Water hygiene

Water consumption and availability, sources of potable water, water treatment, water contaminants, mineral water, recreational water use, sewage treatment
Definition of water hygiene

• Water hygiene focuses on natural and anthropogenic pollutants (from soil and through air precipitation, chemicals, waste, sewage) present in water, affecting human health.
Importance of safe water

• Annually, safer water could prevent:
  • 1.4 million child deaths from diarrhea;
  • 500 000 deaths from malaria;
  • 860 000 child deaths from malnutrition; and
  • 280 000 deaths from drowning.

• In addition, 5 million people can be protected from being seriously incapacitated from lymphatic filariasis and another 5 million from trachoma.
Mortality and burden of disease from water and sanitation

• http://www.who.int/gho/phe/water_sanitation/burden/en/
How to decrease the burden?

• Providing leadership in Water, Sanitation, and Hygiene related issues (by making authoritative statements, influencing policy and coordinating networks of partners and collaborating centers)

• Normative work (mainly on water quality, but also on monitoring approaches and interventions, usually resulting in guidelines and best practice texts)

• Providing evidence (through various monitoring activities, but also through commissioned research)

• Supporting Member States (through technical cooperation and capacity building)

• Responding to emergencies (the role in the Health Cluster - WASH in healthcare - and in the WASH cluster - restoring safe water supplies and adequate sanitation)

• Knowledge management (through analysis, synthesis and dissemination of reliable and credible information)
Water consumption and availability

Available water, industrial and domestic water consumption
Distribution of Earth’s water

Fresh water

• Only 2.5% of the Earth's water is fresh water.
• Water is not an innate matter, through the water cycle, it is present not only on the Earth’s surface but in the air as well. This explains the many effects of water pollution on human health and environment.
Water consumption worldwide

- Worldwide, 70% of all water consumption is used in agriculture, 20% for the industry and only 10% for domestic use.
- In the developed, industrialized countries, almost half of water consumption is used for industrial purposes.
- Belgium, for example, uses 80% of the water available for industry.
Increasing water demand

- Demand for freshwater is increasing by 64 billion cubic meters a year
- Almost 80% of diseases in so-called "developing" countries are associated with water, causing around three million early deaths. For example, 5,000 children die every day from diarrhea.

Water consumption in industry

- Paper industry: 38%
- Metal industry: 33%
- Chemical industry: 9%
- Petroleum and coal industry: 8%
- Food industry: 7%
- Other: 5%
Water consumption of an individual

• Physiological water demand:
  • 2-3 liter/capita/day (depending on temperature, wind, relative moisture, work intensity, physical activity)

• Domestic daily consumption (direct):
  • Drinking 2-3 l/capita/day,
  • Cooking 4-5 l/capita/day,
  • Cleaning 8-15 l/capita/day,
  • Washing (dishes, clothes) 30-40 l/day/capita,
  • Personal hygiene (including the use of toilette) 50-180 l/capita/day.
Fun fact

- Water is used to produce very different products. For instance, if we take into consideration the total indirect water consumption for the production of a single hamburger (salad, meat, bun), we would need 2400 l of water in all to produce it.
Availability of water

- More than 1.5 billion people lack access to clean, healthy water already.
- More than 1 billion people have to travel at least 3 hours to reach a clean water source.
Alarming trends
Sources of potable water

Bank filtration and ground water
Source of water
Source of potable water

- Drinking water may come from surface water and ground water.
- Large-scale water supply systems tend to rely on surface water resources, and smaller water systems tend to use ground water.
- Slightly more than half of the US population receives its drinking water from ground water sources. This figure may vary greatly depending on the country’s characteristic.
Surface water

- Surface water includes rivers, lakes, and reservoirs.
- In Hungary 44% of drinking water is extracted from surface water.
- In this case the river bed acts as a filterer itself, so it is considered safe. Of course, water must be treated afterwards.
Ground water

• Ground water is pumped from wells that are drilled into aquifers. Aquifers are geologic formations that contain water.

• Depending on the components of the soil, confined aquifers can be contaminated with certain naturally present substances (e.g. Arsenic, see below) that are harmful to human health.

