WATER SUPPLY AND HEALTH CARE

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Summary

Water is an essential material for all organisms to sustain life on Earth, and a satisfactory water supply must be made available to consumers for health care. For this reason, the WHO recommended the drinking water guidelines for defining the water quality standards of drinking water. The main water that people drink is tap water. Contamination by chemicals and aquatic microorganisms is generated by various causes. The pollution of water sources for water supply occurs due to pathogenic microbes, naturally occurring chemicals, such as arsenic and fluoride, microcystin, which is produced by cyanobacteria, and industrial chemicals, such as pesticides. From water purification plants, there are disinfection by-products, such as trihalomethanes,

haloacetic acid and haloacetonitrile, newly produced by chlorination. In the water supply process, metals used for distribution pipes, such as iron, zinc, lead and copper, may often be eluted in the tap water. The storage tanks for supplied water may cause microbial contamination and contain unsuitable materials.

Recently, pharmaceuticals that people use have been detected in the environmental water of many countries. Trace levels of pharmaceuticals, such as carbamazepine and ibuprofen, have been detected in drinking water from investigations in USA, Europe, and Canada. Although parts-per-billion concentrations may not pose much acute risk, it is unknown whether other receptors in non-target organisms are sensitive. With regard to swimming pool water, sometimes many people go into pools of limited capacity simultaneously, and therefore suitable water quality and management are needed.

1. Introduction

Water is indispensable in order to maintain the life of humans and the ecosystem. About 60% of the human body consists of water, and the human intake is about 1.5L of drinking water every day. Water contained in food is also taken in, with the sum total being two to three litres taken into the body every day. Moreover, about 1500g of water as urine and feces, about 400g of expiration evaporation, and about 900g of sweat evaporation were discharged as human waste, and humans lose water at a total of about 2.7 L every day. Thus, in order to maintain the body healthily, a safe and suitable quality of drinking water is required.

At present, safe drinking water is not being supplied to various countries in the world, and many infants die due to infection by waterborne diseases. For this reason, the water quality standards of drinking water have been defined in many countries. The WHO has recommended drinking water guidelines to define the water quality standards of drinking water. The detailed contents are described in this Theme of EOLSS. In addition, swimming pool and bath water, which are used for amenities, may also require water quality standards and guidelines.

In recent years, pharmaceuticals used for humans or animals have been detected from environmental water areas, and it is feared that they may affect the ecosystem such as aquatic organisms, contaminate sources of water supply, or occur in drinking water.
In this article, we describe the water utilized by humans and its health effects.

2. Drinking water

The main water that people drink is tap water. Each person has tap water supplied to them, after suitable treatment and chlorination at the water purification plant. The flow of the supply process from this raw water to tap water, and the contamination of harmful chemicals and pathogens in each process are shown in Figure.1.

In these processes, the following problems can be considered about the contamination of hazardous chemicals and waterborne pathogens related to human health effects.

