

FOOD- AND WATERBORNE DISEASES AND ZOOZOSES

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Alimentary infection

- Entry of an infective agent into the organism through the **digestive tract**
- represent a permanently serious health, and in their effect also economic problem all over the world.
- Etiology: bacteria, viruses, protozoa and helminths.
- The source of infection is man or animal, usually at the end of an incubation period, in the course of an illness, but also during convalescence when the infective agent is excreted (carrier)
- Transmission: indirect (through ingestion of contaminated food, water or milk products) or direct by contaminated hands (faecal-oral)

Primary and secondary contamination

- Primary contamination – applies only to **animal products** (meat, eggs or milk from infected animals)
- Secondary contamination – contamination (by human or animal) **of any food or water** during processing, cultivation, distribution, storage, cooking

Food- and waterborne diseases and zoonoses

- Anthrax
- Botulism
- Brucellosis
- Campylobacteriosis
- Cholera
- Cryptosporidiosis
- Echinococcosis (hydatid disease)
- Shiga toxin/verocytotoxin-producing *Escherichia coli* (STEC/VTEC) infection
- Giardiasis
- Viral hepatitis A
- Viral hepatitis E
- Leptospirosis
- Listeriosis
- Salmonellosis
- Shigellosis
- Taeniasis
- Toxoplasmosis (congenital)
- Trichinellosis
- Tularaemia
- Typhoid/paratyphoid fever
- Variant Creutzfeldt–Jakob disease (vCJD)
- Yersiniosis
- Rotaviruses
- Noroviruses

Alimentary infection – causative agents

- Bacteria
 - Zoonoses (*Campylobacter*, *Salmonella* Enterica, *Yersinia*, *Listeria*...)
 - Anthroponoses (*Shigella*, *Salmonella* Typhi, *Vibrio cholerae*...)
 - Enterotoxicoses (*Bacillus cereus*, *Staphylococcus*, *Clostridia*)
- Viruses: rotavirus, norovirus, astrovirus, hepatitis A and E virus...
- Parasites: *Toxoplasma*, *Taenia*, *Giardiasis*...

Enterotoxicooses

Source: **food contaminated with bacteria that produce toxins**

1. toxin is produced by bacteria and is already present in the food (e.g. *Staphylococcus aureus*) – shorter incubation period
2. toxin is produced by bacteria in the digestive system after eating contaminated food (e.g. *Clostridium perfringens* type A)
3. both mechanisms (*Bacillus cereus*, *Clostridium botulinum*)

- **Non-transmissible among people**
- Clinical signs: nausea, stomach cramps, vomiting, diarrhea (usually no fever!)

