QUALITY STANDARDS FOR POTABLE WATER

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Contents

Summary

The primary aim of the quality standards for potable drinking water is the protection of public health. The quality of water defined by potable drinking water standards is such that it is suitable for human consumption of health-related chemicals and microbiological components, with satisfactory aesthetic and organoleptic characteristics aspects. The water must be suitable for all usual domestic purposes, including personal hygiene.

The WHO guidelines list many contaminants, but it is unlikely that all of these chemical s will occur in all water supplies, or even in all countries. Care needs to be taken in selecting substances and other aspects for establishing national drinking water standards. Many factors should be considered, including the types of human activities that take place in the region.

Practical implementation of water quality standards, values or guidelines values requires collection and analysis of samples. The sampling program should be designed to cover both random and systematic variations in water quality and to ensure that the collected samples are representative of water quality throughout the distribution system. The type and magnitude of spatial and temporal variations in the concentration of water constituents depends on both their sources and their behavior in the distribution systems.

Drinking water is one of the cornerstones of life and a sufficient and clean drinking water supply is a fundamental requirement. The potential for microbiological contamination of water to cause disease has been known for well over 1000 years, although the connection

between microorganisms and disease was not actually known until the nineteenth century. The impact of waterborne disease was particularly recognized in the teeming cities of nineteenth century Europe by the outbreaks of typhoid and cholera. Dr. John Snow in London discovered the link between waterborne diseases and sewage-contaminated water in 1854. Drinking water standards were not introduced until much later, although efforts were always made to use clean sources and to install treatment such as filtration or disinfection with chlorine to ensure safety.

The control of fecal contamination in drinking-water systems is of primary importance. Fecal-specific indicator bacteria such as *Eschericia. coli* are parameters of first importance in verification of fecal pollution. Therefore, WHO drinking water quality guidelines and many national standards set their microbiological target by the number of *E. coli* in drinking water. In addition to *E. coli*, heterotrophic plate counts are generally used as a surrogate parameter of the performance of water treatment, as well as the re-growth potential of supplied water in the distribution system.

Chlorine is the most widely used disinfectant because of its workability and sustainability in distribution network. It has no reported specific adverse treatment-related effects in humans or other animals. Disinfection of drinking water was one of the important public health advances of the twentieth century. It has been a major factor in reducing communicable disease epidemics such as typhoid and cholera. However, disinfectants can react with naturally occurring organic and inorganic matter in source water and distribution systems to form organic and inorganic disinfection by-products (DBPs) that may pose health risks. A major challenge for water suppliers is how to balance the risks from microbial pathogens and DBPs. It is important to provide protection from these microbial pathogens while simultaneously ensuring decreasing potential health risks to the population from DBPs.

1. Introduction

Water is supplied by precipitation, flows over the ground surface, and becomes available as a water resource. In this process, it dissolves or suspends various kinds of impurities. There is an acceptable level of impurities for every purpose of water use. It is necessary to show the level which does not cause any hazard, whether to human bodies or to use of water, according to the purpose of water usage. Many organic and inorganic chemicals and microorganisms can be present in drinking water as well as ambient waters. WHO drinking water quality guidelines (WHODWQG) and the regulatory standards of many countries register their risk management level using their toxicity, their occurrence in water and the feasibility of analysis and treatment.

The primary aim of the quality standards for potable drinking water is the protection of public health. The quality of water defined by potable drinking water standards is such that it is suitable for human consumption of health-related chemicals and microbiological constituentsts, with suitable aesthetic and organoleptic characteristics, and usable for all normal domestic purposes, including personal hygiene.

The WHODWQG is able to provide for the establishment of national standard of drinking water. It describes how guideline values for drinking-water contaminants are to be used, defines the criteria used to select the various chemical, physical, microbiological, and radiological contaminants included in the report, describes the approaches used in deriving guideline values, and presents brief summary statements either supporting the guideline values recommended or explaining why no health-based guideline value is required at the present time. The process for the development of water quality standard is given by showing the protocol of WHO drinking water quality guidelines. Since the regulatory standard should be applicable and feasible to enforce it in each country and area where its natural, geological, cultural and economical situations are different, it is necessary to assess and evaluate the regulatory standard periodically.

2. Development of national standards using WHODWQG

The WHODWQG include many drinking contaminants, but also it is unlikely that all of these chemical contaminants will occur in all water supplies or even in all countries. Care should be taken in selecting substances and other characteristics for establishing national drinking water standards. However, a number of factors should be considered, including the types of human activities taking place in the region. For example, if a particular pesticide is not used in the region, it is unlikely to occur in the drinking water. In other cases, such as the disinfection by-products, it may not be necessary to set standards for all substances for which guideline values have been proposed. If chlorination is practiced, the trihalomethanes, of which chloroform is the major component, are likely to be the main disinfection by-products, together with the chlorinated acetic acids in some instances. In many cases, control of trihalomethanes, halo-acetic acids and other DBPs will also provide an adequate measure of control over other chlorination by-products.

In developing national standards, care should also be taken to ensure that scarce resources are not unnecessary diverted to the establishment of standards and monitoring of substances of relatively minor importance. Generally, microbiological indices, inorganic and organic substances, and aesthetic items, are used in national drinking water quality standards.

