POU FILTRATION ON TAP
Who needs these end-of-faucet anti-microbial purifiers and why?

By Dr. Charles P. Gerb and Pamela M. Watt

It generally has been accepted that water delivery at the tap in any developed country, like the United States, was adequate to protect the health of consumers. However, it is becoming increasingly evident the quality of water may not be adequate to protect all consumers. This is due to several important events in recent years. The emergence of new waterborne pathogens resistant to disinfection, surveys that demonstrate the widespread occurrence of protozoan parasites in treated water supplies, the frequent occurrence of enteric viruses in groundwater used as a source of drinking water and changing demographics of the population in the United States are all factors.

It is now recognized that certain segments of our population are more likely to become ill and die of disease from microorganisms transmitted by water.[4] These individuals include the very young, the elderly, pregnant women, immuno compromised individuals, persons undergoing cancer chemotherapy and organ transplant patients *(see Table 1).* This segment of our population is currently believed to represent 20-to-25 percent of the U.S. population and is increasing. For example, the number of persons over 65 years old will increase from 12-percent to 20-percent by the year 2000. Immunocompromised individuals represent another growing segment of our population and is magnified by the current AIDS epidemic and the escalation in the number of organ and tissue transplants. Furthermore, advances in the treatment of cancer often involve the use of immunosuppressive drugs, thus putting the patient at a greater risk for serious microbial infection.

Recent outbreaks of waterborne *Cryptosporidium* in Milwaukee, Wis., and Las Vegas, Nev., have demonstrated the seriousness of these infections in the immunocompromised individual. In the outbreak in Milwaukee, more than 400,000 persons became ill and more than 100 died." The benefit of filtration units at the tap was clearly demonstrated during both of these outbreaks. And, in the Las Vegas outbreak, it was the lower incidence of *Cryptosporidium* infections in AIDS-infected individuals who only drank bottled water that led investigators to the conclusion that tap water was the source of transmission.[9]

Outbreaks occur only when there has been a dramatic and often massive contamination of a drinking water supply. Even then, it is believed only a fraction of such outbreaks are ever recognized and reported. More important are low-level or short-term spikes of contamination that go unrecognized. Two recent epidemiological studies in Canada reported that as much as 35 percent of the gastroenteritis which families experience is due to tap water,[7&8] this may be due to lack of current methods to detect low levels of pathogens in the water, unrecognized pathogens that cannot be detected by current methods or recontamination of water as it flows through pipes to reach the individual household.

Treatment plant reliability

Modern water treatment plants designed to treat surface water contain multiple barriers to improve removal of pathogenic microorganisms. Conventional water treatment begins with the addition of a compound—such as alum—to floe or coagulate the suspended matter. This step is followed by filtration and disinfection. This removes, to a degree, pathogenic microorganisms. Some steps in this treatment remove certain types of microorganisms better than others. For example, since disinfection alone cannot be relied on, filtration is the main barrier for removal of protozoan parasites such as *Cryptosporidium.* The proper functioning of these barriers is essential for providing microbiologically safe water.

Unfortunately, like all manufactured systems, water treatment plants cannot be expected to operate at 100-percent efficiency all the time. Changes in raw water quality, below optimal concentrations of flow, settling times, or insufficient contact time for the disinfectant can cause less than optimal conditions for the removal of pathogenic organisms to required levels. The question is, how often might these events occur and for how long? Even if they only occur two or three times a year, this could result in a significant exposure of the population and an increased risk of illness. With microorganisms, such short-term exposures are significant to an entire population. Unlike trace amounts of toxic chemicals that may take years or a lifetime to have a harmful effect, the harmful effects of microorganisms occur after a onetime exposure. While these uncommon events usually present only a risk of minor illness—one that goes unreported to public health agencies—it can cause serious illness and may even be life threatening to sensitive populations.

Research is currently under way to assess the reliability of surface drinking water treatment plants in producing microbiologically safe water. Such information is essential to better understand how much illness might be associated with treated drinking water.

