

EPIDEMIOLOGY OF INTESTINAL INFECTIONS

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GASTROENTERITIS

is defined as vomiting or diarrhea due to inflammation of the small or large bowel, often due to infection.

Although they can continue for as long as 14 days, GI infections usually last a few days. They're characterized by abdominal cramps and discomfort followed by diarrhea.

Other symptoms might include:

- ▶ nausea
- ▶ vomiting
- ▶ fever
- ▶ loss of appetite
- ▶ muscle aches
- ▶ dehydration
- ▶ headache
- ▶ mucus or blood in the stool
- ▶ weight loss

Gastrointestinal infections (GI) are the significant cause of childhood morbidity and mortality worldwide.

Gastrointestinal infections reflects the balance between the intrinsic virulence factors of the enteropathogens

X and host mechanisms which defend against enteric infections.

Host defense factors include:

- gastric acidity,
- intestinal motility,
- the normal indigenous intestinal mikroflóra (microbiota),
- mucous secretion,
- and specific mucosal and systemic immune mechanisms.

GI is usually caused by viruses.

However, bacteria, parasites, and fungus can also cause gastroenteritis.

VIRUSES



- ▶ **Rotavirus** is the most common cause of gastroenteritis in children, and produces similar rates in both the developed and developing world.

Viruses cause about 70% of episodes of infectious diarrhea in the pediatric age group. Rotavirus is a less common cause in adults due to acquired immunity.

Due to both its effectiveness and safety, in 2009 the World Health Organization recommended that the rotavirus vaccine be offered to all children globally.

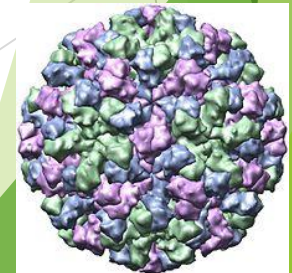
Two commercial rotavirus vaccines exist and several more are in development..

This vaccine may also prevent illness in non-vaccinated children by reducing the number of circulating infections (herd immunity).

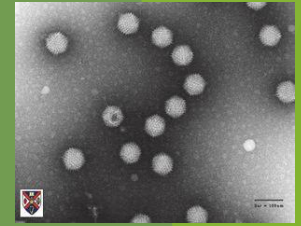
The first dose of vaccine should be given to infants between 6 and 15 weeks of age.

- ▶ **Norovirus** (Norwalk) is the cause in about 18% of all cases. Norovirus is the leading cause of gastroenteritis among adults in America, causing greater than 90% of outbreaks. These localized epidemics typically occur when groups of people spend time in close physical proximity to each other, such as on cruise ships, in hospitals, and in restaurants.

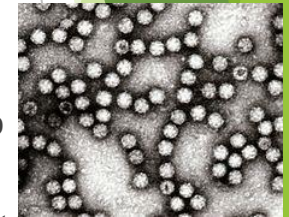
People may remain infectious even after their diarrhea has ended. Norovirus is the cause of about 10% of cases in children.



VIRUSES



- ▶ **Adenoviruses** are non-enveloped, double-stranded DNA viruses and are very stable in the environment. Adenoviruses can infect and replicate in epithelial cells of the gastrointestinal (GI) tract, respiratory tract, eyes, and urinary bladder. Some human adenoviruses (HAdVs) spread via local outbreaks in common areas, such as summer camps, playgrounds, dormitories, and schools. HAdV infection can also occur through an individual's lack of proper hygiene, such as improper handwashing. Transmission occurs from an infected person to other individuals via respiratory routes, fecal-oral contamination, and/or direct contact. A person infected with HAdV is extremely contagious during the incubation period, which typically ranges from 4–8 days, but can last up to 24 days, depending on the HAdV serotype.



- ▶ **Astroviruses** are nonenveloped, single-stranded RNA viruses associated with 5–9% of the cases of gastroenteritis in young children. Human astroviruses are transmitted by the fecal-oral route. The main mode of astrovirus transmission is by contaminated food and water. Human astroviruses may be released in large quantities in the stool of infected individuals and contaminate groundwater, fresh water and marienewater due to inadequate wastewater treatment. Fruits and vegetables grown in such contaminated water may also act as sources of viral infection. Poor food handling practices, poor hand hygiene and contamination of inanimate objects are other factors that encourage enteric virus transmission. Astroviruses can also be transmitted to humans from other animal species.

Bacteria

- ▶ Campylobacteriosis
- ▶ Salmonellosis
- ▶ Yersiniosis
- ▶ Shiga toxin/verocytotoxin-producing *Escherichia coli* (STEC/VTEC) infection
- ▶ Shigellosis
- ▶ Cholera
- ▶ Typhoid/paratyphoid fever
- ▶ Brucellosis
- ▶ Anthrax
- ▶ Botulism
- ▶ Leptospirosis
- ▶ Listeriosis

Campylobacteriosis

Etiology:

Campylobacter is a genus of Gram-negative bacteria. *Campylobacter* species are typically spira-shaped and able to move via unipolar or bipolar flagella.

The source of infection

The animals such as poultry, cattle, pigs, wild birds and wild mammals.

Route of transmission

It is usually acquired from eating or drinking contaminated food and water; nevertheless, it can also be caught directly from animals or, rarely, from person to person though contact with infected faeces. Drinking raw or inadequately pasteurised milk has caused outbreaks of campylobacteriosis and cases have also been caused by birds pecking at milk in foil-topped bottles. People have also been infected through drinking from streams when trekking or canoeing. Contact with animals on farm visits and with infected pets, especially puppies, can be a risk factor for children younger than five years of age. Person-to-person spread can happen, although it is unusual, and is most likely from children who have diarrhoea or are not toilet-trained.

Susceptibility

General.

Preventive measures:

There is currently no vaccine against *Campylobacter* infection. Drinking pasteurised milk and chlorinated drinking water is important in preventing contamination. Good hygiene in commercial and domestic kitchens—especially avoiding cross-contamination—is important as is cooking meat properly, especially poultry. Conventional disinfectants are active against *Campylobacteriosis*. Doorstep milk should be protected against birds and it is important to wash hands carefully after contact with faeces, nappies, meat or animals, including on farm visits.

