Water Quality and Acceptable Risk: Are We Safe Enough?

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Editor's Note: Based on recent revelations about chromium contamination in California, this column is being reprinted with the author's permission from *WC&P*, April 2007.

You've heard it repeatedly, "the United States has some of the best quality drinking water in the world". While this is true, the fact is that drinking water from the tap is not risk free, meaning that exposure to drinking water and the contaminants that may be present at various times, leads to some level of disease risk. This should not cause too much worry since we can easily recognize that life is not risk free and there will always be some inherent level of risk (meaning an adverse outcome to our health or well-being) in the natural process of living. The point is that zero risk associated with water consumption is not achievable, thus we must choose what level of adverse outcome we are willing to accept due to this or any other defined exposures; i.e., what is the acceptable risk related to exposure to contaminants in drinking water?

How much risk is too much?

In 1973, the Food and Drug Administration stated that a one-in-a-100-million chance of developing cancer in a lifetime following exposure to food contaminants was considered safe. About four years later the figure was amended to one in one million. This level is also the standard goal for acceptable risk in guidelines set by the US EPA, although ranges of one in ten thousand and up are utilized for various hazards, based in part on feasibility of achieving set levels. Also keep in mind that a risk of infection from a pathogen that has a low (or no) fatality rate is more acceptable to the public compared to exposure to a pathogen that may lead to death or long-term illness.

Primarily under the guidance of the *Safe Drinking Water Act* of 1974, drinking water contaminants that are known or expected to harm humans are regulated to some degree but acceptable levels are not always defined.

A variety of factors must be considered when evaluating acceptable risk levels. While contracting a disease from poor quality water is not desired by anyone, economic costs, political issues, illness severity and emotional factors, to name a few, must be considered. Individuals tolerate risk in very different ways. The job of regulators, therefore, is to balance the feasibility of an intervention (i.e., increased water treatment) with how much risk the public is willing to tolerate.

Is the intervention worthwhile?

Today's technology provides the ability to treat water down to its basic atomic structure of H_2O; however, the cost associated with the production of water purified to this level would be prohibitive and the overall health benefit could not be justified. While this is an extreme example, it illustrates the point that the benefit must outweigh the cost. There are quantitative values placed on the quality and longevity of human life and certainly we can calculate the direct cost of illness (dollars spent on health care, medications and lost productivity at work). This process may be fine for the regulators but what factors are important to the general public?

Consider the following example: currently, there are ongoing debates on the need for improved food safety protocols associated with produce production in California, stemming largely from recent outbreaks associated with *E. coli* O157:H7 contaminants in spinach. Investigations are suggesting that contamination occurred due to wild animals traipsing through cattle farms (*E. coli* O157:H7 hosts) to the spinach fields. While not proven, the potential for contaminated irrigation water to contribute to such an outbreak is also being considered.

If water turns out to be a factor in foodborne outbreaks, what intervention should be implemented? Should all irrigation water be treated before use in the fields? What level of treatment should be applied? What is the risk of exposure to *E. coli* O157:H7 if the water remains untreated? How many illnesses/deaths would be prevented with the intervention? Who will pay for the intervention?

Now emerges a wide range of social, political and economical issues that must somehow be manipulated to alleviate the worry among the public and restore confidence in the consumer.

Are you sure this is safe?

Despite the best efforts to mathematically define risk and balance cost-benefit ratios, there are always unforeseen factors that lead to uncertainty in the assessment associated with a particular exposure. Assuming that everyone (the general public, scientists, regulators, special interest groups, public health professionals, etc.) agrees that one death in a million following a lifetime exposure to a particular contaminant in drinking water is an acceptable risk, do we also accept the uncertainty that the risk might be much higher?

An example of uncertainty in microbial water quality risk assessment is the variability of the exposed population. If information is available from previous outbreaks that identifies the risk of illness/death after a group of people were exposed to an infectious microbe, this information can help to determine an acceptable exposure level to a similar population. Remember that risk cannot be zero (unless you want to live in a bubble!).

In the above example, consider the following uncertainties.

What if the next population exposed is not a similar population? Perhaps now the exposure is in a nursing home or a hospital where the risk is much higher due to decreased immune function in this particular group. In fact, generally speaking, the risk of infection and disease in the elderly population is anywhere from 10 to 100 times higher than the general population. How does this fact impact acceptable levels of 'X' contaminant in water? In the end, whatever level of protection is decided upon, it will not be the same for all people.

POU devices and individual control

For ten years now, this On Tap column has been focused on identifying hazards of tap water quality and the benefits of POU water treatment. Treatment of drinking water at the tap, as part of an individual's strategy for reducing the risk of exposure to contaminants, is recognized as a health benefit in many risk assessment modeling publications. The cost of water treatment at the tap is a factor, however, requiring that the benefit of POU treatment interventions be weighed. Federal efforts to reduce waterborne illness risks are also improving, such as the more stringent arsenic limits in drinking water and the groundwater disinfection rule, aimed at decreasing the public's exposure to microbial disease-causing agents known to be present in some municipal groundwater supplies.

Consideration of the most vulnerable populations must be carefully applied. Although the Centers for Disease Control and Prevention (CDC) and US EPA recommend that severely immunocompromised populations utilize POU water treatment designed to remove pathogenic protozoa from drinking water (i.e., *Cryptosporidium*), little information is available on how many comply with this recommendation and how many lives are lost due to noncompliance.

In conclusion, the notion of acceptable risk relative to water quality is a complex issue. Complicating things further is that any level of state, federal or international guidelines will not adequately address uncertainty factors, such as variances in the populations exposed, geographical changes in water quality, distribution system aging, treatment failures, etc. An understanding of your specific source water quality (don't forget to read those consumer confidence reports your utility is required to provide) and particular health status is important in determining your level of risk and what quality of water is considered acceptable for consumption. For many, a proactive approach is desired since contamination events cannot always be predicted or detected and because our individual ability to fight off infection may change over time.

Additional information

WHO. 2001. *Water Quality: Guidelines, Standards and Health. World Health Organization. Acceptable Risk*. P.R. Hunter and L. Fewtrell (Eds.) IWA Publishing, London, UK.

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