infection that can afflict humans with serious disease. However, the human body is not without defenses against these threats, for it is equipped with a comprehensive immune system that reacts quickly and specifically against disease organisms when they attack. Survival throughout the ages has depended largely on these reactions, which today are supplemented and strengthened through the use of medical drugs.

### **Categories of organisms**

The agents of infection can be divided into different groups on the basis of their size, biochemical characteristics, or manner in which they interact with the human host. The groups of organisms that cause infectious diseases are categorized as bacteria, viruses, fungi, and parasites. Bacteria can survive within the body but outside individual cells. Some bacteria, classified as aerobes, require oxygen for growth, while others, such as those normally found in the small intestine of healthy persons, grow only in the absence of oxygen and, therefore, are called anaerobes. Most bacteria are surrounded by a capsule that appears to play an important role in their ability to produce disease. Also, a number of bacterial species give off toxins that in turn may damage tissues. Bacteria are generally large enough to be seen under a light microscope. Streptococci, the bacteria that cause scarlet fever, are about 0.75 micrometre (0.00003 inch) in diameter. The spirochetes, which cause syphilis, leptospirosis, and rat-bite fever, are 5 to 15 micrometres long. Bacterial infections can be treated with antibiotics. Bacterial infections are commonly caused by pneumococci, staphylococci, and streptococci, all of which are often commensals (that is, organisms living harmlessly on their hosts) in the upper respiratory tract but that can become virulent and cause serious conditions, such as pneumonia, septicemia (blood poisoning), and meningitis. The pneumococcus is the most common cause of lobar pneumonia, the disease in which one or more lobes, or segments, of the lung become solid and airless as a result of inflammation. Staphylococci affect the lungs either in the course of staphylococcal septicemia—when bacteria in the circulating blood cause scattered abscesses in the lungs—or as a complication of a viral infection, commonly influenza—when these organisms invade the damaged lung cells and cause a life-threatening form of pneumonia. Streptococcal pneumonia is the least common of the three and occurs usually as a complication of influenza or other lung disease.

Pneumococci often enter the bloodstream from inflamed lungs and cause septicemia, with continued fever but no other special symptoms. Staphylococci produce a type of septicemia with high spiking fever; the bacteria can reach almost any organ of the body—including the brain, the bones, and especially the lungs—and destructive abscesses form in the infected areas. Streptococci also cause septicemia with fever, but the organisms tend to cause inflammation of surface lining cells rather than abscesses—for example, pleurisy (inflammation of the chest lining) rather than lung abscess, and peritonitis (inflammation of the membrane lining the abdomen) rather than liver abscess. In the course of either of the last two forms of septicemia, organisms may enter the nervous system and cause streptococcal or staphylococcal meningitis, but these are rare conditions. Pneumococci, on the other hand, often spread directly into the central nervous system, causing one of the common forms of meningitis.

Staphylococci and streptococci are common causes of skin diseases. Boils and impetigo (in which the skin is covered with blisters, pustules, and yellow crusts) may be caused by either. Staphylococci also can cause a severe skin infection that strips the outer skin layers off the body and leaves the underlayers exposed, as in severe burns, a condition known as toxic epidermal necrolysis. Streptococcal organisms can cause a severe condition known as necrotizing fasciitis, commonly referred to as flesh-eating disease, which has a fatality rate between 25 and 75 percent. Streptococci can be the cause of the red cellulitis of the skin known as erysipelas. Some staphylococci produce an intestinal toxin and cause food poisoning. Certain streptococci settling in the throat produce a reddening toxin that speeds through the bloodstream and produces the symptoms of scarlet fever. Streptococci and staphylococci also can cause toxic shock syndrome, a potentially fatal disease. Streptococcal toxic shock syndrome (STSS) is fatal in some 35 percent of cases.

Meningococci are fairly common inhabitants of the throat, in most cases causing no illness at all. As the number of healthy carriers increases in any population, however, there is a tendency for the meningococcus to become more invasive. When an opportunity is presented, it can gain access to the bloodstream, invade the central nervous system, and cause meningococcal meningitis (formerly called cerebrospinal meningitis or spotted fever). Meningococcal meningitis, at one time a dreaded and still a very serious disease, usually responds to treatment with penicillin if diagnosed early enough. When meningococci invade the bloodstream, some gain access to the skin and cause bloodstained spots, or purpura. If the condition is diagnosed early enough, antibiotics can clear the bloodstream of the bacterium and prevent any from getting far enough to cause meningitis. Sometimes the septicemia takes a mild, chronic, relapsing form with no tendency toward meningitis; this is curable once it is diagnosed. The meningococcus also can cause one of the most fulminating of all forms of septicemia, meningococemia, in which the body is rapidly covered with a purple rash, purpura fulminans; in this form the blood pressure becomes dangerously low, the heart and blood vessels are affected by shock, and the infected person dies within a matter of hours. Few are saved, despite treatment with appropriate drugs.