Salmonellosis

Etiology:

Salmonella bacteria are generally referred to by the term 'salmonellosis' when they are due to *Salmonella* species other than *Salmonella typhi* and *Salmonella paratyphi*.

The source of infection

Various animals (especially poultry, pigs, cattle, and reptiles) can be sources for *Salmonella*, and humans generally become infected by eating poorly cooked, contaminated food.

Route of transmission

Salmonellosis in humans is generally contracted through the consumption of contaminated food of animal origin (mainly eggs, meat, poultry and milk), although other foods, including green vegetables contaminated by manure, have been implicated in its transmission.

Susceptibility

Person-to-person transmission through the faecal-oral route can also occur.

General

Preventive measures:

Prevention requires control measures at all stages of the food chain, from agricultural production, to processing, manufacturing and preparation of foods in both commercial establishments and at home.

National/regional surveillance systems are important means to detect and respond to salmonellosis and other enteric infections in early stages, and thus to prevent them from further spreading.

Escherichia coli (*E.coli*)



Escherichia coli (*E.coli*) are very common bacteria in the gastrointestinal tract of people and animals, and part of the normal bacterial flora.

However, some *E.coli* strains (*E.coli* O157;H7) are able to produce a toxin that can abdominal cramps, vomiting, and bloody diarrhea.

The main reservoir of such *E.coli* strains is grass-feeding animals, cattle in particular. Their meat might become contaminated by faecal matter due to poor processing methods during slaughter, and their faeces might end up contaminating other foods (e.g. milk, vegetables) and water.

E.coli can also spread through direct person-to-person contact.

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Route of transmission

Transmission of STEC infection mainly occurs through contaminated food or water and contact with animals. Person-to-person transmission is also possible among close contacts (families, childcare centres, nursing homes, etc).

Susceptibility

General; However, about 8% of patients (children under five years old and the elderly being the most susceptible) may develop "haemolytic uraemic syndrome" (HUS), characterised by acute kidney failure, bleeding and neurological symptoms.

Antibiotic therapy is not helpful (it might even favour HUS development).

Shiga toxin-producing *E. coli* (STEC)

Shiga toxin-producing *E. coli* (STEC) is a group of pathogenic *Escherichia coli* strains capable of producing Shiga toxins, with the potential to cause severe enteric and systemic disease in humans.

The full serotype is usually defined by determining both O and H antigens.

There are around 200 different *E. coli* O serotypes producing Shiga toxin, of which over 100 have been associated with human disease.

Two major Shiga toxin types (Stx1 and Stx2) have been associated with strains causing human disease. While the serotype O157:H7 is considered as clinically the most important, it is estimated that up to 50% of STEC infections are caused by non-O157 serotypes.

STEC is of public health concern because of the potential for outbreaks and the risk of serious complications.

Haemolytic uremic syndrome (HUS) is considered as the most common cause of acute renal failure in European children. Even if the clinical presentation of non-O157 STEC infections may vary, they can be as virulent as O157:H7 infections.

Shigellosis

Epidemiology

- ▶ Insufficient data exists, but conservative estimates suggest that *Shigella* causes approximately 90 million cases of severe dysentery annually, with at least 100,000 of these resulting in death, mostly among children in the developing world. *Shigella* also causes approximately 580,000 cases annually among travelers and military personnel from industrialized countries.
- ▶ An estimated 18,000 cases of shigellosis occur annually in the United States. Infants, the elderly, and the critically ill are susceptible to the severest symptoms of disease, but all humans are susceptible to some degree. Individuals with acquired immune deficiency syndrome (AIDS) are more frequently infected with *Shigella*. Shigellosis is a more common and serious condition in the developing world; fatality rates of shigellosis epidemics in developing countries can be 5–15%.

Shigellosis

- ▶ *S. sonnei*: Most common symptoms are diarrhoea (which is sometimes bloody), abdominal pain and cramps, and fever. Nausea and/or vomiting, loss of appetite, headache or malaise can also occur.
- ▶ *S. flexneri*: Also causes diarrhoea, abdominal pain and cramps, and fever but is often more severe than *S. sonnei* infection. Inflammation and ulceration of the lower part of the bowel is also common and illness can be prolonged and more severe.
- ▶ *S. boydii*: Can cause diarrhoeal diseases of varying severity, but mostly are similar to those caused by *S. sonnei*.
- ▶ *S. dysenteriae*: This species causes more severe disease than other forms of shigellae with higher death rates. Inflammation and ulceration of the lower part of the bowel occurs in most cases, displaying itself as bloody stools.

Shigellosis

Etiology:

caused by one of four species of Shigella bacteria: *Shigella sonnei*, *S. flexneri*, *S. boydii* and *S. dysenteriae*.

The source of infection

The causative organism is frequently found in water polluted with human feces, and is transmitted via the fecal-oral route. The usual mode of transmission is directly person-to-person hand-to-mouth, in the setting of poor hygiene among children.

Route of transmission

Susceptibility

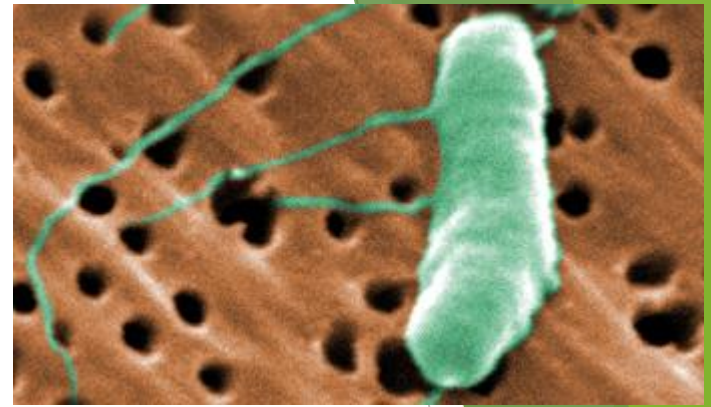
Shigellosis is largely a disease of children, with the highest number of cases reported in children younger than five. Infection occurs most frequently in the summer. People at highest risk include those attending daycare, travellers abroad and men who have sex with men.

Preventive measures:

Simple precautions can be taken to prevent getting shigellosis: wash hands before handling food and thoroughly cook all food before eating.