Enterotoxigenesis: Botulism

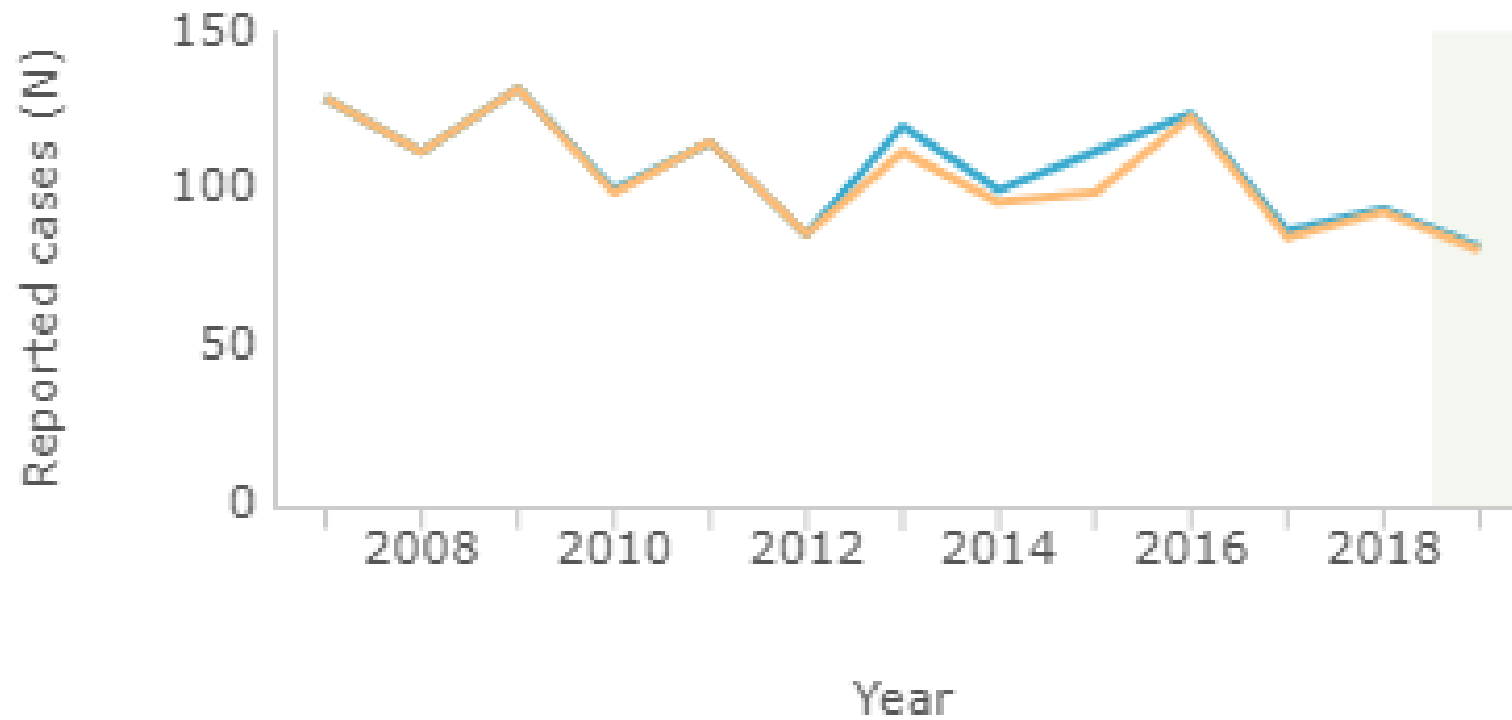
Botulism is a serious paralytic illness caused by a nerve **toxin** (7 types, A – G) produced by the bacterium ***Clostridium botulinum***. The disease may occur after eating foods containing the toxin or due to development of the spores within the intestine.

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.

Symptoms may be very severe, and require intensive-care treatment and the administration of an anti-toxin (passive immunisation). 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



Botulism

Symptoms

Botulinum toxin causes **paralysis** by affecting the nerves (prevents muscle contraction).

- blurred vision, difficulty swallowing, double vision, stammering or stuttering, vocal disturbance, drooping eyelids, facial weakness and weakness of the tongue. Weakness in the neck and arms follows, after which the respiratory and lower body muscles are affected. Respiratory problems may be severe enough to need ventilation in hospital. Other symptoms may include dry mouth, urinary problems and dysfunction of the stomach, intestines, heart and blood vessels. Patients **do not usually have a fever**, and have no loss of sensory functions or awareness.

Botulism caught from food usually affects the stomach and intestines, causing nausea, vomiting, constipation, diarrhoea and abdominal cramps.

Botulism in a wound causes inflammation around the wound, followed by low blood pressure and circulatory collapse. Patients with wound botulism often look and feel quite well before deteriorating dramatically over a few hours.

Babies with botulism may have constipation, lethargy, feeding difficulties, floppy muscles, increased drooling and a weak cry.

Botulism

Ways to catch botulism

Botulism **spores are widespread** in the environment and can be found in dust, soil, untreated water and the digestive tracts of animals and fish.

Risk Food: **meat products** (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 (e.g. honey), 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 (incl. drug users)

Botulism

Diagnosis: Laboratory tests can detect botulinum toxin in faeces, serum, stomach contents, a swab from a wound or in samples from contaminated food.

Treatment: Patients need to be admitted to hospital for investigation and treatment. Botulinum **antitoxin** (trivalent: A, B, E or heptavalent) is available and reduces the length of illness and fatality rates, but may have serious side effects. Treatment can be given based on a doctor's diagnosis of symptoms, without waiting for laboratory confirmation. Wound botulism can be treated with antibiotics and surgery to remove dead tissue.

