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**DEPARTMENT OF GENERAL HYGIENE
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Kusova A.R., Tsilidas E.G.

Hygienic assessment drinking water and water sources

Methodological recommendations for medical students

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This methodological guide contains material that reflects modern hygienic ideas about the most important factor in the human environment - water. The data on the types of water sources and water supply, methods of their selection and protection are presented. Information is provided on the basic hygienic requirements for drinking water: its chemical, epidemiological and organoleptic properties, as well as the effect of changes in these indicators on human health.

The manual contains situational tasks, test tasks, a list of basic and recommended additional literature that facilitate the assimilation of the material.

The manual contains a list of used and recommended literature. Educational and methodological manual "Hygienic assessment drinking water and water sources", prepared in the discipline "Hygiene" in accordance with the Federal State Educational Standard of Higher Professional Education for students studying in the specialty of Medicine (31.05.01).

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Reviewers:

Kalagova R.V. - Doctor of Chemistry, Associate Professor, Head of the Department of Physics and Chemistry of the FSBEI of HE NOSMA of the Ministry of Health of Russia.

Tuaeva I.Sh. - Candidate of Medical Sciences. Associate Professor of the Department of Hygiene of the PMF with the course FPAE FSBEI of HE NOSMA of the Ministry of Health of Russia.

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FIZIOLOGO-GIGIENICHESKOE VALUE OF WATER

Water is one of the most important factors of the environment necessary for human life, animals, plants. Any vital process in a human body cannot be made without water, any its cell is not able to do without water environment. It is necessary as solvent of nutrients and as Wednesday in which processes of assimilation and dissimulation, elimination and a resorption, diffusion, osmosis, filtering proceed.

The human body for 63 - 65% consists of water in which all exchange processes proceed. It makes the main part of fluid mediums of an organism - blood, a lymph, intercellular lymphs, secrets of digestive and other glands, being also a component of dense body tissues.

Loss of 10% of water leads to sharp concern, thirst, weakness, a tremor of extremities, and loss of 20-25% is incompatible with life. Maintenance of physiological requirements of an organism requires 1,5-2,0 l of water a day, and this quantity joins the water which is a part of the first and third courses.

Besides, high-quality water is necessary for processing of foodstuff, production of medicines, a soderyozhaniye of domestic animals, personal hygiene, maintenance of a saniyotarny condition of the dwelling, public buildings, areas and so forth, for watering of green plantings, performance of technological processes by production of foodstuff, drinks, stroiyotelny materials etc. Water is also used for holding ozdoyorovitelny, sports actions, etc.

Hygienic characteristic of sources of water supply

By origin and localizations of water happen three types:

- underground (soil, interbedded),
- superficial (seas, rivers, lakes, oceans and others),
- atmospheric.

Underground waters form from the atmospheric precipitation passing through thickness of the soil and lingering on vodoyonepronitsayemy layers of clay or granite.

Ground waters accumulate on the first from a zemyola surface a waterproof layer. Depth of their bedding makes from 1-2 to tens of meters. Are used for the device of wells. They can easily become soiled in a reyozyultata of economic and household activity of the person.

Interreservoir waters are located between two vodouporony layers and therefore are more reliably protected from all viyod of pollution.

Surface water forms from the atmospheric precipitation which is flowing down on roughnesses of the soil and accumulating on the waterproof horizons in the form of the rivers, lakes, water reservoirs, channels, ponds, the seas and oceans. A surface water is widely used for economic and drinking water supply. About purity of water of superficial water sources judge by flora and fauna (aquatic organisms) which can live in waters, different in impurity degree, that is called saprobity (Latin sapos-putrefactive). All inhabitants of reservoirs share on polysaprobic, α and β -mezosaprobny and oligosaprobic organisms.

The polysaprobic zone - the dirtiest as in it many organic compounds soderyozhitsya, is not enough oxygen, priyosutstvut protein decomposition products (ammonia, sulfates, etc.). Anaerobic microorganisms, saprophytes and filamentous bacteria can live in this zone.

Alpha мезосапробная the zone is characterized by what in it is nayochinat to proceed aerobic processes of oxidation of organic matters owing to what salts of ammonium appear and blue-green seaweed poselyayotsya, but water still remains dostayotochno dirty.

Beta мезосапробная the zone differs in the high content of oxygen supporting processes of aerobic oxidation. The quantity of microbes decreases, infusorians, mollusks, some species of fish appear. Processes of self-cleaning in this zone proceed actively.