Since shigellosis is spread very quickly among children, keeping infected children out of daycare for 24 hours after their symptoms have disappeared, will decrease the occurrence of shigellosis in daycares

Cholera



The illness caused by bacteria called *Vibrio cholerae*. It causes diarrhoea and can lead people to become severely dehydrated very quickly, which can be fatal. It is a major public health problem in many parts of the world and a threat to Europeans travelling to these areas.

Cholera can range in severity from a mild illness which may show no symptoms through to very severe symptoms. The first signs are nausea and discomfort in the abdomen, followed by sudden watery diarrhoea and vomiting. Vomiting tends to disappear after around 12 hours, although the diarrhoea may continue. Cholera often causes people to painlessly loose large amounts of liquid stools – often called “rice water” stools because of their appearance. People with cholera often have extremely painful muscle cramps.

Cholera

Etiology:

Vibrio cholerae of serogroups O1 or O139. Vibrios can survive for a long time in coastal waters contaminated by human excreta

The source of infection

Humans.

Route of transmission

Consumption of contaminated water and food, especially seafood eaten under-cooked, results in infection.

Susceptibility

General

Preventive measures:

In areas where cholera is more common, improved sanitation and water supplies and food hygiene measures are important in reducing the spread of cholera. Water should be chlorinated or boiled before it is considered safe to drink. Although this is a low risk, travellers to countries where cholera is more common should be aware of the possibility of contracting it and drink only boiled or mineral water.

A vaccine is available that is effective against cholera.

Cholera

► Complications

If cholera is untreated, severe dehydration and “hypovolemic” shock can happen, which leads to symptoms including sunken eyes, wrinkled skin, a very fine and scarcely perceptible pulse, undetectable blood pressure and reduced levels of consciousness. Severe untreated cholera can cause kidney failure and, in 50% of cases, death. In children, a condition called hypoglycaemia (low blood sugar) can occur which can be severe and cause convulsions and coma. In pregnant women, cholera can cause miscarriages and premature birth.

Typhoid and Paratyphoid Fever

Typhoid and paratyphoid fevers are systemic diseases.

Humans can carry the bacteria in the gut for very long times (chronic carriers), and transmit the bacteria to other persons (either directly or via food or water contamination).

After 1-2 weeks incubation period, a disease characterised by high fever, malaise, cough, rash and enlarged spleen develops. Diarrhoea may be present at some stage.

When *Salmonella typhi* is the cause, intestinal perforation and haemorrhage may occur. *Salmonella typhi* blood stream infection can also cause infection in all organs. Antibiotic therapy has radically changed the prognosis of typhoid, which, untreated, has a 10% death rate.

Typhoid and Paratyphoid Fever

Etiology:

Salmonella typhi and *Salmonella paratyphi*

The source of infection

Humans are the only reservoir for *Salmonella typhi* (which is the most serious), whereas *Salmonella paratyphi* also has animal reservoirs.

Route of transmission

Humans can carry the bacteria in the gut for very long times (chronic carriers), and transmit the bacteria to other persons (either directly or via food or water contamination).

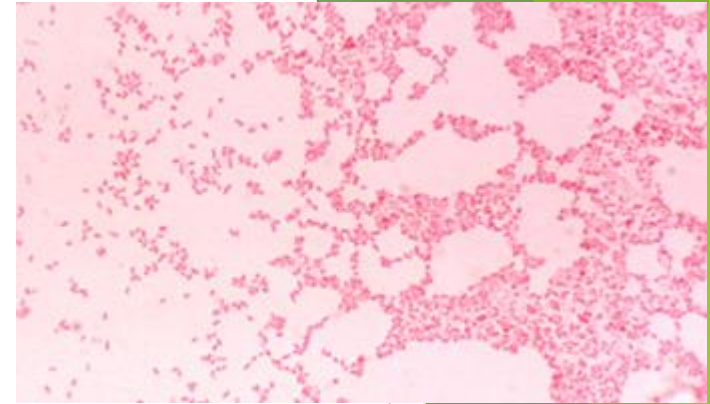
General

Preventive measures:

Preventive measures include good personal and food hygiene. An effective vaccine is also available.

Susceptibility

Brucellosis



Brucellosis is an infection caused by *Brucella bacteria*. The common reservoirs for *Brucella bacteria* that may infect humans are cattle, dogs, sheep, goats, and pigs. Brucellosis occurs worldwide but the Mediterranean region has been particularly affected. Humans become infected by direct or indirect contact with animals or with contaminated animal products (including unpasteurised milk and dairy products) or by the inhalation of aerosols.

After an incubation period of five to 60 days, symptoms may appear either acutely or insidiously. Untreated, the disease may become chronic. The various symptoms are both general (fever, weakness, joint pain) and organ-specific (including infections in the brain infection and heart valves). Untreated, brucellosis can lead to death. Prolonged antibiotic treatment is usually effective.

Brucellosis

Etiology:

Brucella is a genus of Gram-negative bacteria.

The source of infection

Cattle, dogs, sheep, goats, and pigs.

Route of transmission

Humans become infected by direct or indirect contact with animals or with contaminated animal products (including unpasteurised milk and dairy products) or by the inhalation of aerosols.

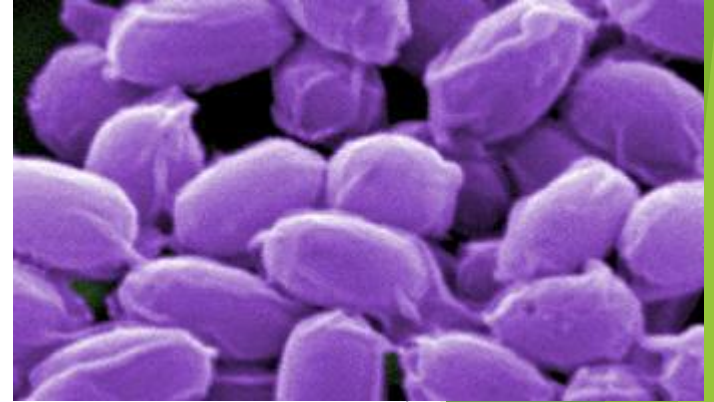
Susceptibility

General.

Preventive measures:

Control measures include animal vaccination and/or test-and-slaughter of infected animals, as well as pasteurisation of milk and dairy products.

Anthrax



▶ Anthrax is...