*Haemophilus influenzae* is a microorganism named for its occurrence in the sputum of patients with influenza—an occurrence so common that it was at one time thought to be the cause of the disease. It is now known to be a common inhabitant of the nose and throat that may invade the bloodstream, producing meningitis, pneumonia, and various other diseases. In children it is the most common cause of acute epiglottitis, an infection in which tissue at the back of the tongue becomes rapidly swollen and obstructs the airway, creating a potentially fatal condition. *H. influenzae* also is the most common cause of meningitis and pneumonia in children under five years of age, and it is known to cause bronchitis in adults. The diagnosis is established by cultures of blood, cerebrospinal fluid, or other tissue from sites of infection. Antibiotic therapy is generally effective, although death from sepsis or meningitis is still common. In developed countries where *H. influenzae* vaccine is used, there has been a great decrease in serious infections and deaths.

### **Chlamydial organisms**

Chlamydia are intracellular organisms found in many vertebrates, including birds and humans and other mammals. Clinical illnesses are caused by the species *C. trachomatis*, which is a frequent cause of genital infections in women. If an infant passes through an infected birth canal, it can produce disease of the eye (conjunctivitis) and pneumonia in the newborn. Young children sometimes develop ear infections, laryngitis, and upper respiratory tract disease from Chlamydia. Such infections can be treated with erythromycin. Another chlamydial organism, *Chlamydia psittaci*, produces psittacosis, a disease that results from exposure to the discharges of infected birds. The illness is characterized by high fever with chills, a slow heart rate, pneumonia, headache, weakness, fatigue, muscle pains, anorexia, nausea, and vomiting. The diagnosis is usually suspected if the patient has a

history of exposure to birds. It is confirmed by blood tests. Mortality is rare, and specific antibiotic treatment is available.

### Rickettsias

The rickettsias are a family of microorganisms named for American pathologist Howard T. Ricketts, who died of typhus in 1910 while investigating the spread of the disease. The rickettsias, which range in size from 250 nanometres to more than 1 micrometre and have no cell wall but are surrounded by a cell membrane, cause a group of diseases characterized by fever and a rash. Except for *Coxiella burnetii*, the cause of Q fever, they are intracellular parasites, most of which are transmitted to humans by an arthropod carrier such as a louse or tick. *C. burnetii*, however, can survive in milk, sewage, and aerosols and can be transmitted to humans by a tick or by inhalation, causing pneumonia in the latter case. Rickettsial diseases can be treated with antibiotics. Humans contract most rickettsial diseases only when they break into a cycle in nature in which the rickettsias live. In murine typhus, for example, *Rickettsia mooseri* is a parasite of rats conveyed from rat to rat by the Oriental rat flea, *Xenopsylla cheopis*; it bites humans if they intrude into its environment. Scrub typhus is caused by *R. tsutsugamushi*, but it normally parasitizes only rats and mice and other rodents, being carried from one to the other by a small mite, *Leptotrombidium* (previously known as *Trombicula*). This mite is fastidious in matters of temperature, humidity, and food and finds everything suitable in restricted areas, or “mite islands,” in South Asia and the western Pacific. It rarely bites humans in their normal environment, but if people invade its territory en masse it will attack, and outbreaks of scrub typhus will follow. The spotted fevers are caused by rickettsias that spend their normal life cycles in a variety of small animals, spreading from one to the other inside ticks; these bite human intruders and cause African, North Asian, and Queensland tick typhus, as well as Rocky Mountain spotted fever. One other spotted fever, rickettsialpox, is caused by *R. akari*, which lives in the body of the ordinary house mouse, *Mus musculus*, and spreads from one to another inside the house mite *Liponyssoides sanguineus* (formerly *Allodermanyssus sanguineus*). This rickettsia is probably a parasite of wild field mice, and it is perhaps only when cities push out into the countryside that house mice catch the infection.

### Mycoplasmas and ureaplasmas

Mycoplasmas and ureaplasmas, which range in size from 150 to 850 nanometres, are among the smallest known free-living microorganisms. They are ubiquitous in nature and capable of causing widespread disease, but the illnesses they produce in humans are generally milder than those caused by bacteria. Diseases due to mycoplasmas and ureaplasmas can be treated with antibiotics. *Mycoplasma pneumoniae* is the most important member of its genus. *M. pneumoniae* is associated with 20 percent of all cases of pneumonia in adults and children over five years of age. Patients have fever, cough, headache, and malaise and, upon physical examination, may be found to have pharyngitis (inflamed throat), enlarged lymph nodes, ear or sinus infection, bronchitis, or croup. Diagnosis is established by chest X-rays and blood tests. Although treatment with erythromycin or tetracycline may shorten the illness, it can last for weeks. Mycoplasmas may also cause a red, bumpy rash—usually on the trunk or back—that is occasionally vesicular (with blisters). Inflammation of the heart muscle and the covering of the heart (pericardium) is rare but can be caused by mycoplasmas. About one-fourth of the people infected with these organisms experience nausea, vomiting, diarrhea, and cramping abdominal pain. Inflammation of the pancreas (pancreatitis) or the liver (hepatitis) may occur, and infection of the brain and spinal cord is a serious complication.

