TO THE DEVELOPMENT OF A REGULATORY DOCUMENT ON THE QUALITY OF DRINKING WATER UNDER CONDITION OF MARTIAL LAW

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The purpose of the research was to scientifically substantiate the conceptual approaches to the development of normative document on drinking water quality in order to prevent morbidity and mortality in martial law during armed aggression in Ukraine and other emergencies.

Materials and methods: descriptive, sanitary-chemical, normative-search, comparative analysis, expert assessments have been used. The paper analyzes the results of observations of efficiency and monitoring of water quality from water supply stations of Ukraine before and after the war, and compare assessment of the main provisions of regulations on drinking water quality of some countries, including those used in emergencies.

Results. The research established that in wartime centralized drinking water supply companies are burdened by problems due to unguaranteed quality of source water, lack of stable conditions for the technological process of water treatment, operation or destruction of water treatment plants and networks etc. Current standards in Ukraine (DSanPiN 2.2.4-171-10 "Hygienic requirements for drinking water intended for human consumption") during martial law require significant changes: supplementation of safety and quality indicators due to the new risks of drinking water pollution; exclusion of certain safety and quality indicators at the expense of non-priority ones; establishment of temporary hygienic standards for tap water and water dispensing points and the procedure for their use; adjusting the frequency of production control of potable water; implementation preventive measures to reduce morbidity and mortality. Today the project of "DSanPIN "Safety indicators and some particular indicators of potable water quality during martial law and emergencies of another nature" (hereinafter - DSanPIN) has been scientifically substantiated and developed. According to the draft of this document, the quality of drinking water in terms of epidemic and radiation safety must meet the requirements of DSanPIN 2.2.4-171: in terms of physicochemical - see requirements of DSanPin. The requirements of DSanPIN after their state registration will be applied during martial law and during emergencies of other nature in a particular area for a specified period as short as possible by the relevant regional or local commission for technogeneous environmental safety and emergencies.

Conclusions. It is established that during the military emergency situation in Ukraine the current DSanPin 2.2.4-171-10 "Hygienic requirements for potable water intended for human consumption" require significant changes in order to: supplement safety indicators due to the emergence of new risks of drinking water pollution; exclude certain indicators of safety and quality due to non-priority; establish temporary hygienic standards for potable tap water and bottling points in personal containers of consumers and the procedure for their use; adjust the frequency of production control of potable water quality; implement other preventive measures to reduce morbidity and mortality. Nowadays the draft DSanPIN "Safety indicators and some indicators of potable water quality in martial law and emergencies of other nature" is scientifically substantiated and developed, and it was submitted to the Ministry of Justice of Ukraine for state registration.

Key words: DSanPin, potable water, water supply stations, dispensing points

Introduction. Now, Ukraine has an extremely difficult military situation, which violates the normal conditions for the existence of ecosystems. War has a significant impact on the environment, but the signs and scales of these effects depend on the remoteness of hostilities and the development of countries at war [1]. Environmentalists describe the situation in Ukraine as "ecocide" and they are trying to open an international criminal case against Russia for destroying the environment, which has been already caused by its armed forces. As of May 11, 2022, 231 environmental crimes of the Russian Federation have already been documented on the territory of Ukraine and in the Black Sea. Most cases of ecocide were detected in Kyiv region - 34, Donetsk region - 27 and Dnipropetrovsk region - 22 [2]. Incidents are far-reaching and affect the air, soil and water quality [3]. The use of banned incendiary munitions with white phosphorus by Russian troops, fuel spills, pollution from destroyed military equipment and weapons, as well as unsystematic burial of the dead, burning of forests and fallows – all
this contaminate the soil and groundwater with chemicals, biological agents, heavy metals, and separate pollutions will remain a priority for a long time [4]. In some settlements of Ukraine due to this, as well as the destruction of centralized potable water supply by Russian troops, tap water is either completely unavailable or its quality does not meet hygienic requirements, which is a factor in morbidity and mortality.

Access to water is an internationally recognized human right [5]. The right to water provides everyone with sufficient, safe, acceptable and physically accessible water for personal and domestic use. Member countries of the International Covenant on Economic, Social and Cultural Rights have committed themselves to guaranteeing the right to water in armed conflict [6]. This commitment includes the protection of facilities necessary for the survival of the civilian population, including infrastructure and potable water supplies, and the provision of civilians, internees, prisoners and returnees with access to water of adequate quality. According to international rules, the obligation to ensure the right to water requires that states must refrain from interfering with the realization of the right to water, including limitation or destroying access to water supply and infrastructure services. The destruction of water supply infrastructure in armed conflict that could violate international humanitarian law is an example of directly restricting access to water or sanitation and violating of the obligation to respect the right to water and sanitation.