...a zoonotic disease that humans can catch from animals. Sources are grass-eating animals, and the spores can survive in the environment for decades.

The disease is endemic in several regions of the world, including southern and eastern Europe.

▶ It causes serious illness.

▶ It used to be largely occupationally related but has also been used deliberately in bio-terrorist attacks.

Antrax

Etiology:

The spore-producing bacterium *Bacillus anthracis*. The spores can survive in the environment for decades.

The source of infection

Anthrax spores can be found in soil and animals, like cows, can then acquire the infection while grazing.

Route of transmission

Humans can catch the spores by eating contaminated or insufficiently cooked meat, through contaminated flies that bite, by a having a break in the skin and then being in contact with contaminated animal skins, bones, wool, hair or tusks or by breathing in spores (e.g., in wool sorting, bonemeal or hide processing factories).

Susceptibility

Preventive measures: Control measures include the correct disposal of dead animal: disinfection, decontamination and disposal of contaminated materials and decontamination of the environment.

Protective equipment must be used by workers.

Vaccination of exposed animals and humans is required.

Anthrax

The symptoms depend on how the anthrax was acquired by the infected person.

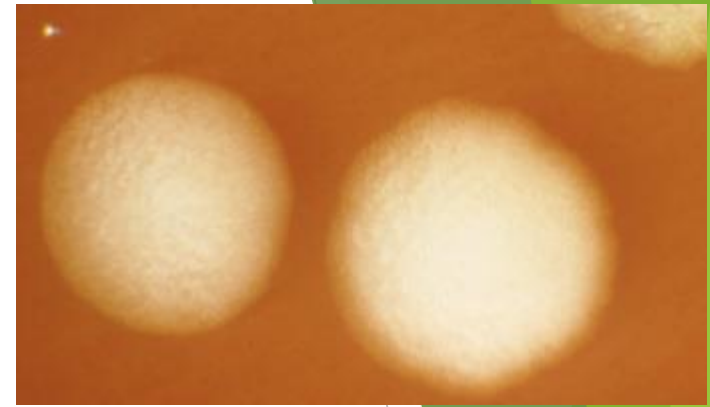
Close physical contact with infected livestock or contaminated dead animal products can cause anthrax affecting the skin also known as **cutaneous anthrax**. This is the most common form of the disease.

A small pointed and inflamed elevation appears on the skin, usually on the face, hands or forearms. Over 2–3 days, this ulcerates to become a dry, black, painless scab, surrounded by a ring of small cysts. This is always accompanied by substantial swellings containing fluid, which extend a long way from the scab. The scab dries and falls off within 1–2 weeks, with little scarring. Patients with cutaneous anthrax usually recover, provided they receive prompt treatment with antibiotics.

Swallowing anthrax can cause **gastrointestinal anthrax**, the form most common in children. Gastrointestinal anthrax can affect either the upper throat or the intestines. The form affecting the throat usually starts with a flu-like illness with a high temperature, followed by throat ulcers and a visible swelling of the neck. The form affecting the intestines causes ulcers in the bowel, leading to nausea and vomiting, loss of appetite and high fever with abdominal pain, vomiting blood and bloody diarrhoea.

Anthrax which is breathed in causes **inhalational anthrax**. This illness comes in two phases beginning with non-specific mild fever, malaise, muscle aches, dry cough and chest pain; disorientation is also common. Within 1–6 days, the illness progresses to the second phase with fever, acute shortness of breath, a harsh, grating sound when breathing and blue-tinged skin, rapidly leading to respiratory failure, shock, a drop in body temperature and death, if untreated.

Botulism



Botulism is a serious paralytic illness caused by a nerve toxin produced by the bacterium *Clostridium botulinum*. The disease may occur after eating foods containing the toxin or due to development of the spores within the intestine of young children or within wounds.

Food botulism is the dominating form of the disease, and paralytic symptoms generally appear after an incubation period of 12–36 hours (up to several days) after consumption of the toxin-containing food. The symptoms may be very severe, and require intensive-care treatment and the administration of an anti-toxin. Even where these are available, between 5 and 10 % of the patients die.

Due to the extremely high potency of the toxin, botulism is included among the potential bio-terrorist threats. Following laboratory accidents, the toxin has also caused symptoms on inhalation, with a substantially reduced incubation period.

Botulism

Etiology:

Clostridium botulinum is a Gram-positive, rod-shaped, spore-forming bacterium. It is an obligate anaerobe, meaning that oxygen is poisonous to the cells.

The source of infection

Botulism spores are widespread in the environment and can be found in dust, soil, untreated water and the digestive tracts of animals and fish. Foods that have led to botulism outbreaks have included the following: meat products, such as sausage and cured ham; canned, vacuum-packed, smoked or fermented fish products; vegetables preserved by canning or stored in oil; baked potatoes; honey; and cheese. Many outbreaks have occurred due to home-preserved foods. Intestinal or infant botulism usually takes place after swallowing botulinum spores, sometimes from food, which then produce toxins in the gut. Wound botulism usually happens from inoculating botulinum spores which then grow in the inoculation wound and produce toxins.

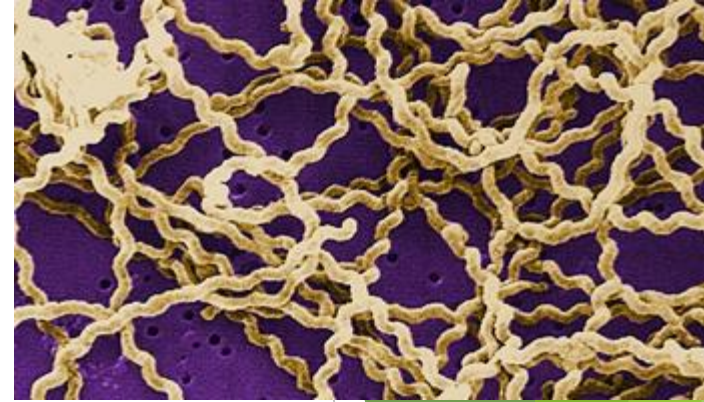
Route of transmission

General.