Oligosaprobic zone - a pure zone in which (nitrates) obnaruyozhivat products of a full albuminolysis prisutyostvut only aerobic microorganisms, plants appear.

In an oligosaprobic zone it is possible to arrange a water intake for a water supply system oryoganzatsiya.

Systems of water supply

1. Centralized (water supply system)
2. Decentralized (a well, a borehole, a piping).

Water supply of modern city and rural naselenyony points has to provide quality and amount of podayovayemy water according to the established hygienic standards, to support the high level of public health, excepting danger of spread of the diseases which are transmitted by the waterway. At the centralized water supply water is taken away from superficial or underground water sources in the meyokhanichesky way, subjected to special processing and on network of pipes delivered under pressure to the place of consumption. The decentralized (local) water supply is called use by the population of water of underground sources for drinking and economic needs by means of wells, a piping without system of the parting network.

Safety of a water intake is ensured by creation around a water source of zones of sanitary protection.

Zones of sanitary protection:

- 1) zone of a high security,

- 2) restriction zone,
- 3) observation zone.

Requirements to quality of drinking water

Now in the Russian Federation requirements to quality of drinking water are regulated by Health regulations and norms.

Drinking water has to be:

It is safe in the epidemiological and radiation plan.

It is harmless on chemical composition.

It is favorable on organoleptic properties.

The waterway transmits many infectious diseases: acute intestinal infections (dysentery, enterita, colenterites, typhoid, paratyphus And yes B, cholera);

- viral infections (hepatitis A, poliomyelitis, adeno-, a company - and enteroviral infections);
- bakterialny zoonotic infections (tularemia, leptospirosis); □protozoyny infections (the diseases caused by the protozoa characteristic of hot climate: amoebic dysentery, balanthidiasis and lambliasis);
- helminthic invasions (geo-and biohelminthoses).

Water epidemics have a number of the characteristics distinguishing them from flashes of epidemics of other origin:

- suddenness;
- mass character;
- existence of the general water source;
- the babies who are raised maternal milk are not ill;
- low lethality;
- the easy course of diseases, bystry recession of number of the relevant anti-epidemic activities which ached after acceptance;
- existence of "a contact tail" owing to cases of household infection with a contact way.

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The noninfectious diseases connected with a chemical soyostav of water Chemical composition of natural waters depends on a viyod of a water source, structure of water-bearing breeds in this mestyonost and on economic activity.

Diseases of the person can be caused by a shortcoming or excess of some salts which are contained in water and also presence of toxic connections.

Rigidity salts (calcium and magnesium). It is established that vvyosoky hardness of water in some territories can play an etiological role in emergence of an urolithiasis as local disease.

It is suggested that low hardness of water moyozht to promote development of cardiovascular diseases.

The standard of the general rigidity - 7 mmol/l

Nitrogen salts (nitrates and nitrites). The increased content of these salts in water promotes a metgemoglobinoobrazovaniye. The toxic hypoxia is caused by formation of a methemoglobin and a partial inactivation of oxyhemoglobin that causes decrease in delivery of oxygen to fabrics, interfering normal oxidizing processes in an oryoganizm. The methemoglobinemia develops (toxic цианоз). This

type of pathology first of all strikes the babies raised by milk mixes if for their prigotovleyoniya water with the increased content of nitrates is used.

Besides, nitrates and nitrites in an organism can vzaimoyodeystvovat with aliphatic and aromatic amines, form the nitrosamines which are active carcinogens.

The standard of nitrates - 45 mg/l

Fluorine. The lack of fluorine of water promotes development of a kayoriyes of teeth. Povyvoshenny intake of fluorine with water causes a fluorosis, there are spots and an erosion of an adamantine substance of tooth, their erasability and fragility increase.

The standard of fluorine - 0,5-1,5 mg/l

Salts of iron meet usually in the form of bicarbonate protoxide. The high content of iron spoils taste of water, gives it an unpleasant smell and reduces transparency. Water with high content of iron forms rusty spots on linen (when washing), on faience wash basins, bathtubs and harms water pipes (narrows their gleam).

Strontium. At the increased content of strontium and low level of calcium Kashin-Beck's disease ("strontic rickets") which is expressed in disturbance of processes of an osteogenesis, a growth inhibition of bones of a hip and shin, by a necrosis of a joint cartilage and the general deformation of a skeleton develops.

Iodine. The lowered content of iodine in external environment promotes development of a local goitrous disease.

