Pathogens in our water supplies

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Pathogens are microbes that cause disease. They include *E. coli*, *Salmonella*, and other bacteria that cause food poisoning, cholera, and typhoid; protozoans (including *Cryptosporidium* and *Giardia*); and viruses (including infectious Hepatitis A). Pathogens often occur as a result of contamination by sewage discharges, leaking septic tanks, runoff from animal feedlots into bodies of water, and improperly sealed wells. For detailed information about the health effects of microorganisms, the reader is referred to the Web site of the Centers for Disease Control: www.cdc.gov.

The disinfection required by the U.S. Environmental Protection Agency (EPA) for public water supplies is good protection against pathogens, with the exception of the protozoan *Cryptosporidium*. Some pathogens associated with water-borne illnesses also can occur through non-drinking activities such as recreational activities (swimming pools and water slides), consumption of food, and person-to-person contact.

The resistance of many protozoans, especially *Cryptosporidium,* to chlorination concentrations has been extensively documented, and the protozoan *Giardia* can be eliminated only by prolonged contact with chlorine. In 2008, there were numerous cryptosporidosis outbreaks around New Mexico, and one caused the temporary closing of the pool at the Ft. Marcy Complex. New technologies are being implemented to ensure reduction of *Cryptosporidium* in public recreational facilities and state and local authorities are increasingly vigilant in protecting against this chlorine-resistant protozoan.

The EPA recommends testing private wells once each year for nitrate and coliform bacteria. Although it is less expensive to test a well for the presence/absence of bacteria, a heterotrophic plate count or HPC (formerly known as the Standard Plate Count or SPC) is highly recommended. The HPC is a measurement of all bacteria, including coliform and many other groups, in a water sample. Heterotrophic bacteria are non-coliform species which utilize an organic substance for growth. The concentration of bacteria, if present, is expressed in CFUs (colony forming units) per milliliter of water. If more than 500 CFUs are present, then testing is conducted for total coliforms, which are a group of closely related, mostly harmless bacteria that live in soil and water and in the intestinal tracks of animals.

Coliform bacteria are used as an indicator of the general quality of the water and as a proxy for fecal contamination. *Escherichia coli (E. coli*) is a subgroup of fecal coliform and is an indicator that pathogens may be present. This bacterium is well known for the outbreaks of a specific strain known as *E. coli* 0157:H7. When *E. coli* is identified in a sample, the lab calls the entity which submitted the sample and instructs them to inform the property owner. A well is typically shock-chlorinated after *E. coli* is identified in the water sample and then the well is re-tested for bacteria. It is not uncommon for a well to be shocked more than once to get rid of bacterial contamination.

The accompanying chart shows drinking water treatment methods based on CDC recommendations. It is intended only as a guide. Without question, boiling is both the most effective and least convenient method to eliminate microbiological contaminants. Boiling is endorsed by the EPA for eliminating *Cryptosporidium* and *Giardia*, which are less likely to occur in well water (unless it has been affected by flood waters). Boiling also concentrates other contaminants, such as arsenic and lead, that may be present in the water. At elevations above 6,500 feet, the water should be boiled for at least three minutes.

Particle (physical) filtration is effective in reducing protozoa because of their large size. For bacteria, a filter with an absolute pore size rating of ≤0.3μ (equal to, or less than, 0.3 microns) is acceptable. A filter with an absolute rating ≤1μ and certified by NSF Standard 53 or 58 for "cyst reduction/removal" is effective. Physical filtration will not reduce viruses. In general, carbon filtration is ineffective in the reduction of microbiological contaminants. Chlorination is effective in eliminating bacteria and viruses; but for the protozoans *Giardia* and especially *Cryptosporidium,* chlorination is an ineffective treatment method.

The most promising (although not new) development is ultrafiltration, which is a physical separation process using hollow fiber tubes with a pore size of 0.015μ, meaning that all cysts, bacteria, and colloidals are removed as well as more than 99 percent of viruses. Ultrafiltration membranes require an effective backwashing system and are about 97 percent efficient in water usage; but because the systems are electrical, they may not be able to backwash during a power failure.

Ozonation is also an effective way to eliminate water-borne pathogens and it is commonly used in storage tanks and cisterns. But because there is no residual disinfection left in the water, and because ozone in combination with other constituents in the water (bromide, in particular) may create disinfection byproducts, ozone is not widely used in municipal water systems.

Ultraviolet (UV) light is a very effective technology for eliminating pathogens in water. The best units are certified under NSF Standard 55 Class A. UV works by attacking the genetic core, the DNA, of pathogens, destroying their ability to function and reproduce. For over 25 years, UV light has been trusted as a cost-effective, chemical-free, taste- and odor-free method to eliminate more than 99 percent of all microbiological contaminants in water.

Unlike chlorine, UV is effective against both *Cryptosporidium* and *Giardia.* UV does have two major limitations: water quality and power availability. Water failing to meet certain general water-quality guidelines may reduce the effectiveness of a UV system. High levels of iron and TDS (total dissolved solids) may interfere with the successful operation of the system by coating the quartz sleeve and decreasing UV transmissiveness. Manufacturers recommend that a 5-micron (nominal) filter be installed in front of UV disinfection systems.

As for so many water contaminants, the best purification solutions for pathogen reduction and elimination are often a combination of several technologies.

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Treatment methods to reduce microorganisms in drinking water

MICROORGANISMS	BOILING	PARTICLE FILTRATION	CARBON	CHLORINATION	ULTRAFILTRATION	OZONATION	UV DISINFECTION
Bacteria	++++	++ if absolute pore size ≤ 0.3μ	–	+++	++++	++++	++++
Protozoa	++++	+++ if absolute pore size ≤ 1μ; tested and certified by NSF Standard 53 or NSF Standard 58 for "cyst reduction/removal"; NSF- or WQA-certified reverse osmosis (RO)	–	– (for *Crypto.*) + to ++ (for *Giardia*)	++++	++++	++++
Viruses	++++	–	–	+++	++++	++++	++++

(- = ineffective; + = low; ++ = moderate; +++ = high; ++++ = very effective)
Source: Centers for Disease Control