• 35% of Hungary’s water supply comes from confined aquifers.
Unconfined aquifers

- Unconfined (meaning above a confining bed, near the surface) aquifers are potentially dangerous because of the high risk of industrial, domestic and agricultural contamination.
Water treatment

Quality requirements, water treatment plant, microbiological examination
Quality requirements of drinking water

- Free of harmful chemical and biological agents
- Contains minerals
- Cool, refreshing, temperature around 12°C
- Clean, odorless, tasteless
- Cheap, accessible in large amounts
How a water treatment plant works

Coagulation — special compounds remove the dirt particles from the water.

Sedimentation — the dirt settles to the bottom and the water becomes cleaner.

From wells or lakes or rivers to the plant....

Filtration — water passes through filters to purify it further.

Disinfection — kills the germs.

From the water tower to your home!
Steps of water treatment may include:

• Pre-chlorination: for algae control and arresting any biological growth
• Aeration: along with pre-chlorination for removal of dissolved iron and manganese
• Coagulation: for flocculation (floc)
• Coagulant aids to improve coagulation and for thicker floc formation
• Sedimentation: for solids separation, that is removal of suspended solids trapped in the floc
• Filtration: removing particles from water
• Desalination: Process of removing salt from the water
• Disinfection
Safety measures

• A very important aspect is to preserve the quality of water during extraction, within the pipes, and until it reaches the homes.

• *Water samples are taken regularly at water extraction facilities.* The frequency depends on the water extraction rate. The more drinking water is produced, the more samples are taken. In larger facilities this may mean *several times* during the day.

• *The area of these facilities is protected as well, as a precaution.* For example, the immediate surroundings of these facilities cannot be used for agriculture or waste disposal.

• *Within the pipes, quality can be maintained by the upkeep of high pressure all along the way.*
Microbiological examination of water

- **Total bacterial count to measure quality of water**: it means total number of bacteria in 1 ml water (incubated at 22 °C and 37 °C for 24 hours).

- **Typically three indicator bacteria are chosen**:
  - Coliforms,
  - *Escherichia coli* (E. coli) and
  - *Pseudomonas aeruginosa*. 
Coliform bacteria

- *Coliform bacteria* are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water is usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

- Fecal Coliform and *E. coli* are bacteria the presence of which indicates that the water may be contaminated with human or animal wastes.
Water contaminants

Chemical, biological, physical contaminants
Most important water contaminants

- **Chemical**
  1. Mercury
  2. Cadmium
  3. Lead
  4. Arsenic
  5. Fluoride
  6. Artificial fertilizer

- **Physical**
  7. Thermal pollution
  8. Radioactive pollution

- **Biological**
  9. Infectious diseases linked to water
1. Mercury (Minamata disease)

- Minamata disease is a neurological syndrome caused by severe mercury poisoning.
- Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision, and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms.
- A congenital form of the disease can also affect fetuses in the womb.
Minamata disease

• The disease was first discovered in Minamata city in Kumamoto prefecture, Japan, in 1956.

• It was caused by the release of methylmercury in the industrial wastewater from the Chisso Corporation's chemical factory, which continued from 1932 to 1968.

• This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which, when eaten by the local population, resulted in mercury poisoning.

• As of March 2001, 2,265 victims had been officially recognized (1,784 had died) and over 10,000 had received financial compensation from Chisso. By 2004, Chisso Corporation had paid $86 million in compensation, and in the same year was ordered to clean up its contamination.
Transformation of mercury
2. Cadmium (Itai-itai disease)

- Itai-itai disease was the documented case of mass cadmium poisoning in Toyama Prefecture, Japan, starting around 1912.
- The cadmium poisoning caused softening of the bones and kidney failure.
- The disease is named for the severe pains (itai=pain) caused in the joints and spine.
Itai-Itai disease

• The disease was caused by cadmium poisoning due to mining in Toyama Prefecture that continuously polluted the rivers of the region.

• The river was used mainly for irrigation of rice fields, but also for drinking water, washing, fishing, and other uses by downstream populations.

• The cadmium and other heavy metals accumulated at the bottom of the river and in the water of the river. This water was then used to irrigate the rice fields.

