



# Contaminated Water Borne Diseases: Causes and Remedies- An Overview

Dr. AKSaxena

Associate Professor, Department of Chemistry, Lohia College, Churu, Rajasthan, India

**ABSTRACT:** Waterborne diseases are conditions (meaning adverse effects on human health, such as death, disability, illness or disorders)<sup>[1]:47</sup> caused by pathogenic micro-organisms that are transmitted by water. These diseases can be spread while bathing, washing, drinking water, or by eating food exposed to contaminated water.<sup>[2]</sup> They are a pressing issue in rural areas amongst developing countries all over the world. While diarrhea and vomiting are the most commonly reported symptoms of waterborne illness, other symptoms can include skin, ear, respiratory, or eye problems.<sup>[3]</sup> Lack of clean water supply, sanitation and hygiene (WASH) are major causes for the spread of waterborne diseases in a community. Therefore, reliable access to clean drinking water and sanitation is the main method to prevent waterborne diseases.<sup>[4]</sup>

**KEYWORDS-**waterborne,diseases,pathogenic,contaminated,sanitation,hygiene,drinking,sanitation

## I. INTRODUCTION

Microorganisms causing diseases that characteristically are waterborne prominently include protozoa and bacteria, many of which are intestinal parasites, or invade the tissues or circulatory system through walls of the digestive tract. Various other waterborne diseases are caused by viruses.

Yet other important classes of waterborne diseases are caused by metazoan parasites. Typical examples include certain Nematoda, that is to say "roundworms". As an example of waterborne Nematode infections, one important waterborne nematode disease is Dracunculiasis. It is acquired by swallowing water in which certain copepoda occur that act as vectors for the Nematoda. Anyone swallowing a copepod that happens to be infected with Nematode larvae in the genus *Dracunculus*, becomes liable to infection. The larvae cause guinea worm disease.<sup>[5]</sup>

Another class of waterborne metazoan pathogens are certain members of the Schistosomatidae, a family of blood flukes. They usually infect people that make skin contact with the water.<sup>[5]</sup> Blood flukes are pathogens that cause Schistosomiasis of various forms, more or less seriously affecting hundreds of millions of people worldwide.<sup>[6]</sup>

### Terminology

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The term waterborne disease is reserved largely for infections that predominantly are transmitted through contact with or consumption of microbially polluted water. Many infections may be transmitted by microbes or parasites that accidentally, possibly as a result of exceptional circumstances, have entered the water. However, the fact that there might be an occasional infection need not mean that it is useful to categorize the resulting disease as "waterborne". Nor is it common practice to refer to diseases such as malaria as "waterborne" just because mosquitoes have aquatic phases in their life cycles, or because treating the water they inhabit happens to be an effective strategy in control of the mosquitoes that are the vectors.

A related term is "water-related disease" which is defined as "any significant or widespread adverse effects on human health, such as death, disability, illness or disorders, caused directly or indirectly by the condition, or changes in the quantity or quality of any water".<sup>[1]:47</sup> Water-related diseases are grouped according to their transmission mechanism: water borne, water hygiene, water based, water related.<sup>[1]:47</sup> The main transmission mode for waterborne diseases is ingestion of contaminated water.

### Causes

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Lack of clean water supply, sanitation and hygiene (WASH) are major causes for the spread of waterborne diseases in a community. The fecal–oral route is a disease transmission pathway for waterborne diseases. Poverty also increases the risk of communities to be affected by waterborne diseases. For example, the economic level of a community impacts their ability to have access to clean water.<sup>[7]</sup> Less developed countries might be more at risk for potential outbreaks of waterborne diseases but more developed regions also are at risk to waterborne disease outbreaks.<sup>[8]</sup>