How to avoid getting 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. Avoid tasting food that might be spoiled. Keep food that has not been completely processed in the fridge. Boiling food for ten minutes before eating it would inactivate the toxin in home-canned foods.

Other enterotoxigenoses, examples

Bacillus cereus

- 2 types of toxin: A - emetic (vomiting) syndrome (incub. period: 1 – 5 hours), B - diarrhoeal syndrome (incub. period: 8 – 16 hours)

Staphylococcus aureus (incub. period: 1 – 6 hours)

- Source of bacteria: mostly **human** (with S.A. on thin skin, in the nose or with pustules on the hands) contaminating food

Clostridium perfringens type A (incub. period: 8 – 24 hours)

- Toxins are released in the small intestine, longer incubation period

Campylobacteriosis

Campylobacteriosis is a diarrhoeal disease caused by *Campylobacter* bacteria (*C. jejuni, coli*), found in animals such as poultry, cattle, pigs, wild birds and wild mammals.

The most frequent way of getting infected is through the **consumption of contaminated food (mainly poultry) or water**. Other risk factors include swimming in natural surface-waters and direct contact with infected animals.

Incubation period: 2 – 7 days (range 1 – 10 days)

As a prophylactic measure, control of *Campylobacter* colonisation in poultry is important, as well as hygienic processing of meat, and the protection and control of private drinking water supplies.

In the Czech republic *Campylobacter* is the most common etiological agent of bacterial diarrhea.

Campylobacteriosis

- **Symptoms**

Campylobacter infection can vary from people who have no symptoms at all to those who are severely ill. Most people with symptoms **have diarrhoea (bloody), abdominal pain and fever**. Before these symptoms patients may have fever, headache, malaise and muscle pain. Usually, symptoms last for a few days and the disease is self-limiting but occasionally they will persist and result in hospitalisation.

- **Complications**

Complications include arthritis (inflamed joints), Guillain-Barré Syndrome (which causes weakened muscles), and a type of kidney failure known as **haemolytic uraemic syndrome (HUS)**. Some types of Campylobacter infection can lead to bacteria in the blood, meningitis, infected blood vessels and abscesses. Some types can also lead to more severe disease in people with chronic conditions, like diabetes.

Campylobacteriosis

- **Ways to catch Campylobacteriosis**

Campylobacteriosis comes from animals including **poultry, cattle, pigs, wild birds, mammals and domestic pets**. 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 through 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.

Campylobacteriosis is common in Europe. All ages are affected but most cases are **in children** aged younger than four years and in young adults. Infections occur throughout the year but are most common from **June to October**.

- People at increased risk: those **working with farm animals** or meat, travellers abroad (it is a common cause of travellers' diarrhoea), gay men and family contacts of cases.

Campylobacteriosis

- **Diagnosis**

Laboratory tests on stool samples can be used to diagnose Campylobacteriosis, as well as blood tests.

- **Treatment**

Most cases settle after 2 – 3 days of diarrhoea and 80 – 90% settle within a week. Most people only need treatment to relieve their symptoms and keeping hydrated is important for those with diarrhoea. However, some cases can be more prolonged or severe. Antimicrobial therapy to treat Campylobacter is not often needed but is available for severe infections or those particularly at risk.

Campylobacteriosis

- **How to avoid getting Campylobacteriosis**

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.

- **What to do if you have Campylobacteriosis**

Food handlers, healthcare workers and children younger than five years should stay away from work, nursery or daycare until 48 hours after symptoms have stopped. Food handlers and healthcare workers should continue to observe careful hygiene measures, especially hand washing.

Salmonellosis (non-typhi, non-paratyphi)

Enteric infections due to *Salmonella* bacteria are generally referred to by the term 'salmonellosis' when they are due to *Salmonella* species (*Salmonella* Enterica) other than *Salmonella* Typhi and *Salmonella* Paratyphi.

Various animals (especially poultry, pigs, cattle, and reptiles) can be **reservoirs** for *Salmonella* – zoonosis.

Transmission:

Primary - products prepared from meat, eggs, and organs of primarily infected animals.