• The rice absorbed heavy metals, especially the cadmium. The cadmium accumulated in the people eating contaminated rice.
3. Lead

• Lead, a metal found in natural deposits, is commonly used in household plumbing materials and water service lines.

• Homes built before 1986 are more likely to have lead pipes, fixtures and solder.

• At a young age exposure to lead in drinking water above the action level can result in delays in physical and mental development, along with slight deficits in attention span and learning abilities.

• In adults, it can cause increases in blood pressure. Adults who drink this water over many years could develop kidney problems or high blood pressure.
4. Arsenic (Black foot disease)

• Arsenic is a semi-metal element in the periodic table. It enters drinking water supplies from natural deposits in the earth OR from agricultural and industrial practices.

• Natural arsenic contamination is a cause for concern in many countries of the world including Argentina, Bangladesh, Chile, China, India, Mexico, Thailand, Hungary and the United States of America.

• A 2007 study found that over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water.

• Consuming water contaminated by arsenic can cause skin and bladder cancer, as well as cardiovascular disease.

• WHO's Guideline Value for arsenic in drinking water is 0.01 mg/liter.
Arsenic contamination
Black foot disease

• *Arsenicosis* is the effect of arsenic poisoning, usually over a long period such as from 5 to 20 years.

• Drinking arsenic-rich water over a long period results in various health effects including skin problems (such as color changes on the skin, and hard patches on the palms and soles of the feet), skin cancer, cancers of the bladder, kidney and lung, and diseases of the blood vessels of the legs and feet, and possibly also diabetes, high blood pressure and reproductive disorders.
5. Fluoride

• The amount of fluoride in drinking water is regulated. Fluoride may cause health problems if present in public or private water supplies in amounts greater than the drinking water standard set.

• Exposure to excessive consumption of fluoride over a lifetime may lead to increased likelihood of
  • Bone fractures in adults, and may result in effects on bone leading to pain and tenderness.
  • Children aged 8 years and younger exposed to excessive amounts of fluoride have an increased chance of developing pits in the tooth enamel, along with a range of cosmetic effects to teeth.
Fluoride supplementation in water

• In certain countries, communities choose to adjust the fluoride concentration in the water supply to a level beneficial to reduce tooth decay and promote good oral health.

• Water is just one of several sources of fluoride. Other sources include dental products such as toothpaste and mouth rinses, prescription fluoride supplements, and professionally applied fluoride products such as varnish and gels.

• Recognizing that it is now possible to receive enough fluoride with slightly lower or zero levels of fluoride in water, new recommendations for community water fluoridation are being developed.
6. Artificial fertilizers

• Fertilizer is any material of natural or synthetic origin (other than liming materials) that is applied to soils or to plant tissues (usually leaves) to supply one or more plant nutrients essential to the growth of plants.

• They contain three main macronutrients: nitrogen (N), phosphorus (P), potassium (K).
Blue Baby syndrome (methaemoglobinemia)

- In the body nitrates are converted to nitrites. The nitrites react with haemoglobin in the red blood cells to form methaemoglobin, affecting the blood's ability to carry enough oxygen to the cells of the body.
- The most common cause of methaemoglobinemia is high levels of nitrates in drinking water and certain vegetables.
- Intense farming practice may increase this to more than 50 mg/liter. Levels greater than 50mg/liter are known to have been associated with methaemoglobinemia in bottle fed infants (Blue Baby syndrome).
Blue Baby syndrome

- Bottle-fed infants less than three months of age are particularly at risk, adults are not.

- This is due to the following reasons:
  - Fetal hemoglobin shows higher affinity to with nitrites than adult Hg.
  - Due to the different bacterial composition of the infant GI tract, the transformation of nitrates to nitrites is much higher at early age.
  - The immature kidney of a newborn shows decreased clearance of these substances.
7. Thermal pollution of water

• Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence. Thermal pollution, unlike chemical pollution, results in a change in the physical properties of water.

• A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers.

• Elevated water temperatures decreases oxygen levels, which can kill fish, and can alter food chain composition, reduce species biodiversity, and promote invasion by new thermophilic species.
8. Radioactive pollution in water

• Deposition of nuclear wastes
  • Scientists studying the movement of groundwater have found that radioactive contaminants can migrate over long distances faster than originally thought.

