



I'm Drinking *What* in My Water?

Product of the Research & Information Support Center (RISC)

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Summary

According to the World Health Organization ([WHO](#)), over one billion people globally do not have access to safe, potable drinking water. According to a [WHO report](#), one-third of the world lives with water stress, and this could rise to two-thirds by 2025. Nearly 50 percent of developing populations are at [high risk](#) for waterborne disease exposure. Exposure to contaminated water is likely to lead directly to disease.

Contamination of the potable water supply can occur for various reasons. Some locations simply do not have active chemical contamination or infectious disease surveillance systems in place that alert epidemiologists of water treatment or waste management failures. The globalization of the food market can bring traditionally localized diseases to a broader audience. International and adventure travel can bring new human hosts in contact with contaminated water or indirectly contaminated products. Deforestation and animal husbandry practices -- including free range farming and animal transport -- can affect water flows and bring animal byproduct into water supplies. Finally, severe weather conditions, like hurricanes and floods, can affect water treatment facilities and cause comingling of clean and unclean water.

While unsafe water is not an issue in many of the most common destinations for U.S. travelers, the risks are real and global – and the consequences are serious enough to warrant precautionary measures against toxic elements, zoonoses, and cross-contamination.

Toxic Elements

Most toxic elements, including arsenic, occur naturally, and exposure at small doses is often inconsequential. Humans can ingest toxic elements through drinking, food consumption, and inhalation. Arsenic is [common](#) in groundwater in Argentina, Bangladesh, Chile, China, India, and Mexico, among others. Acute poisoning symptoms include: vomiting, abdominal pain, diarrhea, numbness/tingling of the extremities, muscle cramping, leading to death in extreme cases.

Nitrates in water causes [Methaemoglobinaemia](#), which is the reduced ability of blood to carry oxygen. It causes “blue baby syndrome,” in which the mouth, hands, and feet turn blue. This most often affects bottle-fed infants. Nitrates are found in fertilizer and manure, often associated with farming and agriculture and can be found in shallow well water; however, nitrates are also found in some vegetables.

Ingesting too much fluoride, called [fluorosis](#), can impact teeth and bones over long periods. Symptoms of chronic fluorosis on the teeth include staining and pitting, but symptoms on the skeletal system include stiffness and joint pain and possibly calcification. Acute high levels of fluoride can be found in contaminated water after fires or explosions; it can also be released into the air as industrial waste. Fluorosis is often reported at mountain bases and at geological deposits where water minerals deposit.

The [Pakistan Council of Research in Water Resources](#) issues a quarterly report on bottled water quality. The most recent [edition](#) (January-March 2015) underscored eight unsafe brands of bottled water due to toxic element (arsenic, sodium, and potassium) contamination and three unsafe brands due to microbiologic (fecal matter and E coli) contamination.

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Zoonoses and other ‘Water-Washed’ Diseases: Protozoa, Bacteria, and Viruses

[Zoonoses](#) are diseases that manifest in humans but originate from microorganisms, like protozoa, bacteria, and viruses (see Appendix A). These zoonoses are a serious threat to potable water. Moreover, 75 percent of infectious diseases are zoonotic, including the causes of recent outbreaks (Ebola, MERS, swine flu, SARS, etc.) Other common water-borne conditions including cholera and other enteric diseases (diarrhea); water is also a key breeding ground for the mosquitoes that carry malaria, dengue, and other infectious.

Cross-Contamination

In some countries, medical waste and pharmaceutical dumping has [contaminated](#) the water system. This often occurs in more developed nations -- Germany, the Netherlands, Italy -- where research and development centers exist. This may also happen with individuals who inappropriately dispose of medications by flushing them down the toilet. Drinking water can also be sullied during inclement weather conditions (hurricanes, floods), making it unpotable for periods. To date, there is no standardization for sampling or analysis to test for pharmaceuticals, so the risks to exposure are unknown.

Various terrorist and extremist organizations have expressed interest in malicious water contamination or sabotage in the form of bioterrorism. None has proven attempted or successful. However, many water works systems have [heightened](#) security protocols and testing procedures to thwart attempts. Implementing security measures in open water systems is more challenging, but contaminants would likely be diluted in larger bodies of water.

Case Studies

Although many water-borne diseases are associated with sub-Saharan Africa and subtropic climates, Western societies also experience water contamination.

[Scotland](#) has one of the highest rates of E.coli cases in the world, and 15 zoonotic diseases are reported regularly. This high zoonotic infection rate is primarily due to the close living proximity of humans and farm animals, a lack of public water works in rural farm areas, and is through both direct and indirect contact. Scottish epidemiologists have worked to vaccinate animals to thwart some of the transmission vectors, and occupational health campaigns have also reduced infection in at-risk sectors.

Similarly, [New Zealand](#)’s animal stock far outnumbers its human population, particularly on the South Island. Campylobacteriosis infections are common and seem to be increasing. In New Zealand, they are statistically higher than countries of similar socio-economic status. These infections seem to be due, at least in some part, to human – not animal – waste in recreational water ways. However, pastoral agriculture and irrigation practices likely contribute to contamination of fresh water catchments.