Susceptibility

Preventive measures: There is no routine vaccination against botulism. Care should be taken when canning food, either commercially or at home, and when preserving fish, meat and vegetables to make sure botulinum is destroyed before storage. Do not eat food from containers that are obviously bulging (which could be caused by gas from the botulinum) or containers that are damaged. Boiling food for ten minutes before eating it would inactivate the toxin in home-canned foods. Potential botulism cases should get urgent medical response and investigation. Prevention work with intravenous drug users is also important

Leptospirosis



Leptospirosis is a zoonotic disease caused by *Leptospira bacteria*. Although more common in tropical areas of the world, the disease is also present in temperate areas, including Europe. Different species of domestic and wild animals act as maintenance hosts. Humans acquire leptospirosis either from direct contact with the urine of infected animals, or from contact with material contaminated by it, such as water or soil. After exposure, the incubation period ranges between two and 30 days (with an average of 10 days). The clinical presentation is variable. Fever, muscle ache and eye infection are very frequent. Liver, kidney, lung, heart, and more rarely brain involvement and bleeding characterise the most serious clinical presentations. Timely antibiotic treatment is effective, and the death rate is low, but does increase with advancing age and may reach up to 20% or more in complicated cases with severe disease.

Preventive measures include controlling rodent populations, avoiding contaminated areas and covering cuts and abraded skin when operating in the environment. Immunisation of persons at occupational risk of exposure has been carried out in some countries (Italy, France, Spain).

Leptospirosis

Leptospirosis is caused by spirochatae bacteria belonging to the genus *Leptospira*. 21 species of *Leptospira* have been identified. 13 species cause disease or have been detected in human cases.

Etiology:

The source of infection

About 160 mammalian species have been identified as natural carriers of pathogenic leptospire. These include feral, semi-domestic and farm and pet animals as important infection sources.

Route of transmission

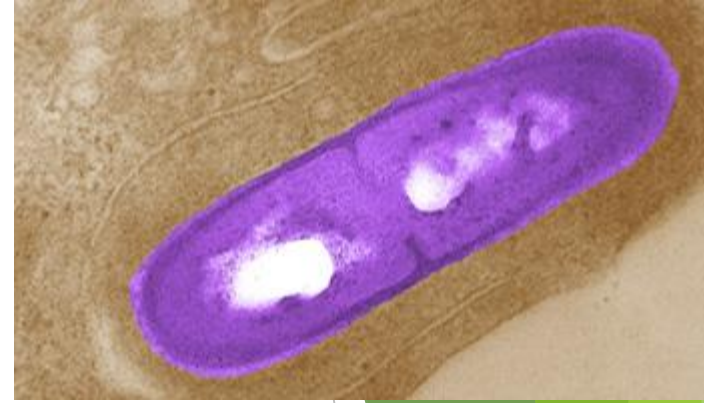
The route of transmission is via broken skin and through mucous membranes of eyes, mouth and nose (consumption, inhalation). Transmission may also occur via sexual contact and mother's milk. In-uterus transmission can lead to reproductive failures such as abortion.

Susceptibility

The risk of acquiring leptospirosis is associated with contact with animals and thus with occupations such as farmers, veterinarians and sewer workers. Case severity is associated with physical condition and increasing age. Leptospirosis as a recreational disease in travellers is increasing in Western countries.

Preventive measures: Prevention and control mainly focus on the identification and reduction of the infection source and the prevention of penetration of leptospire into the accidental host. Prevention of transmission can be achieved by wearing protective clothing.

Listeriosis



- ▶ *L. monocytogenes* was not identified as a cause of foodborne illness until 1981, however.
- ▶ An outbreak of listeriosis in Halifax, Nova Scotia, involving 41 cases and 18 deaths, mostly in pregnant women and neonates, was epidemiologically linked to the consumption of coleslaw containing cabbage that had been contaminated with *L. monocytogenes*-contaminated sheep manure. Since then, a number of cases of foodborne listeriosis have been reported, and *L. monocytogenes* is now widely recognized as an important hazard in the food industry.

Listeriosis

Etiology:

Listeria monocytogenes is a Gram-positive bacterium. The genus

Listeria currently contains 10 species; only *L. monocytogenes* is consistently associated with human illness.

The source of infection

Researchers have found *L. monocytogenes* in at least 37 mammalian species, both domesticated and feral.

Route of transmission

L. monocytogenes has been associated with such foods as raw milk, pasteurized fluid milk, cheese (particularly soft-ripened varieties), ice cream, raw vegetables, fermented raw-meat sausages, raw and cooked poultry, raw meats (of all types), and raw and smoked fish. Its ability to grow at temperatures as low as 0°C permits multiplication in refrigerated foods.

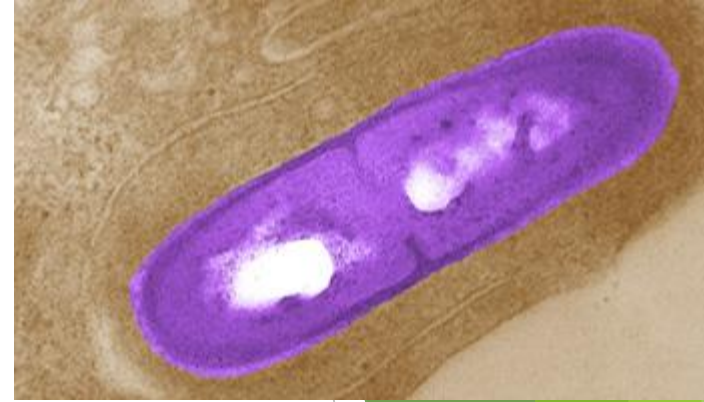
Susceptibility

Reported cases in Europe are highest among those over 65 and children younger

Preventive measures:

Pasteurising dairy products is important as the process kills *Listeria*.

Listeriosis



► Symptoms

Listeriosis can cause a range of symptoms. Some patients can have no symptoms at all. Previously well, non-pregnant people often get symptoms of acute gastroenteritis— inflammation of the stomach and intestines. This can cause headache, fever, abdominal pain, sleepiness, nausea and diarrhoea. Fatigue, aching muscles, painful joints, vomiting and a sore throat may also occur.

► Complications

Listeriosis can also cause serious illness, most often in those with long-term health conditions, the elderly, or people whose immune systems are compromised. Severe symptoms can include the following: blood poisoning; inflammation of the brain and its lining; abscesses; inflammation of the lining of the heart; and infected or inflamed joints.