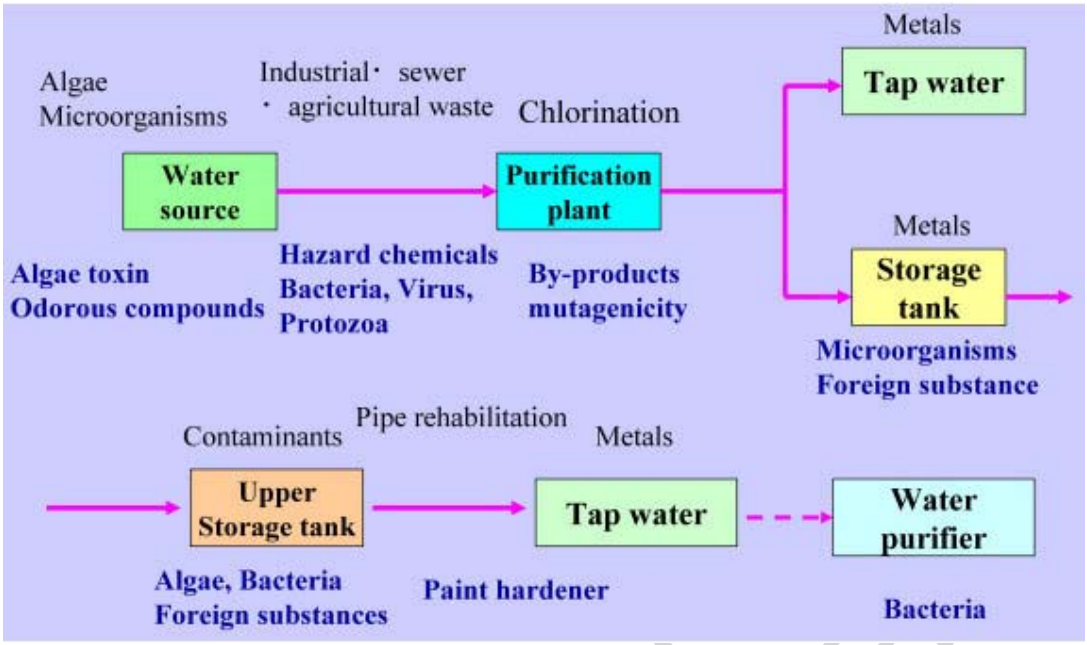

Figure 1: Scheme for treatment and supply of drinking water

2.1. Contamination of water sources

The quality of the water source, which becomes tap water, is influenced by the water discharged by people, industrial activity and agriculture. Industrial effluents contain chemical substances; organic pollutants and waterborne pathogens are present in sewage effluent, agriculture and stock raising drainage contains chemicals such as pesticides, veterinary medicines and waterborne pathogens. Eutrophication of water bodies is a major problem; aquatic organisms are extensively produced, posing threats to human health from naturally occurring chemical substances that are metabolites of aquatic organisms.

2.1.1 Contamination by aquatic organisms

Aquatic organisms in the source of the water supply are induced by various human or industrial activities in these regions.

Influent or effluent waste waters discharge into water environments, such as rivers and lakes as point source discharges. Rainwater flows into the whole environmental region as non-point discharge source. Coliforms and viruses, which originate in the intestines, can be detected in these areas. Water containing drainage from livestock areas is contaminated with protozoans such as *Cryptosporidium* and *Giardia*. Table 1 shows the total detected colonies and coliforms from the raw water of drinking water supply in the water purification plants in the Tokyo metropolis.

Purification plant	**Total colonies (N ml^{-1})**			**Coliform (MPN 100ml^{-1})**		
	Max.	**Min.**	**Average**			
No.1 well	2	0	0	1.0	0.0	0.1

No.2 river-bed	110	0	9	220	0.0	40
No.3 reservoir	1,800	1	72	310	3.6	12
No.4 river	39,000	1,300	8,400	92,000	1,700	18,000
No.5 river-bed	280	0	28	1,000	2.0	91.0
No.6 lake	2,100	110	650	2,400	80.0	620
No.7 reservoir+river	1,800	20	310	4,900	33.0	920.0
No.8 reservoir+river	25,000	190	3,900	46,000	230	5700
No.9 river	910	12	220	13,000	130	2,000
No.10 river	160,000	270	7,900	160,000	45.0	18,000
No.11 river	18,000	1,400	4,000	24,000	780	7,700

Table 1. Total colonies and coliforms detected in raw water of the Tokyo metropolis.

The number of total colonies and coliforms were investigated anually in the eleven drinking water purification plants in Tokyo metropolis. The number of total colonies was found to range from zero to 8400 CFU by average value of raw water of each water purification plant. Also, the numbers of coliforms ranged from 0.1 to 18,000 MPN $100ml^{-1}$ were detected in the raw water

Since the water purification plant of No.1 is used groundwater as water source of water supply, which is good water quality, and there is almost no contamination of microorganisms. As a result, total colonies are not detected, and most coliform has not been detected. In the water purification plant of NO.2 and No.5, little microbe are detected, since the infiltration which purified to some extent is used for the raw water. Raw water of No.3 water purification plant using reservoir in the place distant from the urban areas has a little microbes.

On the other hand, large numbers of total colonies and coliforms were detected from the raw water of a water purification plant, which uses the river, which flows through urban areas. The detection of the total colonies and coliforms of each water purification plant increased the numbers of microorganisms when the volume of water decreased during summer. Treated water of these water purification plants does not detect all of the total colonies and coliforms by treatment such as chlorination or ozonation.

In general, the inland water mostly contains aquatic microorganism, and usually disinfection is necessary, when it is used for drinking water.