Occurrence of pathogens in raw and treated water

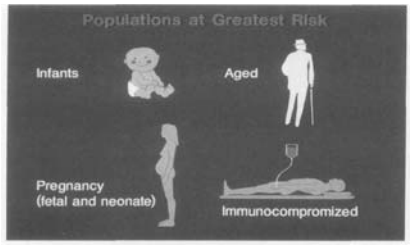
Waterborne microorganisms

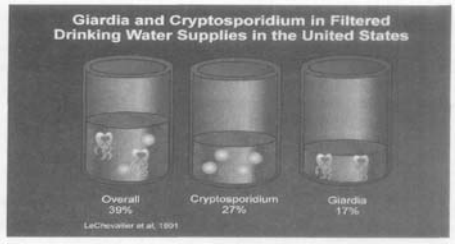
The actual occurrence of waterborne, disease-causing microorganisms in U.S. surface water and groundwater has largely been unknown. Until the beginning of this decade, only limited regional studies had been conducted.

Two nationwide studies in the early 1990s demonstrated widespread occurrence of *Giardia* and *Cn/ptosporidium* in surface waters in the United States.[6610] The conclusion was that these organisms could be expected to be present in all of the surface waters of the United States at one time or another. This is due to the fact that animals such as beavers, muskrats and even cattle could be sources of these human pathogens. While fewer organisms were found in water in pristine areas vs.

TABLE 1
Sensitive Populations

Newborns (Neonates) Pregnant Women Elderly Immunocompromised Cancer Chemotherapy Patients Organ Transplant Patients AIDS Patients





agricultural and urban areas, all utilities that depend upon surface water can be expected to have these organisms in their raw water. Of particular concern was the common occurrence of these parasites in treated water. In fact, 39 percent of tap waters tested revealed the presence of *Crypto, Giardia* or both.

Enteric viruses

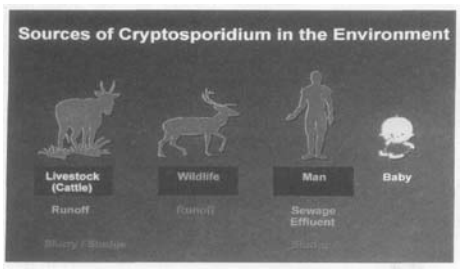
Although their presence has been documented, less is currently known about the occurrence of enteric, or intestinal, viruses in surface water. No nationwide studies have ever been conducted. Since there are no animal reservoirs (humans being the only significant source), their occurrence is dependent on the presence of sewage discharge or human fecal material in the water. Furthermore, human enteric viruses are believed to be a problem associated more with groundwater contamination. Since they are smaller than other waterborne pathogens, they are less likely to be filtered out by the soil. Numerous groundwater disease outbreaks have been associated with the presence of disease-causing enteric viruses. Studies currently under way suggest up to 40 percent of the drinking water wells may contain enteric viruses.[1] The concentrations of viruses detected have not been great enough to cause waterborne disease outbreaks, but could cause a low level of unrecognized infections within a community. The presence of viruses may be less of a problem with utilities that currently disinfect their drinking water; however, half of the U.S. utilities that obtain their drinking water from groundwater do not disinfect.