II. DISCUSSION

Diseases by type of pathogen

Disease and transmission <sup>[3][9]</sup>	Microbial agent	Sources of agent in water supply	General symptoms
Acanthamoeba keratitis (cleaning of contact lenses with contaminated water)	<i>Acanthamoeba</i> spp. ( <i>A. castellanii</i> and <i>A. polyphaga</i> )	widely distributed free-living amoebae found in many types of aquatic environments, including surface water, tap water, swimming pools, and contact lens solutions	Eye pain, eye redness, blurred vision, sensitivity to light, sensation of something in the eye, and excessive tearing
Amoebiasis (hand-to-mouth)	Protozoan ( <i>Entamoeba histolytica</i> ) (Cyst-like appearance)	Sewage, non-treated drinking water, flies in water supply, saliva transfer (if the other person has the disease)	Abdominal discomfort, fatigue, weight loss, diarrhea, bloating, fever
Cryptosporidiosis (oral)	Protozoan ( <i>Cryptosporidium parvum</i> )	Collects on water filters and membranes that cannot be disinfected, animal manure, seasonal runoff of water.	Flu-like symptoms, watery diarrhea, loss of appetite, substantial loss of weight, bloating, increased gas, nausea
Cyclosporiasis	Protozoan parasite ( <i>Cyclospora cayetanensis</i> )	Sewage, non-treated drinking water	cramps, nausea, vomiting, muscle aches, fever, and fatigue
Giardiasis (fecal-oral) (hand-to-mouth)	Protozoan ( <i>Giardia lamblia</i> ) Most common intestinal parasite	Untreated water, poor disinfection, pipe breaks, leaks, groundwater contamination, c ampgrounds where humans and wildlife use same source of water. Beavers and muskrats create ponds that act as reservoirs for Giardia.	Diarrhea, abdominal discomfort, bloating, and flatulence
Microsporidiosis	Protozoan phylum ( <i>Microsporidia</i> ) , but closely	<i>Encephalitozoon intestinalis</i> has been detected in groundwater, the origin of drinking water <sup>[10]</sup>	Diarrhea and wasting in immunocompromised individuals.



	related to fungi		
Naegleriasis (primary amebic meningoencephalitis [PAM]) (nasal)	Protozoan ( <i>Naegleria fowleri</i> ) (Cyst-like appearance)	Watersports, non-chlorinated water	Headache, vomiting, confusion, loss of balance, light sensitivity, hallucinations, fatigue, weight loss, fever, and coma

**Bacteria**

Disease and transmission <sup>11][12]</sup>	Microbial agent	Sources of agent in water supply	General symptoms
Botulism	<i>Clostridium botulinum</i>	Bacteria can enter an open wound from contaminated water sources. Can enter the gastrointestinal tract through consumption of contaminated drinking water or (more commonly) food	Dry mouth, blurred and/or double vision, difficulty swallowing, muscle weakness, difficulty breathing, slurred speech, vomiting and sometimes diarrhea. Death is usually caused by respiratory failure.
Campylobacteriosis	Most commonly caused by <i>Campylobacter jejuni</i>	Drinking water contaminated with feces	Produces dysentery-like symptoms along with a high fever. Usually lasts 2–10 days.
Cholera	Spread by the bacterium <i>Vibrio cholerae</i>	Drinking water contaminated with the bacterium	In severe forms it is known to be one of the most rapidly fatal illnesses known. Symptoms include very watery diarrhea, nausea, cramps, nosebleed, rapid pulse, vomiting, and hypovolemic shock (in severe cases), at which point death can occur in 12–18 hours.
E.	Certain strains of <i>Escherichia</i>	Water contaminated with the	Mostly diarrhea. Can cause death



coli Infection	coli (commonly <i>E. coli</i> )	bacteria	in immunocompromised individuals, the very young, and the elderly due to dehydration from prolonged illness.
<i>M. marinum</i> infection	<i>Mycobacterium marinum</i>	Naturally occurs in water, most cases from exposure in swimming pools or more frequently aquariums; rare infection since it mostly infects immunocompromised individuals	Symptoms include lesions typically located on the elbows, knees, and feet (from swimming pools) or lesions on the hands (aquariums). Lesions may be painless or painful.
Dysentery	Caused by a number of species in the genera <i>Shigella</i> and <i>Salmonella</i> with the most common being <i>Shigella dysenteriae</i>	Water contaminated with the bacterium	Frequent passage of feces with blood and/or mucus and in some cases vomiting of blood.
Legionellosis (two distinct forms: Legionnaires' disease and Pontiac fever)	Caused by bacteria belonging to genus <i>Legionella</i> (90% of cases caused by <i>Legionella pneumophila</i> )	Legionella is a very common organism that reproduces to high numbers in warm water; <sup>[13]</sup> but only causes severe disease when aerosolized. <sup>[14]</sup>	Pontiac fever produces milder symptoms resembling acute influenza without pneumonia. Legionnaires' disease has severe symptoms such as fever, chills, pneumonia (with cough that sometimes produces sputum), ataxia, anorexia, muscle aches, malaise and occasionally diarrhea and vomiting
Leptospirosis	Caused by bacterium of genus <i>Leptospira</i>	Water contaminated by the animal urine carrying the bacteria	Begins with flu-like symptoms then resolves. The second phase then occurs involving meningitis, liver damage (causes jaundice), and kidney failure
Otitis	Caused by a number	Swimming in water	Ear canal swells, causing



