Lecture 4 GM Hygiene 2020 / 2021

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Water quality – risk of chemical and infectious factors, communicable diseases related to water, water supplies, the sources of drinking water. Division of WHO of all diseases related to the water. Division of waterborne diseases, epidemiology of water related diseases.

Introduction – water quality

Water quality is one of the greatest factors afecting human health. Safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes. The quality of the water has a great influence on the public health, in particular microbiological and chemical quality. The prevision of safe and fresh and drinking water and the management of wastewaters had a central roll in reducing the incidence of many waterborne and water-related diseases.

The disease associated with the contaminated water have become of very minor significance in the mortality and morbidity in the most developed countries. The increase pressure on natural resources of fresh water in one environmental consequence of growing population. Inadequate supplies of water increase the problem of maintaining water quality, especially when are multiple sources of water pollution.

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Water pollution can occur when any type of chemical, microorganism, or toxin contaminates an ocean, lake, river, or other body of water. Pollution can come from a single source, such as a ditch or pipe. This is known as point source water pollution. Nonpoint source pollution, in contrast, refers to contamination that does not originate from a single source. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities.

The most common sources of water pollution include:

a) **communal sources from public sewages** – organic components, bacteria, detergents, phosphates and other sources,
b) **industrial sources** – heavy metals, petrochemicals, fluorides, oil pollution, radioactive waste,
c) **agricultural sources** – fertilizers, irrigation, pesticides, drug residues, saline drainages,
d) **natural sources** – floods, storms, urban run-off.

Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. An estimated of 580 people in India die of water pollution related illness every day. Around 90 % the water in the cities of China is polluted, and as of 2007, half a billion Chinese had no access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 % of assessed lake acres, and 32 % of assessed bays and estuarine square miles were classified as polluted.

Health risk resulting from drinking water can be classified as:

a) **chemical health risk** – nitrates, arsenic, pesticides, heavy metals, chloroform, asbestos fibers, fluorides and others,
b) **communicable disease risk** – waterborne diseases, water-washed diseases, water-based diseases, water-related diseases, water-dispersed diseases.

Chemical health risk

Chemical contamination of drinking water may also have effects on health. Although in general these tend to be chronic rather then acute, chemical pollutants which affects health includes nitrate, arsenic, mercury, pesticides, heavy metals and fluorides, they can be cause a long term problems, so that mean all sources of drinking water must be strongly protected from chemical contamination through the land use control so called protection zones.

Nitrates

Nitrates and nitrites are nitrogen-oxygen chemical units which combine with various organic and inorganic compounds. The greatest use of nitrates is as a fertilizer. Once taken into the body, nitrates are converted to nitrites. Infants below six months who drink water containing nitrate in excess of the maximum contaminant level could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and **blue baby syndrome – methemoglobinamenia.**

This health effects language is not intended to catalog all possible health effects for nitrate. Rather, it is intended to inform consumers of some of the possible health effects associated with nitrate in drinking water when the rule was finalized.

The major sources of nitrates in drinking water are runoff from fertilizer use; leaking from septic tanks, sewage; and erosion of natural deposits. A federal law called the Emergency Planning and Community Right to Know Act requires facilities in certain industries, which manufacture, process, or use significant amounts of toxic chemicals, to report annually on their releases of these chemicals.

Standard limit of nitrates for **infants' nutrition is below 15 mg/l**, the guideline value (Slovak Standard Norm) for adult use of nitrate is 50 mg/l.

At high levels, chronic effects including a possible greater likelihood of gastric cancer are likely to be noted. Nitrates removal from the drinking water is very difficult. If dermal contact will occur, the risk of allergy skin disease have been described.

Arsenic

Sources of arsenic in the drinking water include discharge from petroleum refineries; fire retardants; ceramics; electronics; solder. Potential health effects from long-term exposure include skin damage, inflamed eyes or problems with circulatory systems, and may have increased risk of getting cancer.

The most well documented cases of arsenic poisoning from drinking water have come from India, where there is arsenic contamination of large numbers of rural water supplies. Arsenic contamination has also been noted in southern Thailand.