The potential consequences of microbial contamination are such that its control must always be of paramount importance and must not be compromised. The provision of a safe supply of drinking water depends upon the use of either a protected high quality groundwater or a properly selected and operated series of treatments capable of reducing pathogens to negligible levels, not hazardous to health. Microbial water quality may change rapidly and over a wide range. Short-term peaks in pathogen occurrence may considerably increase disease risks and may also trigger outbreaks of waterborne disease that may affect large numbers of persons. For these reasons reliance cannot be placed on water quality measurements, even when frequent determinations of the safety of drinking water are made. This approach cannot guarantee timely indication of water quality deterioration.

The health risks due to toxic chemicals in drinking water differ form those caused by microbiological contaminants. The fact that chemical contaminants are not normally associated with acute effects places them in a lower priority category than microbiological contaminants, the effects of which are usually acute and widespread.

Therefore, it can be argued that chemical standards for drinking water are of secondary consideration in a supply subject to severe bacterial contamination.

The problems associated with chemical substances in drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure; of particular concern are contaminants that have cumulative toxic properties, such as heavy metals, and substances with carcinogenicity.

The presence of nitrate and nitrite in water, causing both acute and chronic effects, i.e. methaemoglobinaemia (known as blue baby syndrome) and liver ailments, may result from the excessive application of fertilizers or from leaching of wastewater or other organic wastes into surface water and groundwater.

Exposure to a high level of naturally occurring fluoride can lead to mottling of teeth and (in severe cases) skeletal fluorosis and crippling. Similarly, arsenic may occur naturally, and long-term exposure via drinking water may result in various risks to health. In areas with aggressive or acidic waters, the use of lead pipes and fittings or solder can result in elevated lead levels in drinking-water, which may affect the mental development of children.

It should be noted that the use of chemical disinfectants in water treatment usually results in the formation of chemical by-products, some of which are potentially hazardous. However, the risks for health from these by-products are extremely small in comparison with the risks associated with inadequate disinfection, and it is important that disinfection should not be compromised in attempting to control such by-products.

There are few chemical substances in water that can lead to acute health problems except through massive accidental contamination to a water source. Moreover, experience shows that, in such incidents, the water usually becomes undrinkable owing to unacceptable taste, odor, and appearance.

In assessing the quality of drinking water, consumer rely principally upon their senses. Microbial, chemical, and physical water constituents may affect the appearance, odor, or taste of the water, and the consumer will evaluate the quality and acceptability of the water on the basis of these criteria. Water that is highly turbid, highly colored, or that has a detectable level of undesirable taste or odor may be regarded by consumers as unsafe and may be rejected for drinking purposes. In extreme cases, consumers may avoid aesthetically unacceptable but otherwise safe supplies in favor of more pleasant but potentially unsafe sources of drinking water. It is, therefore, vital to maintain a quality of water that is acceptable to the consumer, and the absence of any adverse sensible effects does not guarantee the safety of the water.

Taste and odor problems in drinking water supplies are often the largest single cause of consumer complaints. Changes from the normal taste of a public water supply may signal changes in the quality of the raw water source or deficiencies in the treatment process. It is therefore wise to be aware of consumer perceptions and to take into account both health-related guidelines and aesthetic criteria when assessing drinking-water supplies.

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Biographical Sketches

Takako Aizawa is Chief of the Water Quality Management Division at the National Institute of Public Health, where she has been in office since 1971. She has served as Chief of Division since 1988. She received her degree of Bachelor of Education at Yokohama National University in 1968. Since 1971, her research and professional activities have been on micro-pollutants in the water environment, and have included analysis and safety evaluation of micro-pollutants, evaluation of disinfectants and disinfection by-products for water supply, and development of new water treatment technology for micro-pollutant removal. In the meantime, she also obtained a Doctor of Philosophy in Engineering from Hokkaido University. At present, she teaches irregular courses at post-graduate level on risk management of pesticides in the water environment.

She has authored or co-authored more than 50 research articles and written books on the aquatic environment.

Yasumoto Magara is Professor of Engineering at Hokkaido University, where he has been on faculty since 1997. He was admitted to Hokkaido University in 1960 and received the degree of Bachelor of Engineering in Sanitary Engineering in 1964 and Master of Engineering in 1966. After working for the same university for 4 years, he moved to National Institute of Public Health in 1970. He served as the Director of the Institute since 1984 for Department of Sanitary Engineering, then Department of Water Supply Engineering. He also obtained a Ph.D. in Engineering from Hokkaido University in 1979 and was conferred an Honorary Doctoral Degree in Engineering from Chiangmai University in 1994. Since 1964, his research subjects have been in environmental engineering and have included advanced water purification for drinking water, control of hazardous chemicals in drinking water, planning and treatment of domestic waste including human excreta, management of ambient water quality, and mechanisms of biological wastewater treatment system performance. He has also been a member of governmental deliberation councils of several ministries and agencies including Ministry of Health and Welfare, Ministry of Education, Environmental Agency, and National Land Agency. He performs international activities with JICA (Japan International Cooperation Agency) and World Health Organization. As for academic fields, he plays a pivotal role in many associations and societies, and has been Chairman of Japan Society on Water Environment.

Professor Magara has written and edited books on analysis and assessment of drinking water. He has been the author or co-author of more than 100 research articles.