Due to insufficient purification and disinfection, water can lead to bacterial, viral and parasitic diseases such as cholera, shigellosis, typhoid fever, paratyphoid fever, hepatitis, gastroenteritis, amoebic dysentery, giardiasis, etc. [7]. Lack of potable water in sufficient quantities can provoke dehydration. The rate of drinking water consumption depends on climate conditions, diseases, age and physical activity. Loss of 20% of water leads to fatal consequences [8].

In case of intensive chemical, biological or radioactive pollution, the use of drinking water should be prohibited, even for domestic purposes. However, if the physiochemical parameters do not significantly exceed the hygienic standards, then human consumption of such water is temporarily allowed in all countries of the world under certain conditions [3, 9]. This is explained by the fact that hygienic standards for such indicators are set "with a margin", and standards for "indicator" indicators are set based on the acceptability of potable water by consumers and taking into account other environmental and technological criteria, such as natural water quality, no corrosion, etc. [10]. In particular, Directive 2020/2184/EU [9] states that standards for indicators are developed using the precautionary principle to ensure safe potable water consumption of appropriate quality throughout life, thus ensuring a high level of health care.

Since 2011, the current legislation of Ukraine (unlike European) does not provide the possibility of adopting temporary hygienic standards for the quality of potable water [11]. Therefore, in case of inadequate quality of tap water in accordance with the requirements of DSanPiN 2.2.4-171-10 centralized drinking water supply in Ukraine should be stopped. This cannot be allowed, especially during martial law, because it will worsen the sanitary and epidemiological situation in the country. According to Directive 2020/2184/EU [9], the risks to human health that may be caused by disruptions in the supply of tap water and the temporary consumption of substandard drinking water should be adequately addressed.

Thus, today in the conditions of martial law during the armed aggression on the territory of Ukraine, relevant scientific justification of preventive measures in the field of potable water supply in order to prevent morbidity and mortality, including the establishment of temporary hygienic standards for the quality and usage of potable water is of current importance.

The purpose of the research is scientific substantiation of conceptual approaches for the development of a normative document on potable water quality in order to prevent morbidity and mortality in martial law during armed aggression in Ukraine and other emergencies.

Materials and methods of research. The paper analyzes the results of observations of efficiency and monitoring of water quality from water supply stations of Ukraine before and after the war, comparative assessment of the main provisions of regulations on potable water quality of some countries, including those used in emergencies. Methods: descriptive, sanitary-chemical, normative-search, comparative analysis, expert assessments.

Research results and discussion. In the zone of active hostilities, the organization of potable water supply to the population is a particularly difficult task. The enterprises of centralized potable water supply bear the burden of problems due to the unguaranteed quality of source water, the lack of stable conditions for the
technological process of water treatment, the mode of operation of water treatment facilities and networks etc. In the case of intense chemical, biological and or radioactive contamination, the use of groundwater from protected potable water sources protected from contamination or other alternative sources should be considered. If it is not possible to supply potable water centrally, the population should be provided with imported drinking water of appropriate quality. Adequate adjustment and operation of the water treatment system with special methods (ultrafiltration, reverse osmosis, adsorption, ion exchange, etc.) can allow the production of safe potable water from almost any water source. At the same time, the use of the reverse osmosis method provides water purification from simple salts by ≥ 98%, while from low-molecular-weight organic substances and some inorganic substances (cyanides, etc.) it can be <50%. Therefore, in the case of water pollution by weapons of mass destruction, drinking water cannot be obtained only from the use of reverse osmosis units, in which case activated carbon and/or ion exchange filters should be used, etc. [12].

Potable water must not contain any pathogenic microorganisms, pathogens of parasitic origin and chemicals that, in combination or in the detected concentration, pose a potential danger to human health [9]. In order to ensure potable water of guaranteed quality in 2010 DSanPiN 2.2.4-171-10 "Hygienic requirements for potable water intended for human consumption" was developed and come into force. However, now, in order to implement Directive 98/83 / EU and partly the new Directive 2020/2184/EU on potable water, the National Security and Defense Council has developed a draft of DSanPiN 2.2.4-171-22 "Hygienic requirements for potable water intended for human consumption" (hereinafter - the draft DSanPiN 2.2.4-171-22). However, in the conditions of martial law during the armed aggression on the territory of Ukraine there was a need to develop DSanPiN "Safety indicators and some indicators of potable water quality in martial law and emergencies of other nature" (hereinafter - the draft DSanPiN).

To this purpose the Ministry of Health of Ukraine together with specialists in the field of potable water supply has developed a draft DSanPiN. This document states that its requirements must be applied in martial law and during emergencies of a different nature in a particular area for a specified period as short as possible by the relevant regional or local commission on technogeneous environmental safety and emergencies. The draft DSanPiN contains requirements for tap potable water and potable water from bottling points. The quality of potable water according to the indicators of epidemic and radiation safety must meet the requirements of DSanPiN 2.2.4-171, according to other indicators - the draft DSanPiN (Table 1).