Pesticides

Pesticides have the potential to contaminate drinking water supplies. They are applied to farmlands, gardens and lawns and can make their way into ground water or surface water systems that feed drinking water supplies. Whether these contaminants pose a health risk depends on how toxic the pesticides are, how much is in the water, and how much exposure occurs on a daily basis.

Along with the states and tribes, EPA implements regulations that protect the nation's drinking water from source to tap. Primary standards protect public health by limiting the levels of impurities in drinking water.

Pesticides can be based on several chemical compounds the most common are pesticide based on dichloro-diphenyl-trichloroethane (DDT) or pesticides on organophosphates.

DDT has accumulating effect in human tissues, the highest amount can be find in human fat tissues. Some of chlorinated hydrocarbons have carcinogenic and mutagenic effect.

Pesticides based on organophosphates – have no accumulation effect, but can cause acute poisoning in farmers and agricultural workers. Acute poisoning may have three basic symptoms: muscarine, nicotine and CNS symptoms of poisoning.

Heavy metals

Underground rocks and soils may contain arsenic, cadmium, chromium, lead, and selenium. However, these contaminants are not often found in household wells at dangerous levels from natural sources. Cadmium, mercury, lead, chromium, nickel are toxic substances causing acute or chronic poisoning.

Minamata disease is methylmercury (MeHg) poisoning that occurred in humans who ingested fish and shellfish contaminated by MeHg discharged in waste water from a chemical plant (Chisso Co. Ltd.). It was in May 1956, that M. d. was first officially "discovered" in

Minamata City, south-west region of Japan's Kyushu Island. The marine products in Minamata Bay displayed high levels of Hg contamination (5.61 to 35.7 ppm). The Hg content in hair of patients, their family and inhabitants of the Shiranui Sea coastline were also detected at high levels of Hg (max. 705 ppm). Typical symptoms of Minamata disease are as follows: sensory disturbances (glove and stocking type), ataxia, dysarthria, constriction of the visual field, auditory disturbances and tremor were also seen. Further, the fetus was poisoned by MeHg when their mothers ingested contaminated marine life. The symptom of patients were serious, and extensive lesions of the brain were observed. While the number of grave cases with acute M. d. in the initial stage was decreasing, the numbers of chronic disease patients who manifested symptoms gradually over an extended period of time was on the increase. For the past 36 years, of the 2252 patients who have been officially recognized as having Minamata disease, 1043 have died.

Chloroform and disinfections by products

To protect drinking water from disease-causing organisms, or pathogens, water suppliers often add a disinfectant, such as chlorine, to drinking water. Chlorination, as a method of water desinfections, has been prectised worldwide. Chlorine is free for react various organic compounds present in the water, producing chlorinated hydrocarbons. However, disinfection practices can be complicated because certain microbial pathogens, such as Cryptosporidium, are highly resistant to traditional disinfection practices.

Also, disinfectants themselves can react with naturally-occurring materials in the water to form by products, such as trihalomethanes and haloacetic acids, which may pose health risks. A major challenge for water suppliers is how to control and limit the risks from pathogens and disinfection byproducts. It is important to provide protection from pathogens while simultaneously minimizing health risks to the population from disinfection byproducts. The primary public health concern respect to chloroform and other disinfection by – product is chronic toxicity, particularly cancer. The epidemiological picture with respect to human cancer and drinking of chlorinated water is still uncertain.

Fluorides

Excess fluoride in the drinking water may lead to dental or skeletal fluorosis. Deficiency of fluoride may cause dental caries, a weekening of the teeth.

Asbestos fibers

Asbestos is a fibrous mineral occurring in natural deposits. Because asbestos fibers are resistant to heat and most chemicals, they have been mined for use in more than 3,000 products, including roofing materials, brake pads, and cement pipe often used in distributing water to communities. Some people who drink water containing asbestos well in excess of the maximum contaminant level for many years may have an increased risk of developing benign intestinal polyps.