► **Pregnant women** who get the infection may only have mild illness, but can suffer miscarriage, premature delivery or stillbirth. Newborn babies can also suffer from severe symptoms, including meningitis, which can lead to death.

Parasites

- ▶ Giardiasis
- ▶ Toxoplasmosis (congenital)
- ▶ Trichinellosis
- ▶ Tularaemia
- ▶ Cryptosporidiosis
- ▶ Echinococcosis (hydatid disease)
- ▶ Many parasites reside within the gastrointestinal tract in humans and other animals. Most helminths have complex life cycles having more than one host. The major route of transmission is through consumption of contaminated food (especially undercooked pork and beef in case of some helminths). The main groups of parasites include protozoans and parasitic worms (helminths). The protozoans, including *cryptosporidium*, *isospora*, *Giardia lamblia* and *Entamoeba histolytica*. *Taenia solium* and *Taenia saginata* invade the muscles and form cysts inside them, this condition is called cysticercosis and may cause neurological disorders. *E. histolytica* causes amoebiasis which is manifested by a range of symptoms from a mild diarrhoea to fulminant dysentery.

Giardiasis

Etiology:

Giardia lamblia (*Giardia intestinalis* and *Giardia duodenalis* are synonyms) is a cyst-producing parasite, able to settle in the human and animal bowel.

Giardia cysts can survive for extended periods of time in the environment and chlorination of water alone cannot inactivate them.

The source of infection

The parasites could cause disease equally in humans and animals such as dogs, cats, cows and sheep. In the environment, major reservoirs of the parasite are contaminated surface waters.

Route of transmission

A major pathway of disease transmission is personal contact with infected patients or exposure to food or water contaminated by them.

Susceptibility

Direct person-to-person transmission, again through contact with infected faeces, is the other main source of infection. Foodborne outbreaks have happened, usually linked to infected food handlers or their contacts.

Preventive measures:

Normal water treatment processes should be effective in removing *Giardia* cysts from drinking water. Good personal and food hygiene, especially hand washing, are important in preventing the spread of giardiasis, especially in institutions like nurseries or care homes. There is no vaccine to protect humans against giardiasis, although a vaccine may be available for pets.

Giardiasis

Symptoms

People who have swallowed *Giardia* cysts sometimes have no symptoms; this is particularly common in children.

For those who have symptoms, the most common are diarrhoea, malaise, flatulence, foul-smelling and greasy stools, abdominal cramps, bloating, nausea, loss of appetite and weight loss. Prolonged diarrhoea, weight loss and not absorbing nutrients from food passing through the intestines are particular symptoms of giardiasis.

Complications

Symptoms can occasionally be very severe, especially in young children or pregnant women. Symptoms can be acute, chronic—lasting some time—or relapsing, clearing up and then recurring.

Toxoplasmosis

Etiology:

Toxoplasma gondii is an obligate intracellular, parasitic protozoan

The source of infection

Cats are the reservoir of the parasite.

Route of transmission

They excrete cysts in the environment, able to infect many other animals, and humans can become infected either by ingesting the cysts (by direct contact with cats or through food or water contaminated by cat faeces), or by eating poorly cooked meat containing cysts, especially pork and mutton.

Susceptibility

Preventive measures:

Basic food handling safety practices can prevent or reduce the chances of becoming infected with *T. gondii*, such as washing unwashed fruits and vegetable and avoiding raw or undercooked meat, poultry, and seafood. Other unsafe practices such as drinking unpasteurized milk or untreated water can increase odds of infection. Oocysts in cat feces take at least a day to sporulate and become infectious after they are shed, so disposing of cat litter daily greatly reduces the chances of infectious oocysts being present in litter.

Toxoplasmosis

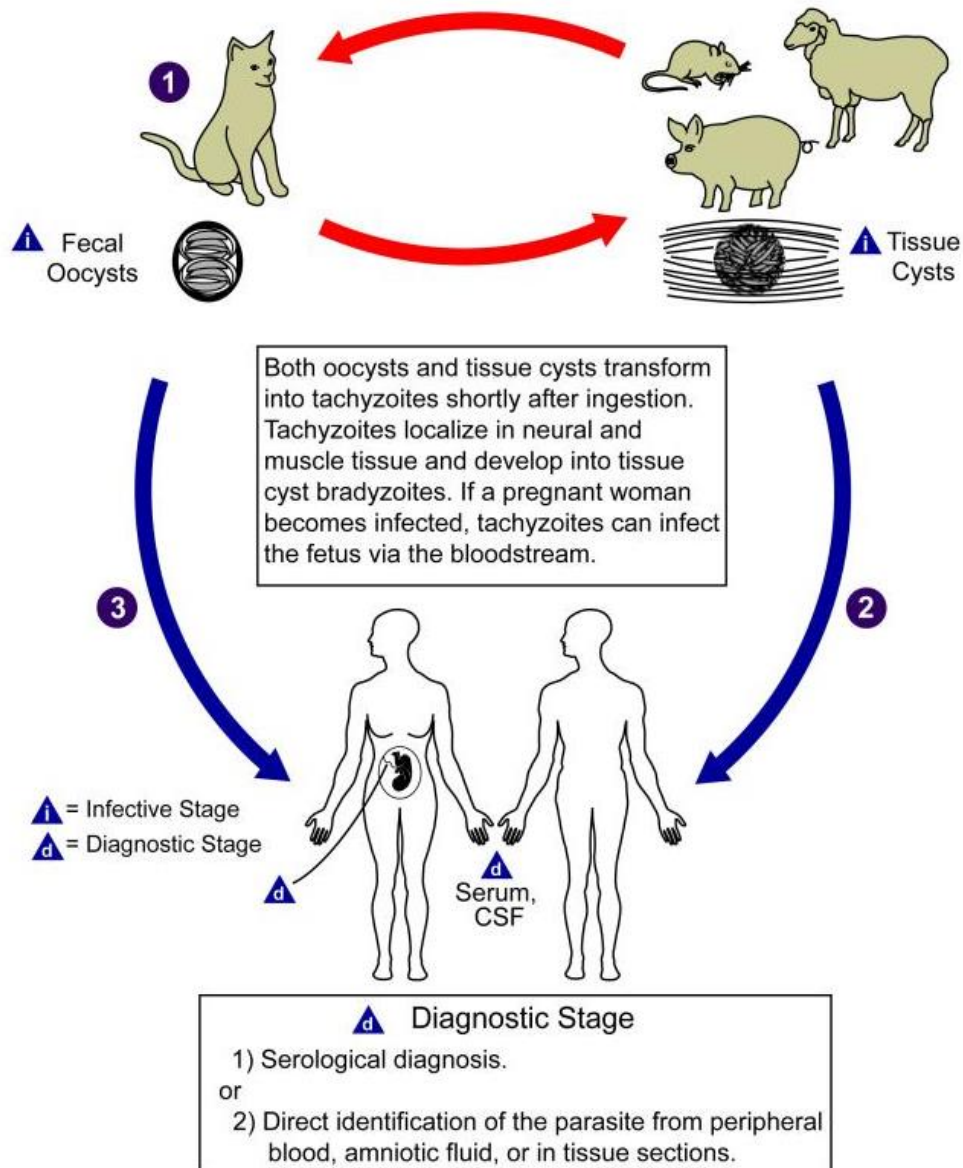
Usually toxoplasmosis goes with no symptoms in humans (and animals), but healthy individuals may experience swollen lymph glands. However, it may also cause life-threatening disease in individuals with impaired immune defence.

