Microbiological parameters of drinking water

II Waterborne diseases

Water is essential to almost every form of life. Many people do not have access to clean and safe drinking water. Thereby, on a global basis, every year, 1.5 million people die from waterborne disease caused by different pathogenic microorganisms. Many of these individuals are young children who die of dehydration caused by diarrhea. According to the World Health Organization, there are almost 1.7 billion cases of diarrhea in young children annually, and diarrhea is the second major cause of death for children under 5 year of age [1].

Worldwide, it is believed that the most common route of infection with a waterborne pathogen is the "fecal-oral" route. Such microorganisms are referred to as enteric pathogens [1;2].

The global concern has been predominantly focused on microorganisms of enteric origin, even though other microorganisms (e.g., *Legionella*, *Naegleria*) can cause waterborne disease. This is mainly because most of these other microorganisms can be 'neutralized' by means of common sanitation measures and handwashing [1].

Waterborne diseases begin as infection, and contaminated water may cause an infection with only small numbers of the pathogen being present. Many different microorganisms can cause waterborne infectious diseases, and some of the major ones are summarized in Table 1 [2;3].

Water supplies in developed countries typically meet rigid quality standards, greatly reducing the spread of waterborne diseases. Drinking water undergoes extensive treatment that includes both filtration and chlorination. Although filtration removes turbidity and many microorganisms, it is chlorination that makes drinking water safe. Chlorine gas (Cl_2) is a strong oxidant and oxidizes not only matter dissolved in the water but also microbial cells [3].

Created with the support of the Pilot Platform of Vocational Excellence Water project.
Project Number 612632-EPP-1-2019-1-NL-EPPKA2-SSA-P

Despite filtration and chlorination, waterborne diseases outbreaks from potable water occasionally occur. It is important to screen water for every pathogenic organism that may be present, and so both potable and recreational waters are routinely tested for specific indicator organisms, the presence of which signals the potential for developing waterborne disease [2;3].

Table 1. Major waterborne pathogens [3].

Pathogen	***Caused disease***
Bacteria	
Vibrio cholerae	Cholera
Legionella pneumophila	Legionellosis
Salmonella enterica (typhi)	Typhoid fever
Escherichia coli	Gastrointestinal illness
Pseudomonas aeruginosa	Nosocomial pneumonia
Campylobacter jejuni	Gastrointestinal illness
Viruses	
Norovirus	Gastrointestinal illness
Hepatitis A virus	Viral hepatitis
Parasites	
Cryptosporidium parvum	Cryptosporidiosis
Giardia intestinalis	Giardiasis
Schistosoma	Schistosomiasis

Further we will pay attention to the most common waterborne diseases and different microorganisms which cause these diseases.

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1. Vibrio cholerae causing cholera.

Cholera is a severe gastrointestinal diarrheal disease that is now largely restricted to countries in the developing world. Illness is caused by a gram-negative and motile curved bacteria *Vibrio cholerae*. The ingestion of a large number (>10^8) of *V.cholerae* cells is required to cause disease. Bacterial cells attach to epithelial cells in the small intestine where they can grow and release cholera toxin [2;3].

Cholera enterotoxin causes severe diarrhea that can result in dehydration and death unless the patient is given fluid and electrolyte therapy. The mortality rate from untreated cholera is 25-50% and can be even higher under conditions of severe crowding and malnutrition as often occurs in refugee camps or in areas that have experienced natural disasters such as floods, earthquakes, and the like. In these situations there is often a near-complete breakdown in sanitation leading to the contamination of drinking water with feces and the rapid transmission of cholera [2;3].

Figure 1. Vibrio cholerae cells under electron microscope.

http://www.bacteriainphotos.com/vibrio_cholerae_under_microscope.html

2. Legionella pneumophila causing legionellosis.

Legionella pneumophila, causing legionellosis, is a gram-negative, obligately aerobic rod-shaped bacteria present in freshwaters and in soil. *L.pneumophila* is known to be a major pathogen in residual water systems as well, where the organism persists in biofilms that form on interior surfaces of water distribution pipes and, also within the cells of certain microbial parasites [2;3].