Communicable diseases risk

The microbiological quality of drinking water has been implicated in the spread of important infections and parasitic diseases such as cholera, typhoid dysentery, hepatitis. Most of diseases agents that contaminated water and food that comes from animal or human feces. They include bacteria, viruses, protozoa, etc.

The mortality of children under 5 years of age is related to diarrhea disease and it has been estimated cause more then 40% of children's death.

Communicable diseases transmitted by water can be categorized:

1. Waterborne diseases
2. Water-washed diseases
3. Water-based diseases
4. Water-related diseases
5. Water-dispersed diseases

Waterborne diseases

Waterborne diseases are any illness caused by drinking water contaminated by human or animal faeces, which contain pathogenic microorganisms. The full picture of water-associated diseases is complex for a number of reasons. Over the past decades, the picture of water-related human health issues has become increasingly comprehensive, with the emergence of new water-related infection diseases and the re-emergence of ones already known.

Data are available for some water-, sanitation- and hygiene-related diseases (which include salmonellosis, cholera, shigellosis), but for others such malaria, schistosomiasis or the

most modern infections such legionellosis or SARS, the analyses remain to be done. The burden of several disease groups can only partly be attributed to water determinants. Even where water plays an essential role in the ecology of diseases, it may be hard to pinpoint the relative importance of aquatic components of the local ecosystems.

Waterborne diseases arise from contaminated of water by human or animal excrements or urine infected by Bactria', fungi or virus, **e.g.: chlorela, shigellosis, poliomyelitis, viral hepatitis A, salmonellosis, Campylobacter infection, rotavirus, E.coli infections, typhoid fever, amoebiasis, leptospirosis etc.**

Water-washed diseases

Water-washed are infections that are caused by poor personal hygiene resulting from inadequate water availability. These ailments may be prevented if people have adequate supplies of clean water available for personal hygiene. Typical water-washed diseases include **trachoma, relapsing, fever, reccurent typhus fever, scabies**.

Water-based diseases

Water provides the habitat for intermediate host organism in which some parasites pass or survive part of their „life cycle“, such as **schistosomiasis, dracunculiasis**. They are spread by organisms that develop in water and then become human parasites. They are spread by contaminated water and by eating insufficiently cooked fish.

Schistosomiasis, also known as bilharzia, snail fever, and Katayama fever is a disease caused by parasitic worms of the Schistosoma type. It may infect the urinary tract or intestines. Symptoms may include abdominal pain, diarrhea, bloody stool, or blood in the urine. In those who have been infected a long time, liver damage, kidney failure, infertility, or bladder cancer may occur. In children it may cause poor growth and learning difficulty. The disease is spread by contact with water that contains the parasites. These parasites are released from freshwater snails that have been infected. The disease is especially common among children in developing countries as they are more likely to play in infected water. Other high risk groups include farmers, fishermen, and people using infected water for their daily chores. Diagnosis is by finding the eggs of the parasite in a person's urine or stool. It can also be confirmed by finding antibodies against the disease in the blood.

Water related diseases

Water-related insect vectors, such as mosquitoes, breed in or near water and spread diseases, **including dengue, malaria, yellow fever**. African trypanosomiasis (sleeping sickness) is transmitted by vector, which is **fly „ts-tce“**. This category is not directly related to water supply or quality.

Water-dispersed diseases

This category of diseases emerges in developed countries - in this group belong infections whose agents can proliferate in water and enter human body throught the respiratory tract. Legionellosis – agent can proliferate in air – conditioning system. Cryptosporidium – pneumonia in immunosuppresed patients and HIV positive patient in hospitals and health care settings.

The bacterium Legionella pneumophila is responsible for most cases of Legionnaires' disease. Outdoors, legionella bacteria survive in soil and water, but rarely cause infections. Indoors, though, legionella bacteria can multiply in all kinds of water systems — hot tubs, air conditioners and mist sprayers in grocery store produce departments. Although it's possible to contract Legionnaires' disease from home plumbing systems, most outbreaks have occurred in large buildings, perhaps because complex systems allow the bacteria to grow and spread more easily.