Secondary - foodstuffs **contaminated** during processing, distribution, storage or transport with the salmonellae of animals or man: **Sausages, pâté, white puddings, and dairy products - dried milk**, various whipped creams, ice-cream, egg products (salads, spreads, mayonnaise and pastry, in which a raw yolk is used) and insufficiently heat-treated **poultry products**. Transmission from man to man applies only rarely, namely during gross negligence of personal hygiene.

Salmonellosis

Incubation period: **12 to 36 hours**

Clinical picture: fever, diarrhoea (bloody), abdominal pain, nausea and vomiting. Symptoms usually last for a few days.

Due to the effects of dehydration, hospital admission may sometimes be required.

Elderly patients are also more prone to developing severe blood infection.

In addition, post-infectious complications, such as reactive **joint inflammation** occur in about 10% of the cases.

Shigellosis

- Shigellosis is a gastrointestinal infection caused by one of four species of Shigella bacteria: *Shigella sonnei*, *S. flexneri*, *S. boydii* and *S. dysenteriae*.
- *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.
- **Complications** of *S. flexneri* can include reactive arthritis and Reiter's syndrome (inflammation of the urethra, conjunctivitis and inflamed joints). Complications of *S. dysenteriae* can include an enlarged colon due to **toxins**, **haemolytic uraemic syndrome** (HUS)—which is a type of kidney failure, blood clots and sepsis (invasion of the body by toxins).

Shigellosis

Reservoir: human (anthroponosis)

Transmission: food and water contaminated by these bacteria.

Incubation period: 1 – 3 days

Infectious dose: **extremely low** (10 – 200 particles)

- 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.

Preventive measures:

- **Safe disposal of faeces** and the **protection and treatment of drinking and swimming water are important to prevent people from getting shigellosis.**
- Hand-washing, especially after using the toilet or changing babies nappies and before preparing or eating food, reduces the risk.
- **Care with food and water** while travelling abroad is also important.
- There is no vaccine currently available to prevent Shigella infection

Escherichia coli (*E.coli*)

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

However, some *E.coli* strains (called EHEC) are able to produce a **toxin** that could produce serious infection.

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

Humans acquire the infection by consuming contaminated food or water. Following an **incubation period of about 10-18 hours**, a variety of gastrointestinal symptoms appear, ranging from mild to severe bloody diarrhoea, mostly without fever.

Infectious dose is very low.

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). The death rate of HUS is about 3–5%.

Vero-toxin/shiga-toxin producing E.Coli (VTEC, STEC)

Shiga toxin-producing E. coli (STEC) is a group of pathogenic Escherichia coli strains (subgroup of EHEC) **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. 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.

Incubation period: 3 – 8 days

Shiga toxin-producing E. coli (STEC)

Transmission of STEC infection mainly occurs through contaminated food or water and contact with animals: **raw (unpasteurised) milk and cheese, undercooked beef, a variety of fresh produce (e.g. sprouts, spinach, lettuce), unpasteurised apple cider, etc.**

Person-to-person transmission is also possible among close contacts (families, childcare centres, nursing homes, etc).

Proper hand hygiene

- Wash your hands properly with soap, rinse carefully and dry using disposable kitchen towel or a textile towel (to be washed regularly at 60°C):
- before preparing, serving, or eating food
- after using the toilet or changing nappies (diapers)
- after handling raw vegetables, roots or meat
- after contact with farm animals or after visiting a farm
- after any contact with faeces from household pets

See also <https://www.cdc.gov/handwashing/when-how-handwashing.html>

Food handling

- Any person with diarrhoea or vomiting should **restrain from handling food**
- Meat, including minced meat, should be thoroughly **cooked**
- All fruits with skin should be **peeled and then rinsed** under running potable water
- All vegetables should be **washed properly under running potable water**, especially those that will not be cooked before consumption
- Peel all root vegetables and rinse them under running potable water
- Thorough **cooking** of vegetables and meat destroys disease causing bacteria and viruses
- Avoid **cross contamination** i.e. spreading bacteria from a raw food item to a ready-to-eat or cooked food item, by for example, using **separate cutting boards** for raw meat and cooked meat or fresh vegetables and wash the cutting board with soap in between the handling of raw and ready-to-eat food.