During pregnancy the infection can affect the foetus.

Pregnant women, also without symptoms, may transmit the infection to the foetus, which can result in abortion, still-birth, perinatal death (due to disseminated toxoplasmosis), or congenital infection with severe malformation affecting the eyes and the brain. Infection in individuals with impaired immunity tends to seriously affect the central nervous system, but also other organs may be affected. Such patients may require prolonged (sometimes life-long) therapy.

Toxoplasmosis

(*Toxoplasma gondii*)



Trichinellosis (trichinosis)

Trichinellosis (trichinosis) is caused by nematodes (roundworms) of the genus *Trichinella*.

Trichinellosis is caused by the ingestion of undercooked meat containing encysted larvae (except for *T. pseudospiralis* and *T. papuae*, which do not encyst) of *Trichinella* species

After exposure to gastric acid and pepsin, the larvae are released from the cysts and invade the small bowel mucosa where they develop into adult worms. Females are 2.2 mm in length; males 1.2 mm. The life span in the small bowel is about four weeks. After 1 week, the females release larvae that migrate to striated muscles where they encyst.

Diagnosis is usually made based on clinical symptoms, and is confirmed by serology or identification of encysted or non-encysted larvae in biopsy or autopsy specimens.

Tularemia (*Francisella tularensis*)

The bacterium that causes tularemia is highly infectious and can enter the human body through the skin, eyes, mouth, or lungs.

Symptoms of infection vary depending on the route of entry. Usual sources of infection are described below. Transmission of tularemia from person to person has not been reported.

F. tularensis bacteria can be transmitted to humans via the skin when handling infected animal tissue. In particular, this can occur when hunting or skinning infected rabbits, muskrats, prairie dogs and other rodents. Many other animals have also been known to become ill with tularemia. Domestic cats are very susceptible to tularemia and have been known to transmit the bacteria to humans. Care should be taken when handling any sick or dead animal. Outbreaks of tularemia have occurred among hamsters purchased from pet stores.

Tularemia (*Francisella tularensis*)

Infection due to handling animals can result in glandular, ulceroglandular and oculoglandular tularemia. Oropharyngeal tularemia can result from eating under-cooked meat of infected animals.

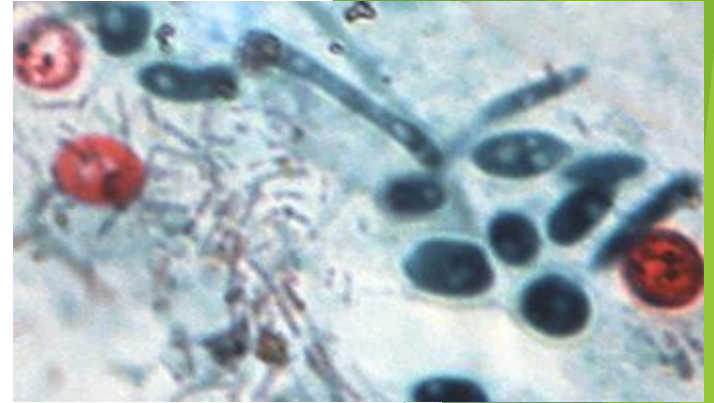
Humans can acquire tularemia by inhaling dust or aerosols contaminated with *F. tularensis* bacteria. This can occur during farming or landscaping activities, especially when machinery (e.g. tractors or mowers) runs over infected animals or carcasses. Although rare, this type of exposure can result in pneumonic tularemia, one of the most severe forms of the disease. Water can also become contaminated with the bacteria through contact with infected animals. Humans who drink contaminated water that has not been treated may contract oropharyngeal tularemia. This mode of transmission appears to be much more common in Europe than the U.S.

Entamoeba histolytica

- ▶ is an anaerobic parasitic amoebozoan, part of the genus *Entamoeba*.
- ▶ Predominantly infecting humans and other primates causing amoebiasis, *E. histolytica* is estimated to infect about 35-50 million people worldwide.
- ▶ *E. histolytica* infection is estimated to kill more than 55,000 people each year. Previously, it was thought that 10% of the world population was infected, but these figures predate the recognition that at least 90% of these infections were due to a second species, *E. dispar*. Mammals such as dogs and cats can become infected transiently, but are not thought to contribute significantly to transmission.



Cryptosporidiosis



In humans, infections without symptoms are common. Especially healthy individuals, may, after an incubation period averaging one week, get a diarrhoea that spontaneously resolves over a couple of weeks. By contrast, patients with impaired immune system may develop profuse, life-threatening, watery diarrhoea that is very difficult to treat with currently available drugs.

Outbreaks have been reported in hospitals, day-care centres, within households, among bathers (affecting participants in water sports in lakes and swimming pools), and in municipalities with contaminated public water supplies. Water distribution systems are particularly vulnerable to contamination with *Cryptosporidium*, which can survive most disinfection procedures such as chlorination

Cryptosporidiosis

Etiology:

Cryptosporidia are intestinal parasites infecting a variety of animals (e.g. cattle, sheep, rodents, cats and dogs, but also birds, fish and reptiles). Human infections occur due to *Cryptosporidium parvum*, a species that also affects domestic animals.