Pre-Departure Guidance

Read the [Crime and Safety Report](#) (CSR) and [Country Information Sheet](#) for your destination. The Medical Emergencies section of the CSRs often highlights potability concerns.

During medical visits for pre-departure vaccinations, inquire about the potability of water. Note that an increasing number of diseases are becoming drug resistant or simply do not have a vaccine.

Consider water purification options:

- Commercially-available kits are expensive and may not completely disinfect water.
- Home water filters, either portable hand-pumps or gravity drip pumps, will likely eliminate particulates that could cause illness but not viruses. Generally “reverse osmosis” filters can remove Cryptosporidium but not viruses, and micro-filtration or –straining generally does remove

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parasitic cysts and bacteria but may not remove viruses. The CDC offers guidance on [water filters](#). Caution should be taken when changing filter cartridges to avoid contamination.

- [Chemical disinfectant](#) with chlorine (sodium hypochlorite) is the most common means of purifying water globally. Iodine (halogen) purification tablets will chemically disinfect water but will not kill certain [parasites](#), including Cryptosporidium and Giardia. Iodine overdoses can also be fatal and cause thyroid complications; consequently, the EU recommends [against](#) iodine. Some travelers have found success with chlorine dioxide drops/tablets. However, parasites that form cysts are often resistant to chlorination.
- UV light can be used to disinfect non-particulate (i.e. clear) water from bacteria, viruses, and cysts. UV irradiation and heating via UVA sunlight can be used in emergency situations but takes hours of direct sunlight.

In-Country Guidance

While you can ask hotel staff if the water is safe, know that local populations may have immunities or tolerances that visitors do not. Similarly, consider any language barriers that may complicate understanding risks fully.

Opt for sealed bottled or pasteurized water, and carry safe water with you. Even if water is clear and free of particulates, it may still contain contaminants. Hotels may offer a boiler in the room; [boil](#) water for no less than one minute (three minutes in high altitudes) before consuming. Do not use ice. Ensure juice, tea, and coffee are made from bottled or purified water, not tap. Instead, [opt](#) for unopened, sealed, factory produced cans/bottles or commercially prepared beverages. Brush teeth with bottled or boiled water. Do not inhale water while bathing, and protect any open wounds from contact with water.

Avoid [recreational activities](#) in most bodies of water, particularly lakes, rivers, streams, and oceans, as they may be contaminated with human excrement or be home to a variety of disease vectors.

As some countries use “[night soil](#)” (human excrement) to fertilize crops, it is generally not advised to consume raw fruits/vegetables, even if rinsed. It is safer to select freshly prepared and hot (i.e. well cooked) food whenever possible.

Avoid opening windows without screens, and keep lighting down during evenings, and eliminate standing water, to avoid attracting insect vectors. Use insect repellent and netting.

Post-trip Guidance

Primarily, self-monitoring goes a long way in detecting emerging diseases. Diarrhea and acute gastroenteritis are often an indicator of contamination. The severity of the disease and the patient's health status will drive treatment and therapy options. Seek professional health care and share specifics from recent travels and dietary choices should any symptoms manifest. [Generally](#) speaking, infants, elderly, pregnant women, and the immunocompromised experience more severe symptoms and suffer from longer term chronic health consequences.

For Further Information

The CDC offers extensive guidance on [drinking water](#).

For additional information on health and pandemics, please contact OSAC's [Health and Disease Analyst](#). For country-specific concerns, please reach out to the appropriate regional analyst.

Appendix A

Pathogen	Description and Transmission	Symptoms	Treatment (from CDC)	Prevalence and Geography
Traveler's diarrhea	the most common form of water-borne contamination; caused by various bacterial, viral, and parasitic organisms often through contamination from human or animal feces.	diarrhea	intense rehydration	impacts 10 million travelers annually; cases reported around the world
Malaria	the world's leading parasitic (Plasmodium) infection, transmitted by the Anopheles mosquito that breeds in brackish water; parasite moves to the liver and bloodstream.	intermittent fever/chill, aches, nausea, jaundice, begin 10 days to 4 weeks after infection; infection can be dormant for five years	continuous intravenous infusion, chloroquine, atovaquone-proguanil (Malarone®), artemether-lumefantrine (Coartem®), mefloquine (Lariam®), quinine, quinidine, doxycycline (with quinine), clindamycin (with quinine), artesunate (not licensed in the U.S.)	300-500 million cases and 1 million deaths each year; majority in sub-Saharan Africa and poor, tropical/sub-tropical areas.
Cholera	caused by the Vibrio cholerae bacteria that comes from contamination with human feces; seafood from blackwater sites can also cause cholera	Symptoms can be mild to severe. profuse watery diarrhea, vomiting, rapid heart rate, loss of skin elasticity, dry mucous membranes, low blood pressure, thirst, muscle cramps, restlessness/irritability	Rapid high-volume rehydration generally leads to recovery in 3-6 days. Doxycycline antibiotic in adult severe cases and azithromycin for children/pregnancy.	In 2013, 47 countries reported a total of 129,064 cases , including 2,102 deaths
Schistosomiasis or bilharzia	caused by one of three flatworms whose larvae develop in fresh water snails and then penetrate human skin. Larvae anchor in veins near the bladder and intestines	eggs cause inflammation to the bladder and liver; causes itchy skin and rashes. About two months after infection, fever, chills, cough, and muscle aches develop. if left untreated, can damage liver, kidneys, bladder and may impact nervous system.	Praziquantel is taken for 1-2 days	often reintroduced by workers in irrigation or fishing industries and, increasingly, with adventure tourists; is present in 76 countries, mostly in freshwater in south and sub-Saharan Africa, Nile River Valley, Brazil, Suriname, Venezuela, Iran, Iraq, Saudi Arabia, Yemen, southern China, Philippines,