Ureaplasmas can be recovered frequently from the genital areas of healthy persons. The organism can cause inflammation of the urethra and has been associated with infertility, low birth weight of infants, and repeated stillbirths. In general, however, ureaplasma infections are mild. Tetracycline is the preferred treatment once the organism has been established as the cause of infection

by microscopic examination of urethral secretions.

### **Viruses**

Viruses are not, strictly speaking, living organisms. Instead, they are nucleic acid fragments packaged within protein coats that require the machinery of living cells to replicate. Viruses are visible by electron microscopy; they vary in size from about 25 nanometres for poliovirus to 250 nanometres for smallpox virus. Vaccination has been the most successful weapon against viral infection; some infections may be treated with antiviral drugs or interferon (proteins that interfere with viral proliferation). Viruses of the Herpesviridae family cause a multiplicity of diseases. Those causing infections in humans are the varicella-zoster virus (VZV), which causes chickenpox and herpes zoster (shingles); the Epstein-Barr virus, which causes infectious mononucleosis; the cytomegalovirus, which is most often associated with infections of newborn infants and immune compromised people; and herpes simplex virus, which causes cold sores and herpetic venereal (sexually transmitted) diseases. There are two serotypes of herpes simplex virus, HSV-1 and HSV-2. HSV-1 is the common cause of cold sores. The primary infection usually occurs in childhood and is without symptoms in 50 to 80 percent of cases. Between 10 and 20 percent of infected individuals have recurrences precipitated by emotional stress or by other illness. HSV-1 can also cause infections of the eye, central nervous system, and skin. Serious infections leading to death may occur in immunocompromised persons. HSV-2 is associated most often with herpetic lesions of the genital area. The involved area includes the vagina, cervix, vulva, and, occasionally, the urethra in females and the head of the penis in males; it may also cause an infection at the site of an abrasion. The disease is usually transmitted by sexual contact. In herpetic sexually transmitted diseases, the lesions are small, red, painful spots that quickly vesiculate, become filled with fluid, and quickly rupture, leaving eroded areas that eventually become scabbed. These primary lesions occur from two to eight days after exposure and may be present for up to three weeks. Viral shedding and pain usually resolve in two weeks. When infections recur, the duration of the pain, lesions, and viral shedding is approximately 10 days. There are numerous other viruses that are transmitted between humans and that are significant causes of illness and death. Seasonal influenza viruses, for example, circulate globally every year, causing illness in tens of millions of people worldwide; an estimated 290,000 to nearly 650,000 people die from seasonal influenza each year. In addition, new types of infectious viruses emerge periodically. In many instances, these viruses “jump” to humans from an animal reservoir, such as bats, pigs, or primates; this occurs when a human is in close contact with an animal that carries the virus. Often the virus then evolves to become transmissible between humans. Examples of infectious viruses that originated from animal reservoirs in the mid-20th or early 21st century and went on to cause epidemics or pandemics of disease in humans include ebolaviruses, SARS coronavirus, influenza A H1N1, human immunodeficiency virus (HIV/AIDS), and SARS-CoV-2 coronavirus.

### **Parasites**

Among the infectious parasites are the protozoans, unicellular organisms that have no cell wall, that cause such diseases as malaria. The various species of malarial parasites are about 4 micrometres (0.0002 inch) in diameter. At the other extreme, the tapeworm can grow to several metres in length; treatment is designed either to kill the worm or to dislodge it from its host. The worm *Ascaris lumbricoides* causes ascariasis, one of the most prevalent infections in the world. *Ascaris* lives in the soil, and its eggs are ingested with contaminated food. The eggs hatch in the human intestine, and the worms then travel through the bloodstream to the liver, heart, and lungs. They can cause pneumonia, perforations of the intestine, or blockage of the bile ducts, but infected people usually have no symptoms beyond the passage of worms in the stool. Specific treatment is available and prognosis is excellent. Infections are also caused by whipworms, genus *Trichuris*, and pinworms, *Enterobius vermicularis*, each popularly named for its shape. The former is parasitic in the human large intestine

and may cause chronic diarrhea. The latter can be found throughout the gastrointestinal tract, especially in children, and can cause poor appetite, loss of weight, anemia, and itching in the anal area (where it lays its eggs). Both conditions are easily diagnosed and treated with drugs.

In conclusion, humans are community participants. As a result, human social habits and circumstances influence the spread of infectious agents. Crowded family living conditions facilitate the passage of disease-causing organisms from one person to another. This is true whether the germs pass through the air from one respiratory tract to another or whether they are bowel organisms that depend for their passage on close personal hand-to-mouth contact or on lapses of sanitation and hygiene.

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