Salts of heavy metals. Their presence at water as правило, it is caused by the technogenic and anthropogenous reasons. Lead salts, cadmium, mercury, chrome, etc. vvyozvyvat acute (up to lethal) and chronic an otravleyoniya of the population using the contaminated water.

As receipt indicator in water of organic pollution increase in maintenance of hloyorid, ammonia, nitrates, nitrites and oxidability can serve.

Ammonia is an initial product of decomposition organicheyosky nitrogen-containing (including proteinaceous) substances. Existence it more than 0,1 mg/l demonstrates fresh pollution by organic matters. Therefore its existence in water in many cases is regarded as a pokazayotel of dangerous water pollution in the epidemic relation.

Salts of nitrous acid (nitrites) represent proyodukta of oxidation of ammonia under the influence of microorganisms in a nitrification proyotsessa. Contents them in water indicates more than 0,002 mg/l the known prescription of pollution of water by organic nitrogen-containing products.

Salts of nitric acid (nitrates) - end products of a miyonerализation of organic nitrogen-containing matters. Presence at water of nitrates without ammonia and nitrites ukazyvayot on completion of process of a mineralization, on old pollution. Simultaneous content in water of ammonia, nitrites and nityorat testifies to incompleteness of this process.

Chlorides in water of water sources are indicators of household pollution. Increase in chlorides in comparison with contents, usual for this vodoyoistochnik, demonstrates dangerous pollution of water waste products of the person (excrements, moyochy). At the same time concentration of chlorides (norm of 350 mg/l) has a principal value.

Oxidability of water is characterized by the number of milligrams of the oxygen which went for chemical oxidation of the organic matters which are contained in 1 l of water. Increase in oxidability demonstrates possible pollution of water (N no more than 5 mg/l).

Table

Criteria of harmlessness of drinking water on chemical composition the Generalized indicators

Hydrogen indicator in limits 6-9ed. pH

General mineralization (dry rest)..... 1000 mg/l

Rigidity is the general 7,0 mmol/l

Inorganic matters (mg/l)

Aluminum 0,5

Barium 0,1

Beryllium 0,0002

Boron (totally) 0,5

Iron (totally) 0,3

Cadmium (totally) 0,001

Manganese (totally) 0,1

Copper (totally) 1,0

Molybdenum (totally) 0,25

Arsenic (totally) 0,05

Nickel (totally) 0,1

Nitrates (on NO₃) 45,0

Mercury (totally) 0,0005

Lead (totally) 0,03

Selenium (totally) 0,01

Strontium	7,0
Sulfates	500,0
Fluorides	1,2-1,5
Chlorides	350,0
Chrome	0,05
Cyanides	0,035
Zinc	5,0
Oxidability permanganate	... .. 5,0 mg/l
Oil products (totally).	... .. 0,1 mg/l
Surfactants (S)	... .. 0,5 mg/l
Phenolic index	... .. 0,25 mg/l
Organic matters, mg/l	
Y-GHTsG (lindane)	0,002
DDT (sum of isomers)	0,002
2,4-D (2,4-dichlorophenoxyacetic acid)	...0,03
The substances arriving and which are formed in drinking water in the course of its processing,	
mg/l	
Chlorine (residual free)	0,3 - 0,5
Chlorine (residual connected)	0,8-1,2
Chloroform (at water chlorination)	..... 0,2
Ozone (residual)	... .. 0,3
Formaldehyde (at water ozonization)	... .. 0,05
Polyacrylamide	..... 2,0
The activated silicic acid (on Si)	.... 10,0
Polyphosphates (on PO ₄)...	... .. 3,5
Criteria of radiation safety, Bq/l	
The general α - radioactivity	0,1
The general β - radioactivity	1,0
Optimum water temperature 7 - 12°C	

Organoleptic properties of drinking water have to conform to the following requirements:

Table	
Criteria of favorable organoleptic properties	
Smell	2 points
Smack	2 points
Chromaticity	20th hail.
Turbidity	1,5 mg/l

Water pollution by industrial and household drains leads to a poyoyavleniye of a smell of oil products, phenols and chlorphenols. Excess of chlorine in a voyoda can be determined by a smell.

Definition of a smell

In a flask measure 100 cm³ of ispytuyemy water. The neck of a flask is zakryovat hour glass and warmed up on the water bath. Flask contents are mixed several times. Shifting glass aside, quickly determine character and intensity of a smell by a pyayotiballny scale.

Taste definition

Make only in full confidence of safety of water (lack of toxic agents and bacterial pollution), otherwise opyoredelyat taste after boiling and cooling of water.