• Mining

• Nuclear power plants

• Health care
9. Infectious diseases linked to water

- **Water-borne**: oral-fecal diseases transmitted through ingestion of contaminated water (cholera, typhoid fever, amoebiasis)

- **Water-washed**: usually oral-fecal or contact diseases resulting from inadequate personal hygiene due to lack of water (salmonellosis, typhoid fever, trachoma, amoebiasis, hepatitis A and E... etc.)

- **Water-based**: the pathogen spends a part of its life-cycle in water and infection occurs through ingestion or contact (schistosomiasis, dracunculiasis)

- **Water-related vector-borne**: the life-cycle of a primary arthropod vector of the pathogen is connected to water (malaria, dengue, filariasis, yellow fever)

- **Water-dispersed**: pathogen lives and reproduces in water and transmission occurs by dispersion of contaminated water droplets into the air and subsequent inhalation (legionellosis).
Patterns of water based epidemics

• The area of the epidemic coincide with the area of a given water supply.
• Suddenly, large number of cases.
• The causative agent can be detected in water.
• Sudden drop of the number of cases after the polluted source is shut off.
Epidemic in Miskolc 2006

• Source of water was karst water.
• Due to episodes of heavy raining the amount of karst water increased.
• Self-cleansing potential was not enough
• Contaminated water entered the system causing an epidemic
Mineral water

Legislation and consumption
Legislation

• In the *European Union*, bottled water may be called mineral water when it is bottled at the source and has undergone no or minimal treatment.
  • Permitted is the removal of iron, manganese, sulfur and arsenic through decantation, filtration or treatment with ozone-enriched air, in so far as this treatment does not alter the composition of the water as regards the essential constituents which give it its properties.
  • No additions are permitted except for carbon dioxide, which may be added, removed or re-introduced by exclusively physical methods.
  • No disinfection treatment is permitted, nor is the addition of any bacteriostatic agents.
Bottled water consumption
Recreational water use

Linked activities, adverse health outcomes, prevention
Recreational activities linked to water

- Swimming
- Rafting, canoeing
- Waterskiing, jet skiing, windsurfing
- Use of inland waterways for boating
- Recreational use of drinking-water reservoirs
- Dog-walking and horse-riding
Adverse heath outcomes linked to recreational water use

• Drowning and injury prevention
• Sun, heat and cold
• Fecal pollution
• Microbial aspects of beach sand quality
• Algae and cyanobacteria in water
• Chemical and physical agent
• Dangerous aquatic organisms
Relative severity

- **Extremely high priority**: Life-threatening or permanent incapacity (e.g., drowning, spinal injury, some dangerous animals, Naegleria infection).
- **High priority**: Long-term incapacity (e.g., near-drowning, infection with E. coli O157 or typhoid).
- **Moderate priority**: Moderate incapacity or requires medical intervention (e.g., skin cancer caused by sun exposure – with medical treatment, leptospirosis, many dangerous aquatic animals).
- **Low priority**: Short-term incapacity, self-limiting (e.g., most mild diarrhoea, upper respiratory tract infection etc. from sewage pollution).
- **Very low priority**: No incapacity (e.g., irritation from low levels of cyanobacteria, some insect bites).

**Relative risk (e.g., of outcomes per bather-year)**

- **Low**
- **High**

**Relative severity**

- **Low**
- **High**
### Examples of non-contact recreational activities

| Angling from shore (1–6)       |
| Boating under power (1–4)    |
| Picnics (1–4, 6)              |
| Walking (1–4, 6)              |
| Sunbathing (2–4, 6)           |
| Birdwatching (1–4, 6)         |

### Principal hazards

1. Falling in, drowning
2. Sunburn, sunstroke, skin cancer
3. Aesthetic revulsion from fish deaths, anaerobic conditions, oil and other visible pollution
4. Bites from mosquitoes and other insect vectors of disease
5. Infection following skin injury and exposure to water
6. Injury; treading on broken glass or jagged metal waste

### Potential risk reduction measures

2. General and local publicity. Use of sunscreen or sunblock, limit exposure. Wearing protective clothing.
3. Control and licensing of discharges from sewage works, industry, storm sewer outfalls, agriculture, landfills and watercraft.
4. Health warnings to travellers, anti-malarial therapy, avoidance of infested regions, application of appropriate insect repellants.
5. Exercising care; covering all injuries with waterproof dressings.
6. Litter control, cleansing recreational area. Putting rubbish in bins or taking it away. Prohibiting use of glass on beach.
Balneotherapy

Indications and contraindications
Balneotherapy

• The term "balneotherapy" is generally applied to everything relating to spa treatment, including the drinking of waters and the use of hot baths and natural vapor baths, as well as of the various kinds of mud and sand used for hot applications.