See also: <https://www.foodsafety.gov/keep-food-safe/4-steps-to-food-safety>

Typhoid and Paratyphoid Fever

Typhoid and paratyphoid fevers are systemic diseases caused by the bacteria ***Salmonella Typhi*** and *Salmonella Paratyphi*, respectively.

Humans are the only reservoir(= anthroponosis) for *Salmonella Typhi* (which is the most serious), whereas *Salmonella Paratyphi* also has animal reservoirs.

Humans can be chronic carriers and transmit the bacteria to other persons (either directly or via food or water contamination).

Typhoid fever

- a life-threatening infection caused by the bacterium *Salmonella* Typhi. It is usually spread through contaminated **food or water**, including ice.
- An estimated 11–20 million people get sick from typhoid and about 150 000 people die from it every year.
- Endemic areas: South East Asia, Africa, Latin America
- Incubation period: 7 – 20 days
- Symptoms: extraintestinal - prolonged fever, fatigue, headache, nausea; abdominal pain, and constipation or diarrhoea. Some patients may have a rash. Severe cases may lead to serious complications or even death in case the spread into the bloodstream.

Typhoid fever, disease burden

- Improved living conditions and the introduction of antibiotics resulted in a drastic reduction of typhoid fever morbidity and mortality in industrialized countries. In developing areas of Africa, the Americas, South-East Asia and the Western Pacific regions, however, the disease continues to be a public health problem.
- Typhoid risk is higher in populations that **lack access to safe water and adequate sanitation**. Poor communities and vulnerable groups including **children** are at highest risk.

Typhoid fever, treatment and preventive measures

- Typhoid fever can be treated with antibiotics.
- Even when the symptoms go away, people may still be **carrying typhoid bacteria**, meaning they can spread it to others through their faeces.
- It is important for people being treated for typhoid fever to do the following:
 - Take prescribed antibiotics for as long as the doctor has prescribed.
 - Wash their hands with soap and water after using the bathroom, and do not prepare or serve food for other people. This will lower the chance of passing the infection on to someone else.
 - Have their doctor test to ensure that no *Salmonella* Typhi bacteria remain in their body (repeated stool examination).

The following recommendations will help ensure safety while travelling:

- 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.
- Vaccination is available (Typhim Vi[®])

Cholera

Cholera is an acute diarrhoeal infection caused by the bacterium *Vibrio cholerae* of serogroups O1 or O139. **Humans are the only** relevant **reservoir**, even though Vibrios can survive for a long time in coastal waters contaminated by human excreta.

Transmission: contaminated water and food, especially seafood eaten under-cooked

Short incubation period of 12 hours to 5 days

Clinical signs: acute, profuse **watery diarrhoea** lasting from one to a few days (there is usually no stomach ache and sometimes vomiting occurs later than diarrhoea).

In its extreme form, cholera can be fatal (from dehydration, especially in young children).

With timely treatment (fluid replacement and antibiotics), less than 1% of patients with symptoms die. The disease has not been endemic in Europe for a long time, and thanks to high hygiene standards the potential for imported cases to generate further ones is low.

Cholera outbreaks 2020

Geographical distribution of cholera cases reported worldwide in 2020

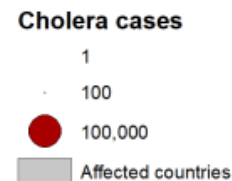
Source: ECDC

Asia: Jemen, Malaysia, Bangladesh

Africa: Nigeria, Somalia, Kenya,
Ethiopia, Cameroon



2019: Haiti...



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Cholera

- According to the WHO, **vaccination** should be considered for travellers at higher risk, such as emergency and relief workers who are likely to be directly exposed.
- Vaccination is generally not recommended for other travellers.
- Travellers to cholera-endemic areas should seek advice from travel health clinics to assess their personal risk and apply precautionary sanitary and hygiene measures to prevent infection. These can include **drinking bottled water or water treated with chlorine**, carefully **washing fruit and vegetables with bottled or chlorinated water** before consumption, regularly washing hands with soap, eating thoroughly cooked food and **avoiding the consumption of raw seafood products**.

Leptospirosis

Leptospirosis is a zoonotic disease caused by *Leptospira* bacteria (G-), is widespread.