The Bradley classification on water related infections (Caincross and Valdmanis, 2006)

Transmission route	**Description**	**Disease group**	**Examples**
Waterborne	The pathogen is in water that is ingested	Feco-oral	Diarrheas, dysenteries, typhoid fever
Water-washed	Person-to-person transmission	Skin and eye infections	Scabies, trachoma
Water based	Transmission via an aquatic intermediate host	Water-based	Schistosomiasis, guinea worm
Water related	Transmission by insects that breed in water or bite near water	Water-related insect vector	Dengue, malaria, trypanosomiasis

Water supplies

Central public system is available for many inhabitants in the large cities and this kind water supply is easy to control. But here is risk of infections in case of accidents. E.g. earth quick, war and floods. In this case higher risk from chemical poisoning because large amount of people in the community is supplied.

Individual system is private system of wells and springs in villages and small community. Mostly not control, higher nitrate level due to agricultural activity and feces disposal. The level of chemical contaminates could be higher but epidemiological chemical risk disease is lower.

The sources of drinking water

Ground water - this water is cleaner the sources is wells and springs, and has high hygienic quality. Contents of Ca, Mg, Fe.

Superficial water - lakes, rivers, this water is more contaminated and have a low mineralization.

Mineral waters

Mineral and thermal springs and sources in Slovakia are a generally known fact. Their diversity is conditioned by the unique geological setting. Of the many recorded mineral resources it is allocated a separate part of the resources that are recognized as natural mineral waters and natural healing waters. The existence of this national wealth has historically conditioned the emergence of spas in areas with healing waters. Mineral waters have been already for two centuries filled into packages and distributed to consumers.

In this small country with an area of 49.035 km2 there are more than 1600 mineral springs registered. Healing water from springs is used either in spa or is bottled. According Slovak standard are mineral waters classified as follows:

1. **Natural table mineral water** - is water, which by its chemical composition, physical properties and taste is suitable as a refreshing drink, which contains in 1 liter of at least

1000 mg of dissolved carbon dioxide and maximum 6000 mg of dissolved solids which neither individually nor together do not have significant pharmacological effects.

2. **Natural mineral water** - is water in natural springs and artificial catchments which in place of groundwater withdrawal contains in 1 litter of water more than 1000 mg of dissolved solids or 1,000 mg dissolved CO2.

3. **Natural healing (spa) water** - is water, which due to its chemical composition and physical properties as positive, scientifically proven effects on human health has, that it is in the public interest to use the water in medical therapy.

Health safety of packaged natural mineral waters placed on the market of the Slovak Republic is regularly checked by individual regional authorities of the Veterinary and Food Administration of the Slovak Republic within the framework of execution of the multiannual national plan of official control.

Content of selected mineral waters in Slovakia

BALDOVSKÁ (mg/l)

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
85	362	82,7	18	0,72	1,83	205	69,9	0,85	1 354	<0,01

BUDIŠ (mg/l)

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
370	172	43,3	40,4	0,36	<1	362	29,9	2,5	1 287	<0,01

FATRA (mg/l)

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
550	44,9	48,2	16	29,9	<1	111	36,2	0,79	1 693	<0,01

GEMERKA

Ca:Mg = 3:1

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
108	426	128	17,5	0,85	1	376	24,7	1,2	1763	<0,01

KORYTNICA

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
4,9	657	151	5,1	0,3	<0,08	1290	3,19	0,36	1110	<0,01

SALVATOR

Na^+	Ca^{2+}	Mg^{2+}	K^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
248	450	173	36,5	1,32	< 1	142	113	1,6	2 586	<0,01

SULINKA

Na^+	Ca^{2+}	Mg^{2+}	Li^+	NH_4^+	NO_3^-	SO_4^{2-}	Cl^-	F^-	HCO_3^-	NO_2^-
833,96	244,38	251,19	2,3		<0,5	7,8	50,72	0,05	4287,9	<0,05

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