Externa (swimmer's ear)	of bacterial and fungal species.	contaminated by the responsible pathogens	pain and tenderness to the touch
Salmonellosis	Caused by many bacteria of genus <i>Salmonella</i>	Drinking water contaminated with the bacteria. More common as a food borne illness.	Symptoms include diarrhea, fever, vomiting, and abdominal cramps
Typhoid fever	<i>Salmonella typhi</i>	Ingestion of water contaminated with feces of an infected person	Characterized by sustained fever up to 40 °C (104 °F), profuse sweating; diarrhea, muscle aches, fatigue, and constipation may occur. Symptoms progress to delirium, and the spleen and liver enlarge if untreated. In this case, it can last up to four weeks and cause death. Some people with typhoid fever develop a rash called "rose spots", small red spots on the abdomen and chest.
Vibrio Illness	<i>Vibrio vulnificus</i> , <i>Vibrio alginolyticus</i> , and <i>Vibrio parahaemolyticus</i>	Can enter wounds from contaminated water. Also acquired by drinking contaminated water or eating undercooked oysters.	Symptoms include abdominal tenderness, agitation, bloody stools, chills, confusion, difficulty paying attention (attention deficit), delirium, fluctuating mood, hallucination, nosebleeds, severe fatigue, slow, sluggish, lethargic feeling, weakness.

**Viruses**

**Hepatitis A virus**-Hepatitis A is one of waterborne diseases and its symptoms are only acute. Symptoms include fatigue, fever, etc.

Disease and transmission <sup>[10][15][3][16][17]</sup>	Viral agent	Sources of agent in water supply	General symptoms
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Hepatitis A	Hepatitis A virus (HAV)	Can manifest itself in water (and food)	Symptoms are only acute (no chronic stage to the virus) and include Fatigue, fever, malaise, abdominal pain, nausea, diarrhea, weight loss, itching, jaundice, and depression.
Hepatitis E (fecal-oral)	Hepatitis E virus (HEV)	Enters water through the feces of infected individuals	Symptoms of acute hepatitis (liver disease), including fever, fatigue, loss of appetite, nausea, vomiting, abdominal pain, jaundice, dark urine, clay-colored stool, and joint pain
Acute gastrointestinal illness [AGI] (fecal-oral; spread by food, water, person-to-person, and fomites)	Norovirus	Enters water through the feces of infected individuals	Diarrhea, vomiting, nausea, stomach pain
Poliomyelitis (Polio)	Poliovirus	Enters water through the feces of infected individuals	90-95% of patients show no symptoms, 4-8% have minor symptoms (comparatively) with delirium, headache, fever, and occasional seizures, and spastic paralysis, 1% have symptoms of non-paralytic aseptic meningitis. The rest have serious symptoms resulting in paralysis or death
Polyomavirus infection	Two of Polyomavirus: JC virus and BK virus	Very widespread, can manifest itself in water, ~80% of the population has antibodies to Polyomavirus	BK virus produces a mild respiratory infection and can infect the kidneys of immunosuppressed transplant patients. JC virus infects the respiratory system, kidneys or can cause progressive multifocal leukoencephalopathy in the brain (which is fatal).

**Algae**

Disease and transmission <sup>[18]</sup>	Microbial agent	Sources of agent in water supply	General symptoms
Desmodesmus infection	desmodesmus armatus	Naturally occurs in water. Can enter open wounds.	Similar to fungal infection.



III. RESULTS

Parasitic worms

Disease and transmission <sup>[5][3]</sup>	Agent	Sources of agent in water supply	General symptoms
<u>Dracunculiasis</u> [Guinea worm disease] (ingestion of contaminated water)	<u>Dracunculus medinensis</u>	Female worm emerges from host skin and releases larvae in water.	Slight fever, itchy rash, nausea, vomiting, diarrhea, dizziness, followed by formation of painful blister (typically on lower body parts)

Prevention

Reliable access to clean drinking water and sanitation is the main method to prevent waterborne diseases.<sup>[4]</sup> The aim is to break the fecal–oral route of disease transmission.