Maintenance hosts: different species of domestic and wild animals.

Transmission: from direct contact with the **urine** of infected animals or **from contact** with material **contaminated by it** (percutaneous infection via broken skin or mucous membranes), **such as water or soil; inhalation, ingestion.**

Incubation period: 2- 30 days (with an average of 10 days).

In Europe: most common *Leptospira icterohaemorrhagiae* and *grippotyphosa*, reservoir: rodents

The clinical presentation is variable – from mild to severe (Weil's disease) : 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.

Preventive measures include **controlling rodent populations**, avoiding contaminated areas and covering cuts and abraded skin when operating in the environment, **improving water and food storage conditions**

Listeriosis

- Zoonosis, ubiquitous bacteria (can be found in soil, surface water, vegetation), there are many types of Listeria, animals carry the bacteria in their faeces.
- Listeriosis is a disease caused by *Listeria monocytogenes* (the only pathogenic for humans), G+
- The disease primarily causes problems **in pregnant women, newborns, and adults with a weakened immune system.**
- Incubation period: 10 – 70 days
- Clinical signs vary, most dangerous is infection in gravidity, it can lead to death of the foetus and consequent abortion or to a dramatic picture of congenital listeriosis in the newborn.
- in adults with weakened immune system and the elderly may lead to meningitis, brain infection, and severe blood infections (extraintestinal signs).

Listeriosis, transmission and prevention

- Transmission:
Most humans catch the infection by **eating contaminated food**. The bacteria can **grow at low temperatures** and are tolerant of salt and therefore can **survive in processed, preserved and refrigerated foods** like processed **meat and fish, cold meats and hot dogs; dairy products, such as soft cheese, butter and milk, especially if unpasteurised; and pre-prepared salads, sandwiches and salads**. Other sources: direct contact from animals or the environment. Pregnant women can pass the infection to their babies during birth or through the placenta.
- Preventive measures include providing appropriate information for consumers on **how to minimise the risk of ingesting food** contaminated by *Listeria*. **Pasteurising** dairy products is important as the process kills *Listeria*. Cook-chill and ready-to-eat foods should not be stored for too long and should be thoroughly reheated before serving. Raw vegetables, fruits and salads should be thoroughly **washed** before eating. **Pregnant women** and people whose immune systems are compromised **are advised to avoid soft cheeses, pâté and pre-packed salads, contact with pregnant or newborn animals and silage**.
- Hand washing is effective at reducing the risk of gastroenteritis from many organisms and may be made even more effective by using antibacterial soap.
- There is no vaccine against listeriosis.

Rotavirus infections

Rotaviruses are the single most important cause of severe diarrhoeal illness in infants and young children worldwide (especially **children under 3 years**). While infected, many children will be in need of medical attention due to extensive fluid loss.

Infectious dose is **extremely low**: 10 – 100 particles

Incubation period: 1 to 3 days

Vaccine for infants available – Rotarix, Rotateq

In the Czech republic most cases are reported during the cold **winter months**.

Rotaviruses, clinical features and sequelae

- Fever, vomiting, diarrhoea
- **Extensive nausea and vomiting** in some children result in difficulties in providing oral rehydration and severe fluid loss in need of medical attention.
- Complications include febrile seizures/seizures due to electrolyte disturbances but no residual sequelae due to seizures have been reported.
- With symptomatic treatment, including rehydration, symptoms are commonly relieved within 3 to 8 days.

Norovirus infection

- Noroviruses belong to the *Caliciviridae* family and they are well known as causing “**winter-vomiting disease**” or “stomach-flu” referring to their rapid spread in human populations especially during winter months. Noroviruses are relatively resistant in the environment: they can **survive freezing** as well as high temperatures (up to 60°C).
- The viruses survive long periods on different surfaces. Steam cooking of shellfish may allow them to survive. It is important to notice that the viruses can survive in up to 10 ppm chlorine, well in excess of levels routinely present in public drinking water systems (less than 2 ppm).

Norovirus infection

- Norovirus cause gastrointestinal illness to humans. Norovirus infection can cause vomiting, diarrhoea, and stomach pain. Less common symptoms are low fever, chills and headache. Vomiting can be sudden and frequent resulting in remarkable fluid loss.