L.pneumophila invade the lungs and grow within macrophages and monocytes. Infections are often asymptomatic or produce only a mild cough, sore throat, mild headache, and fever; these self-limiting cases typically resolve themselves in 2-5 days. However, the elderly and those with compromised immune systems, often acquire more serious Legionella infections resulting in pneumonia [2;3].

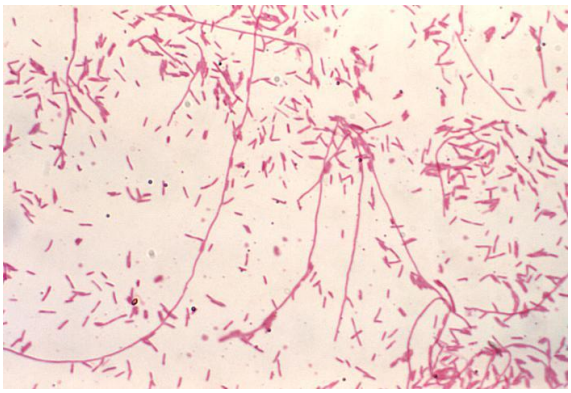

Figure 2. Legionella pneumophila cells under light microscope.

https://www.stepwards.com/?page_id=3794

3. Typhoid Fever caused by *Vibrio cholerae* and *Salmonella enterica (typhi)*.

Probably the most important waterborne bacterial pathogens are *Vibrio cholerae* and *Salmonella enterica (typhi)*, the organisms that causes typhoid fever. *Salmonella enterica (typhi)* is a gram-negative, motile bacterium which can be transmitted in feces-contaminated water, and thus typhoid fever, like cholera, is primarily restricted to areas where sewage treatment and general sanitation are either absent or poorly maintained [2;3].

Typhoid fever progresses in several stages. Cells of the pathogen ingested in contaminated water or food reach small intestine where they can grow and enter the lymphatic system and the bloodstream. From here, pathogen can travel to many different organs. One or two weeks later, the first symptoms appear, including a mild fever, headache and general malaise. About a week later, the fever becomes more intense (up to 40° C) and the patient typically becomes delirious. Complications can follow, including intestinal bleeding and perforation of the small intestine [2;3].

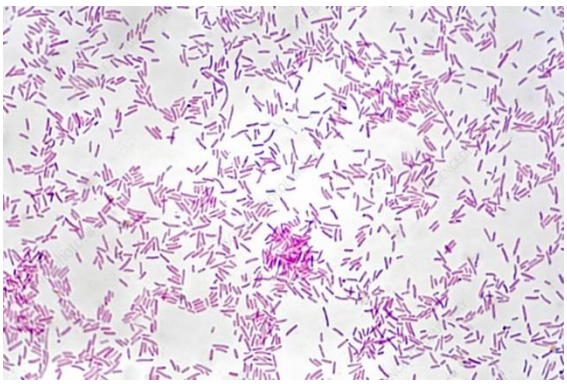

Figure 2. Salmonella typhi cells under light microscope. Magn. 1400x.

https://www.sciencephoto.com/media/917522/view

Self-control questions.

1. What public health conditions allow for outbreaks of typhoid fever?

2. Identify specific measures for control of *Legionella pneumophila*.

3. Using additional sources of information, find and briefly describe what microorganisms also can cause waterborne diseases.

4. State your suggestions on what measures should be taken to reduce the number of waterborne diseases worldwide.

Created with the support of the Pilot Platform of Vocational Excellence Water project.
Project Number 612632-EPP-1-2019-1-NL-EPPKA2-SSA-P

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Project Number 612632-EPP-1-2019-1-NL-EPPKA2-SSA-P