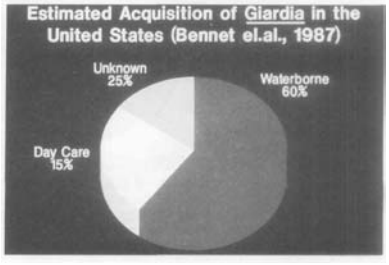
Sensitive populations

The outcome of ingestion of waterborne pathogens depends on a number of factors, including nutrition, age, ability to produce antibodies and other nonspecific factors. Infection occurs when growth of the organism takes place within the individual. Infection, however, does not mean the individual will become ill. In most enteric infections, only half of the individuals become ill. For example, with infectious hepatitis (hepatitis A)—the same virus that, this past spring, was associated with the strawberries imported from Mexico that made their way into school lunches in the West—only one will become sick However, in adults, three out of four infected become ill. If the illness becomes serious enough, death can result. For most enteric pathogens, usually less than one person in a thousand who become sick will die. In the case of some enteric viruses that cause diarrhea, the risk may be as low as one in a million.[2] Disease from hepatitis A is more likely to result in death, with six deaths per thousand reported cases. Table 2 shows the percentage of persons who die in the general populations when infected with various enteric pathogens. While these risks of serious illness and death are generally low for most of the population, the risk for certain segments of our population is much greater. These risks may be 100 times greater in the elderly and immunocompromised.

Mortality from diarrhea is greatest in the very young and the very old *(see Table* 2). The majority of diarrheal deaths that occur in the United States are in persons over 55 years of age (78 percent of all deaths). In addition, the illness is usually more protracted. The same is true for infectious hepatitis, with the age of those dying from this infection most often in excess of 60 years.

Infections in the immunocompromised constitute a relatively new and severe problem. Enteric pathogens are among the many agents that take advantage of the impaired immune system, often with fatal results. *Cryplosporidium* and adenovi-rus, which affects the respiratory system, cause severe illness in AIDS patients, with mortality rates of 50 percent.[4] Cancer patients often undergo intensive chemotherapy with toxic and immunosuppressive drugs or radiation treatment in an attempt to destroy the growth of cancer cells. These measures attack the immune system, leaving the patient with little defense against enteric pathogens. For example, the fatality rate in cancer immunosuppressed patients for adenovirus infection is 53 percent.[5] Bone marrow transplants are an effective therapy in patients with acute leukemia. However, because of a very weakened immune system, they are very susceptible to infection. The mortality rate of bone marrow transplant patients with an enteric viral (rotavirus, Coxsackie virus, aden-oyirus) infection is greater than 50 percent.[4]





Conclusion

This review was prepared to show that even in a developed country like the United States, the risk of acquiring a waterborne infection still exists. While water may not be the major route by which we acquire many enteric infections, it still poses a risk that can easily be reduced through the use of point-of-use (POU) water treatment devices. The risk of serious illness and death to certain individuals is significant enough that additional precautions should be taken to reduce this risk from tap water. The Centers for Disease Control[3] suggests that immunocompromised persons can help reduce the risk of acquiring waterborne cryptosporidiosis through the use of sub-micron filters at the tap.

Many point-of-use devices are capable of effectively reducing the threat from waterborne parasites. POUs capable of removing wider ranges of waterborne microorganisms (i.e., viruses, bacteria and protozoan parasites) should be considered for maximum protection. While many POU filtration devices are currently available for the removal of protozoan parasites, only units which use reverse osmosis, ultraviolet light disinfection or distillation are capable of filtering or removing viruses.

In conclusion, it is obvious that drinking water in the United States cannot always be relied upon to be pathogen free. Although the risk of serious illness by the presence of these organisms in the water may be low to the general population, a growing percentage of our population is at increased risk of serious illness. POUs designed to remove pathogenic microorganisms can reduce this risk.

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TABLE 2
Case Fatality Observed for Enteric Pathogens in Nursing Homes v. General Population

Organism		
Campylobacter jejuni	0.1	1.1
Escherichia Coli 0157:H7	0.2	11.8
Salmonella	0.1	3.8
Rotavirus	0.01	1.0

Source: Gerba et al, 1996.

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About the authors

♦ *Charles P. Gerba is a professor of soil, water and environmental science at the University of Arizona in Tucson. Gerba has authored or co-authored more than 400 articles in the area of environmental microbiology. He is a member of the American Academy of Microbiology and recipient of the A.P. Black Award in 1997 from the American Water Works Association for significant research contributions to water science.*

♦ *Pamela Watt is a research technician in environmental parasitology and virology in the University of Arizona's Department of Soil, Water and Environmental Science. She has been involved in numerous studies on the occurrence of Cryptosporidium and enteric viruses in water*