Ispytuyemy water is gathered in a mouth in the small portions (10 ml), without swallowing, zayoderzhivat 3-5 pages. Intensity of taste and smack determine by a five-point scale. It is accepted to distinguish four types of taste of water: bitter, salty, acid and sweet. Other (less important) flavoring feelings nazyyovat smacks: marsh, knitting, etc.

Chromaticity definition

Qualitatively color of water is defined, comparing the filtered issleyoduyemy water poured in the colourless cylinder in number of not less than 40 ml to the same volume of the distilled water in other cylinder over white bumayogy. Water is characterized so: colourless, light yellow, dark yellow, brown, etc.

Quantitatively color is defined by comparison with a scale of standard solutions (standards) and expressed in conditional degrees.

Solution of situational tasks

SANITARY AND HYGIENIC ASSESSMENT OF WATER

Example of the solution of a situational task

Criteria for evaluation of quality of water		Requirements to quality of drinking water
Water analysis:		
Chromaticity, a hail	35°	20°
Water temperature at a fence , °C	17°	7-12°
the Deposit	amorf.bury	absence
the Turbidity, mg/l	2,2	1,5
Began to smell at 20 C, points	musty 4	2
Smack at 20, points	Solon. 3	2
Dry rest, mg/l	720	1000
the Chlorides, mg/l	470	350
Sulphates, mg/l	610	500
Iron, mg/l	1,2	0,3
Rigidity the general, mol/l	6,5	7,0
Ammonium salts, mg/l	2,1	absence
Nitrites, mg/l	0,8	absence
Nitrates, mg/l (on NO3)	70	45
Oxidability, mg/l Fluorine, mg/l	6,7	50
Ftor, мг/л	1,3	0,5-1,5
Thermotolerant coliform bacteria in 100 ml	3,0	absence
Total microbic number in 1 ml	130	no more 50
Disputes of Sulfitredutsiryuyushchy clostridium in 20 ml	2,0	absence
General α-radioactivity, Bq/l	0,17	0,1

- To compare indicators of quality of water to hygienic standards.
- What sanitarno - chemical indicators demonstrate water pollution by organic compounds?
Direct - microbiological and parasitological indicators.
Indirect - oxidability, a nitrogen triad, sulfates and chlorides.
- Presumably, from what source water is taken?
From a superficial source subject to continuous anthropogenous pollution.

The control training tests

- Detection at the same time of ammonia, nitrites and nitrates in water is an indicator:
 - blossomings;
 - rigidity;
 - continuous and long fecal pollution;
 - old fecal pollution;
 - fresh fecal pollution.
- Water has to be drinking quality in water supply system points:
 - before receipt in distribution network;
 - before receipt in distribution network and in places of water analysis;
 - before receipt in distribution network, in places of water analysis and in places of a water intake
 - in places of a water intake
- When rationing content of chemicals in drinking water the account the climatic area it is carried out:
 - for fluorine
 - for fluorine and arsenic

- c) for fluorine, arsenic, lead
 - d) for all chemicals normalized in drinking water
4. The infection caused by protozoa and extending water in the way:
- a) lambliasis
 - b) cholera
 - c) hepatitis A
 - d) typhoid
 - e) epidemic parotitis
5. Hygienic requirements to chemical composition of drinking water extend to substances:
- a) natural origin
 - b) a natural origin and the reagents applied to water processing
 - c) anthropogenous origin
 - d) a natural origin, the reagents applied to water processing anthropogenous pollutants of water of a source
6. Treat organoleptic properties of water:
- a) smell, smack
 - b) smell, smack, chromaticity
 - c) smell, smack, chromaticity, turbidity
 - d) smell, smack, chromaticity, turbidity, rigidity
7. The size 1 of a ZSO belt of an underground source of water supply depends:
- a) from degree of security of a source
 - b) from degree of security and a water profuseness
 - c) from degree of security and size of water selection
 - d) from degree of security, a water profuseness and size of water selection
8. Mineral composition of water can be the main reason:
- a) water fever
 - b) convulsive disease
 - c) fluorosis
 - d) local crow
 - e) caries
9. Features of salt composition of water are risk factors on:
- a) dysentery
 - b) to diabetes
 - c) urolithiasis
 - d) to hepatitis A
10. Drinking water has to:
- a) to have favorable organoleptic properties
 - b) not to contain salts
 - c) to be harmless on chemical composition
 - d) to be safe in the epidemic relation
 - e) to be safe in the radiation relation