• Balneotherapy refers to the medical use of these spas, as opposed to recreational use.

• Common minerals found in spa waters are sodium, magnesium, calcium, and iron, as well as arsenic, lithium, potassium, manganese, bromine, and iodine.

• All these may be contained in the peat that is commonly used in preparation of spa waters.

• Resorts may also add minerals or essential oils to naturally-occurring hot springs.
Balneotherapy indication

- The major dermatologic and musculoskeletal diseases that are frequently treated by balneotherapy with a remarkable rate of success are:
  - atopic dermatitis,
  - psoriasis,
  - rheumatoid arthritis (RA),
  - ankylosing spondylitis,
  - osteoarthritis,
  - low back pain.
Contraindications of balneotherapy

- Fever
- Active tuberculosis
- Active infectious disease
- Active/acute inflammation
- Hemodynamic instability
- Pregnancy and lactation
- Patients without rehabilitation potential, suffering from
  - Internal organs diseases in the stage of decompensation
  - Cancers and cancer conditions after operations
  - Epilepsy
  - Mental disorders
  - Vascular diseases – phlebothrombosis, active thrombophlebitis, etc.
  - Pacemaker implants
  - Unstable hypertension
Evidence-based hydro- and balneotherapy in Hungary: a systematic review and meta-analysis

• http://www.ncbi.nlm.nih.gov/pubmed/23677421
Sewage treatment

Primary, secondary, tertiary treatment, sludge disposal
Sewage treatment schematically
Sewage treatment

• Sewage treatment is the process of removing contaminants from wastewater and household sewage, both run-off (effluents), domestic, commercial and institutional. Sewage is generated by
  • residential (household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers)
  • institutional, commercial and industrial establishments (includes liquid waste from industry and commerce)

• Sewage treatment generally involves three stages called primary, secondary and tertiary treatment.
The distribution of wastewater treatment methods in Europe

(1) Belgium, the Czech Republic, Spain, the Netherlands, Austria (estimate), Portugal and Turkey, 2008; Germany, Latvia and Croatia, 2007; Hungary and Sweden, 2006; Denmark, Ireland, France, Italy, Cyprus, Luxembourg, Slovakia and Finland, not available.
(2) England and Wales only.
(3) Primary, not available.
(4) Tertiary, not available.
(5) Primary and tertiary, not available.
(6) Secondary and tertiary, not available.
Source: Eurostat (online data code: env_watq4)
Primary and secondary treatment

• **Primary treatment** consists of temporarily holding the sewage in a basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.

• **Secondary treatment** removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne microorganisms in a managed habitat. Secondary treatment may require a separation process to remove the microorganisms from the treated water prior to discharge or tertiary treatment.
Tertiary treatment

- **Tertiary treatment** is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, and coral reefs).
- Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park.
- If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.
Sludge disposal

• **Sludge** refers to the residual, semi-solid material left from industrial wastewater or sewage treatment processes. Sludge can be incinerated, used for landfill, compost or other agricultural use later on.

• The most important disposal methods are:
  • incineration
  • landfilling
  • composting
  • agricultural use
The disposal methods used in the Europe

(1) Belgium, the Czech Republic, Germany, France, Luxembourg, the Netherlands and Austria, 2008; Ireland, Cyprus, Latvia, Hungary and Slovakia, 2007; Switzerland, 2006; Denmark, Italy, Portugal, Finland, Sweden and the United Kingdom, not available.

(2) Based on a total excluding the category of other types of treatment.

Source: Eurostat (online data code: env_watq8)
Thank you for your attention!