Epidemiology

According to the World Health Organization, waterborne diseases account for an estimated 3.6% of the total DALY (disability- adjusted life year) global burden of disease, and cause about 1.5 million human deaths annually. The World Health Organization estimates that 58% of that burden, or 842,000 deaths per year, is attributable to a lack of safe drinking water supply, sanitation and hygiene (summarized as WASH).<sup>[4]</sup>

United States

The Waterborne Disease and Outbreak Surveillance System (WBDOSS) is the principal database used to identify the causative agents, deficiencies, water systems, and sources associated with waterborne disease and outbreaks in the United States.<sup>[19]</sup> Since 1971, the Centers for Disease Control and Prevention (CDC), the Council of State and Territorial Epidemiologists (CSTE), and the US Environmental Protection Agency (EPA) have maintained this surveillance system for collecting and reporting data on "waterborne disease and outbreaks associated with recreational water, drinking water, environmental, and undetermined exposures to water."<sup>[19][20]</sup> "Data from WBDOSS have supported EPA efforts to develop drinking water regulations and have provided guidance for CDC's recreational water activities."<sup>[19][20]</sup>

WBDOSS relies on complete and accurate data from public health departments in individual states, territories, and other U.S. jurisdictions regarding waterborne disease and outbreak activity.<sup>[19]</sup> In 2009, reporting to the WBDOSS transitioned from a paper form to the electronic National Outbreak Reporting System (NORS).<sup>[19]</sup> Annual or biennial surveillance reports of the data collected by the WBDOSS have been published in CDC reports from 1971 to 1984; since 1985, surveillance data have been published in the Morbidity and Mortality Weekly Report (MMWR).<sup>[19]</sup>

WBDOSS and the public health community work together to look into the causes of contaminated water leading to waterborne disease outbreaks and maintaining those outbreaks.<sup>[19]</sup> They do so by having the public health community investigating the outbreaks and WBDOSS receiving the reports.<sup>[19]</sup>

Society and culture

Socioeconomic impact

Waterborne diseases can have a significant impact on the economy. People who are infected by a waterborne disease are usually confronted with related healthcare costs. This is especially the case in developing countries. On average, a family spends about 10% of the monthly households income per person infected.<sup>[21]</sup>

## History

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Waterborne diseases were once wrongly explained by the miasma theory, the theory that bad air causes the spread of diseases.<sup>[22][23]</sup> However, people started to find a correlation between water quality and waterborne diseases, which led to different water purification methods, such as sand filtering and chlorinating their drinking water. Founders of microscopy, Antonie van Leeuwenhoek and Robert Hooke, used the newly invented microscope to observe for the first time small material particles that were suspended in the water, laying the groundwork for the future understanding of waterborne pathogens and waterborne diseases.<sup>[24]</sup>

## IV. CONCLUSION

### Waterborne diseases

- Amoebiasis
- Buruli ulcer
- Campylobacter
- Cholera
- Cryptosporidiosis
- Cyclosporiasis
- Dracunculiasis (guinea-worm disease)
- Escherichia coli
- Fascioliasis
- Giardiasis
- Hepatitis
- Leptospirosis
- Norovirus
- Rotavirus
- Salmonella
- Schistosomiasis
- Shigellosis
- Typhoid fever

### Diseases related to lack of sanitation and hygiene

- Dermatophytosis (ringworm)
- Lymphatic filariasis
- Scabies
- Soil transmitted helminthiasis
- Trachoma

### Vector-borne diseases

- Arboviral encephalitis
- Dengue fever
- Malaria
- Onchocerciasis
- Rift Valley fever
- Yellow fever

## Toxins

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### Lead

Sources of lead poisoning/pollution include paint (e.g. lead paint deterioration), petroleum products, mining, smelting, manufacturing and recycling activities (e.g. battery recycling).<sup>[4][5][6][7]</sup>





- Cardiovascular disease
- Cerebrovascular disease
- Chronic Kidney disease
- Hemorrhagic stroke
- Hypertensive heart disorder
- Ischemic heart disease
- Ischemic stroke
- Neurological impairment

#### Arsenic

Arsenic is a naturally occurring element and can be found in food, water, or air. There are also industrial sources of arsenic, including mining and smelting.<sup>[8]</sup> "People are exposed to elevated levels of inorganic arsenic through drinking contaminated water, using contaminated water in food preparation and irrigation of food crops, industrial processes, eating contaminated food and smoking tobacco. Long-term exposure to inorganic arsenic... can lead to chronic arsenic poisoning. Skin lesions and skin cancer are the most characteristic effects."<sup>[9]</sup>

- Arsenicosis
- Cancers (lung, bladder, and skin)
- Cardiovascular disease
- Chronic kidney disease
- Neurobehavioral impairment

#### Mercury

- Acrodynia
- Arthritis
- Cerebellar ataxia
- Dysarthria
- Kidney and autoimmune dysfunction
- Minamata disease
- Neurological damage
- Respiratory failure

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