2.1.2. Contamination of chemicals

All natural water contains a range of inorganic and organic chemicals. The former derive from the rocks and soil through which water percolates or over which it flows. The latter derive from the breakdown of plants or from algae and other microorganisms that grow in the water or on sediment.

Naturally occurring inorganic chemicals that exist abundantly in water may influence human health, such as a hyperkeratosis of the skin and skin cancer. For example, a chronic arsenic disease occurs when there is long-term intake of well water that contains a high concentration of arsenic. In addition, groundwater often contains fluoride, boron

and nitrate, which show possible health effects in humans. Heavy metals, such as Cd, Pb, Cr, Ni, Mn and Hg, and inorganic compounds, such as cyanide, may contaminate the water source from mining wastewater and industrial effluent, and health effects may occur. For example, Itai-itai disease is caused by exposure to cadmium in water contaminated by mining waste, and Minamata disease caused by the mercury intake of fish accumulated from sea water.

As for organic compounds, this occurs when industrial products contaminate the water source, since chlorinated organic compounds, such as dioxins and PCBs, are very resistant to change and do not decompose in water; thus, they remain in the water environment. Even when these substances occur at extremely low concentrations in water, they can accumulate in fish and shellfish by bioaccumulation through the food chain. This may have health effects on humans when consuming these fish as food.

Recently, organic brominated compounds, such as brominated diphenyl ether and brominated dioxin, and endocrine disrupting chemicals, such as phthalate ester, alkylphenols, bisphenol A, organic tin, and hormones originating in humans and animals, such as estradiol, have been detected in the aquatic environment. Moreover, various pharmaceuticals used for human and animals, such as antibiotics, have also been found in surface water, sewage treatment water and groundwater.

Pesticides used for agriculture or environmental maintenance and golf courses may contaminate drinking water by flowing into water bodies. In Japan, a water quality standard has been conventionally defined for each of the pesticides. Since two or more pesticides may exist in water, it was decided in 2004 that the water quality standard should use the total pesticide concentration of a selected 101 substances, by revision of the Water Works Law. The 101 substances were selected because they were substances detected in sources of tap water, and their high level of use in the market; the target value for each is based on the ADI value. The ratio of the concentration of pesticides and the target values that were measured and detected is actually determined, and the sum of the ratios of the concentrations of each to its guideline value should not exceed 1. The chemical substances that affect humans, depending on their concentration detected at the source of these tap waters, require a definition of the water quality standard in order to prevent their toxic influence. The WHO has presented the drinking water guidelines for inorganics, metals, organic substances and pesticides that have suspected health effects (see *Water Quality and Standards*).

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Biographical Sketches

Yoshiteru Tsuchiya is a Lecturer in the Faculty of Engineering of Kogakuin University, where he has been in his present post since 2000. He obtained a Bachelor Degree in Meiji Pharmaceutical College in 1964. He worked for Department of Environmental Health in Tokyo Metropolitan Research Laboratory of Public Health until 2000. In the meantime, he obtained a Ph.D in Pharmaceutical Sciences from Tokyo University. From 2002 to 2003, he worked for the Yokohama National University Cooperative Research and Development Center as Visiting Professor. He has written and edited books on risk assessment and management of waters. He has been the author or co-author of approximately 70 research articles. He is member of the Japan Society on Water Environment, Pharmaceutical Society of Japan, Japan Society for Environmental Chemistry, Japan Society of Endocrine Disrupters Research, and International Water Association.(IWA)

Hideo Utsumi has been Professor of Bio-function Science in the Faculty of Pharmaceutical Sciences at Kyushu University, since 1994. He was admitted to University of Tokyo in 1967 and received Bachelor Degree of Pharmaceutical Sciences in 1971 and Ph.D. in 1976 from University of Tokyo. He became an Assistant Professor of Physical Chemistry at Teikyo University in 1976, and then an Associate Professor of Health Science at Faculty of Pharmaceutical Sciences, Showa University in 1982. Since 1982, his research subjects have been in environmental health chemistry and he has studied bio-assay of hazardous chemicals in drinking water, determination of reactive oxygen species in advanced water purification for drinking water, and management of ambient water quality. He has written and edited books on risk assessment and management of waters. He has written and edited books on bio-assay and oxidative diseases. He has been the author or co-author of more than 150 research articles. He is a board member and a president elected for 2007 of Pharmaceutical Society of Japan, a past president of Society of Electron Spin Science and Technology, a board member of Japan Society on Water Environment.

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