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				Laos
Typhoid fever	Salmonella typhi bacteria is excreted by humans and cycled back into the water system. It is an infection of the intestinal tract and blood. While poor general hygiene practices is the primary means of spreading typhoid, consumption of shellfish in contaminated water also spreads it. Carriers can also reinfect others.	Symptoms generally appear 1-3 weeks after infection and can persist for months if left untreated. sustained fever as high as 104° F, weakness, stomach pains, headache, loss of appetite, rash of flat, rose-colored spots	Antibiotics include: fluoroquinolones (e.g., ciprofloxacin) for susceptible infections, ceftriaxone, azithromycin	17 million people are infected annually, most parts of the world except in industrialized regions
Onchocerciasis or river blindness	borne of the Onchocerca volvulus parasite, the blackfly's bite, which breeds in water, transmits the disease. This worm can live for up to 14 years in a host. often requires more than one infectious bite	larvae settle in fibrous nodules in the skin, causing severe itching, vision changes, lymph swelling. It is the world's second leading infectious cause of blindness. Symptoms appear 1-3 years after infection.	ivermectin, which will need to be given every 6 months for the life span of the adult worms or for as long as the infected person has evidence of skin or eye infection, doxycycline that kills the adult worms	affects 18 million people; present in remote rural areas of 30 countries of Africa, Yemen, Venezuela, Brazil
Ascariasis	a large roundworm, called Ascaris lumbricoides, infection in the small intestine. The worm's sticky eggs are laid in soil, and they are ingested by accident, by insufficiently prepared earthen vegetables, or by blackwater contamination. The eggs mature in the intestines but move via bloodstream into the lungs where they are coughed up in phlegm (commonly identified as "ascaris pneumonia") and re-swallowed. Eggs are then expelled in feces and are infective for several months to	often no symptoms; light abdominal discomfort, cough	albendazole and mebendazole for 1-3 days	up to 10 percent of the developing world has a parasite; Ascaris is believed to account for a large percentage.

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	years.			
Leptospirosis	caused by the <i>Leptospira</i> spp. Bacteria, transmitted via urine of infected animals (humans, wild and domestic animals) or indirect contact of infected urine. Human-to-human transmission is rare.	High fever, Headache, Chills, Muscle aches, Vomiting, Jaundice, Red eyes, Abdominal Pain, Diarrhea, Rash all after 2 days to four weeks after infection.	large doses of doxycycline or penicillin work well when treated early. It can be fatal in its icteric form. without treatment kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, respiratory distress, and even death	Worldwide but most common in temperate or tropical climates. but impacts people who work with animals or adventure travelers who swim in blackwater.
Guinea worm disease or dracunculiasis	a long, worm-like parasitic disease that is virtually eradicated. It is transmitted by consuming blackwater with water fleas (copepods) that carry the larvae, which penetrate the intestine walls and move throughout the body. The larvae matures between 10-14 months and emerges from the host via a blister on the lower leg. Patients often submerge the leg in water, releasing hundreds of larvae into the water system.	Blisters often on lower extremities with burning pain.	no specific drug to treat or prevent GWD	In 2013, only 148 cases worldwide. Chad, Ethiopia, Mali, South Sudan
scabies	contagious skin infection, a microscopic <i>Sarcoptes scabiei</i> mite burrows into the skin to lay eggs. spread from skin-to-skin contact or indirect contact with linens or clothing. proper sanitation and hygiene would ameliorate these conditions. Sterilized washing and heightened personal sanitation are key preventative measures.	rash and the presence of burrows, intense itching about 2-6 weeks after infection	Scabicide lotion or cream	There are 300 million cases of scabies annually worldwide.

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ringworm (tinea)	contagious skin infection, dermatophytes fungus; spread from skin-to-skin contact or indirect contact with linens or clothing. proper sanitation and hygiene would ameliorate these conditions. Sterilized washing and heightened personal sanitation are key preventative measures.	Typically on feet, scalp, groin, or beard. Itchy skin, Ring-shaped rash, Red, scaly, cracked skin, Hair loss. Symptoms typically appear between 4 and 14 days after infection.	On skin: non-prescription antifungal creams, lotions, or powders applied to the skin for 2 to 4 weeks For Scalp: Griseofulvin (Grifulvin V, Gris-PEG), Terbinafine, Itraconazole (Onmel, Sporanox), Fluconazole (Diflucan)	Worldwide, common in public showers or locker rooms, close contact sports,
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For more information on zoonoses, please reference the WHO [website](#).