The source of infection

Cryptosporidium eggs (oocysts) can survive for months in moist soil or water and survive harsh environmental conditions (e.g. heat, cold, droughts) for extended periods of time.

Route of transmission

Person-to-person or animal-to-person disease transmission occurs mainly through contaminated water and food..

Everyone is susceptible to the infection but the highest numbers of cases are found in children, with those aged younger than two years at the most risk.

Preventive measures:

Good quality drinking water, swimming pool hygiene and general hygiene measures are all important in preventing cryptosporidiosis. Good hand-washing, taking care when preparing food and carefully disposing nappies are all important in limiting the spread of infection. People whose immune systems are compromised should avoid contact with animals with diarrhoea and young pets, and avoid swallowing water when swimming. If drinking water supplies are affected, water should be boiled before drinking.

Susceptibility

Echinococcosis



Echinococcosis is a zoonotic disease (transmitted from animals to humans) caused by the larval stage (hydatid cyst) of tapeworms. Eggs are excreted in the faeces of infected dogs and foxes and can be ingested by humans either by close contact with these animals or through contaminated food.

- ▶ The most common location of cysts is the liver, but cysts may develop in almost any organ, including lungs, kidneys, spleen, nervous tissue, etc, years after the ingestion of the echinococcus eggs. In the case of cystic disease, symptoms usually appear due to the large size of the cysts. Cysts in the lungs invades tissues in a cancer-like fashion and if untreated always leads to death.
- ▶ Patients are treated with surgery and the specific anti-helminthic drugs. The disease occurs in areas where dogs have access to animal inner organs, usually of sheep and cattle (intermediate hosts), containing cysts. The lung form is restricted to northern countries, where foxes abound.
- ▶ Poor hand hygiene, close contact with infected animals and consumption of undercooked, unwashed food contaminated with echinococcus eggs (e.g. vegetables) are all risk factors.

Echinococcosis

The genus *Echinococcus* includes six parasite species.

Etiology:

The source of infection

The infection is most often spread from dogs, wolves and foxes but can also come from sheep, goats, cattle, camels and horses.

Infected humans do not excrete eggs.

Route of transmission

People get echinococcosis by swallowing the eggs of parasites when they eat contaminated food or drink water contaminated with the faeces of animals which have been infected with the tapeworm.

General

Susceptibility

Preventive measures:

Good hygiene measures are important to avoid getting echinococcosis. Vaccines are available for animals to reduce the risk of their spreading the parasite to humans.

Helminths types causing infections

▶ Of all the known helminth species, the most important helminths with respect to understanding their transmission pathways, their control, inactivation and enumeration in samples of human excreta from dried feces, faecal sludge, wastewater, and sewage sludge are: soil-transmitted helminths, including *Ascaris lumbricoides* (the most common worldwide),

▶ *Trichuris trichiura*, *Necator americanus*, *Strongyloides stercoralis* and

▶ *Ancylostoma duodenale*

▶ *Hymenolepis nana*

▶ *Taenia saginata*

▶ *Enterobius*

▶ *Fasciola hepatica*

▶ *Schistosoma mansoni*

▶ *Toxocara canis*

▶ *Toxocara cati*

Recommendations for the public and travellers

- ▶ Ensure food is properly cooked and still hot when served.
- ▶ Avoid raw milk and products made from raw milk. Drink only pasteurized or boiled milk.
- ▶ Avoid ice unless it is made from safe water.
- ▶ When the safety of drinking water is questionable, boil it or if this is not possible, disinfect it with a reliable, slow-release disinfectant agent (usually available at pharmacies).
- ▶ Wash hands thoroughly and frequently using soap, in particular after contact with pets or farm animals, or after having been to the toilet.
- ▶ Wash fruits and vegetables carefully, particularly if they are eaten raw. If possible, vegetables and fruits should be peeled.
- ▶ When travelling, refer to WHO's brochure *A guide on safe food for travellers*.

Recommendations for food handlers

- ▶ Both professional and domestic food handlers should be vigilant while preparing food and should observe hygienic rules of food preparation.
- ▶ Professional food handlers who suffer from fever, diarrhoea, vomiting or visible infected skin lesions should report to their employer immediately.
- ▶ **The WHO Five Keys to Safer Food** serve as the basis for educational programmes to train food handlers and educate consumers. They are especially important in preventing food poisoning.
- ▶ The Five Keys are:
 - ▶ Keep clean.
 - ▶ Separate raw and cooked.
 - ▶ Cook thoroughly.
 - ▶ Keep food at safe temperatures.
 - ▶ Use safe water and raw materials.

Recommendations for producers of fruits and vegetables

- ▶ The WHO "**Five keys to growing safer fruits and vegetables**" is an educational manual for rural workers, including small farmers who grow fresh fruits and vegetables for themselves, their families and for sale in local market. It provides them with key practices to prevent microbial contamination of fresh produces during planting, growing, harvesting and storing.
- ▶ The five keys practices are:
 - ▶ Practice good personal hygiene.
 - ▶ Protect fields from animal faecal contamination.
 - ▶ Use treated faecal waste.
 - ▶ Evaluate and manage risks from irrigation water.
 - ▶ Keep harvest and storage equipment clean and dry.

WHO response

- ▶ WHO promotes the strengthening of food safety systems, promoting good manufacturing practices and educating retailers and consumers about appropriate food handling and avoiding contamination. Education of consumers and training of food handlers in safe food handling is one of the most critical means to prevent foodborne illnesses including salmonellosis.
- ▶ WHO strengthens and enhances the capacities of national and regional laboratories in the surveillance of *Salmonella*, the other major foodborne pathogens and antimicrobial resistance in *Salmonella* and campylobacter from humans, food and animals through the network called Global Foodborne Infections Network (GFN) .
- ▶ WHO's main tool to assist Member States in surveillance, coordination and response to outbreaks is the use of the International Network of Food Safety Authorities (INFOSAN) . which links national authorities in Member States in charge of managing food safety events. This network is managed jointly by FAO and WHO.