Recovery occurs usually in one or two days. The incubation period ranges between **12 and 48 hours**.

- Noroviruses are **highly contagious and 10-100** viral particles may be sufficient to infect an individual. They are transmitted primarily through the **faecal-oral route**, either by consumption of contaminated food or water, or by spreading directly from person to person.
- Virus shedding usually starts with the onset of symptoms (mainly vomiting and diarrhea) and may continue for 2 weeks after recovery.

Norovirus infection

- As the immunity may only last a few months and is strain-specific, and given their genetic variability, infection can happen several times in a lifetime and affects individuals of all ages.

Risk food items: Raspberries and oysters have caused several national and international outbreaks; any food item may become **contaminated** if handled by infected person or if washed or humidified with contaminated water. **Norovirus infections spread effectively from person to person** in community settings like hospitals, schools, day care centers and nursing homes. Several outbreaks have been recorded in **cruise ships**, which provide an ideal closed setting for the spread of infection.

Toxoplasmosis

- Toxoplasmosis is an infection caused by the parasite *Toxoplasma gondii*. **Cats are the reservoir** of the parasite. They excrete cysts in the environment, able to infect many other animals
- 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**.
- *Toxoplasma* can be transmitted to humans by for routes:
 - a) **ingestion of raw or inadequately cooked infected meat – most common**
 - b) ingestion of oocysts, an environmentally resistant form of the organism that cats pass in their feces, with exposure of humans occurring through exposure to cat litter or soil
 - c) a newly infected pregnant woman passing the infection to her unborn fetus
 - d) via organ transplant

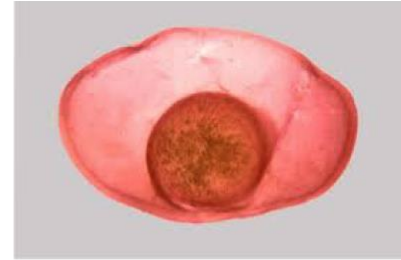
Toxoplasmosis

- Pregnant women, also without symptoms, may **transmit the infection to the foetus**, which can result in abortion, stillbirth, perinatal death (due to disseminated toxoplasmosis), or **congenital infection** with severe malformation affecting the eyes and the brain (Sabin's triad).
- The Toxoplasma cysts can survive in the environment for a long time, contaminating fruit and vegetables, and cysts in meat remain infective as long as the meat is edible.

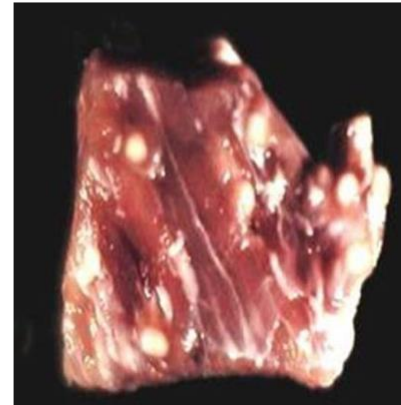
Taeniasis (tapeworms)



Taenia solium adult. Up to 10 ft (3 m) long.



T. solium cysticercus. About 1 cm long.





Measly pork, with several cysticerci (the white cysts)

- human parasitic infection caused by the tapeworm species *Taenia saginata* (beef tapeworm), *Taenia solium* (pork tapeworm). Adult worms live in the small intestine and release proglottids and eggs.
- Humans can become infected with these tapeworms by eating raw or undercooked beef (*T. saginata*) or pork (*T. solium*).

Acquiring Taenia

- *Taenia saginata* – humans become infected only by **eating undercooked beef meat** (containing parasite larvae=cysticerci). Humans are the only definitive hosts (taeniasis). Larvae can not cause cysticercosis in human organs.

- *Taenia solium* – humans get infected by:

- 1. **eating undercooked pork** meat with cysticerci  taeniasis
- 2. worm eggs from feces (even autoinfection)  cysticercosis

T. Solium is more dangerous, it causes not only intestinal problems, but also organ cysticercosis (in brain, muscle...)

Taenia solium, life cycle

Cysticercosis

(*Taenia spp.*)