Table 1

Comparative table of indicators of safety and quality of potable water and their standards

| №  | Indicator | Unit | Draft DSanPiN 2.2.4-171-22 | Criterion of significant deteriorati on | Draft DSanPiN | WHO recomm endations | Comment |
|----|-----------|------|----------------------------|------------------------------------------|--------------|----------------------|---------|
| 1  | Aluminum ** | mg/l | ≤ 0,2-0,5                  | 5,0                                 | ≤ 0,5       | ≤ 0,9                |         |
| 2  | Beryllium * | mg/l | ≤ 0,0002                   | -                                     | -           | -                    |         |
| 3  | Boron **   | mg/l | ≤ 0,5-2,4                  | 5,0                                   | ≤ 2,4       | ≤ 2,4                |         |
| 4  | Cadmium ** | mg/l | ≤ 0,001-0,005              | 0,005                                  | ≤ 0,005     | ≤ 0,003              |         |
| 5  | Cobalt **  | mg/l | ≤ 0,1                      | 1,0                                    | -           | -                    |         |
| 6  | Arsenic ** | mg/l | ≤ 0,01                     | 0,25                                   | ≤ 0,01      | ≤ 0,01               | according to the NATO document - 0,02 mg/l in case of consumption for no longer than 30 days |
| 7  | Molybdenum | mg/l | ≤ 0,07                     | 0,5                                    | -           | -                    |         |
|   | Parameter                  | Unit | Value Range          |
|---|----------------------------|------|----------------------|
| 8 | Sodium                     | mg/l | ≤ 200                |
| 9 | Nickel                     | mg/l | ≤ 0.02               |
| 10| Nitrates (for NO₃)         | mg/l | ≤ 50                 |
| 11| Nitrites ** (for wells – 3,3) | mg/l | ≤ 0.5                |
| 12| Mercury*                   | mg/l | ≤ 0.0005 - 0.001     |
| 13| Lead**                     | mg/l | ≤ 0.01               |
| 14| Selenium **                | mg/l | ≤ 0.01               |
| 15| Strontium**                | mg/l | ≤ 7.0                |
| 16| Antimony**                 | mg/l | ≤ 0.005              |
| 17| Fluorides **               | mg/l | ≤ 0.7                |
| 18| Chlorates                  | mg/l | ≤ 0.7                |
| 19| Chlorites                  | mg/l | ≤ 0.7                |
| 20| Chrome                     | mg/l | ≤ 0.05               |
| 21| Cyanides (total number of all their forms) ** | mg/l | ≤ 0.05               |
| 22| Benz(a)pyrene              | µg/l | ≤ 0.005 - 0.01       |
| 23| Benzene**                  | µg/l | ≤ 1.0                |
| 24| 1,2 - dichloroethane e ** | µg/l | ≤ 3                  |
| 25| Pesticides                 | µg/l | ≤ 0.1                |
| 26| Pesticides (total)         | µg/l | ≤ 0.5                |
| 27| Trihalogen methanes (total) | µg/l | ≤ 100                |
| 28| Chloroform                 | µg/l | ≤ 60                 |

**b) organic components**

|   | Parameter                  | Unit | Value Range          |
|---|----------------------------|------|----------------------|
| 22| Benz(a)pyrene              | µg/l | ≤ 0.005 - 0.01       |
| 23| Benzene**                  | µg/l | ≤ 1.0                |
| 24| 1,2 - dichloroethane e ** | µg/l | ≤ 3                  |
| 25| Pesticides                 | µg/l | ≤ 0.1                |
| 26| Pesticides (total)         | µg/l | ≤ 0.5                |
| 27| Trihalogen methanes (total) | µg/l | ≤ 100                |
| 28| Chloroform                 | µg/l | ≤ 60                 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 29 | Trichloroethylene and tetrachloroethylene (total)** µg/l | ≤ 10 | ≤ 10 | ≤ 10 |

**Physico-chemical parameters**

**a) inorganic components**

| 30 | General rigidity mmol/l | ≤ 7,0-10,0 | 15,0 | 10 |
| 31 | Copper mg/l | ≤ 1,0-2,0 | 3,0 | 2,0 |
| 32 | Solid residue mg/l | ≤ 1000-1500 | 2000 | 1500 |

**Indicators according to Directive 2020/2184 / EU and the draft DSanPiN 2.2.4-171-22**

**Organoleptic indicators**

| 33 | Odor at t 20°C and when heated to 60°C points | ≤ 2 | 4 |
| 34 | Turbidity nephekometric unit of turbidity NUT (1 NUT = 0,58 mg/l) | ≤ 1,0-3,5 ≤ 2,6-3,5- for underground water source (for wells – 3,5) | 4,3 3,5 |
| 35 | Chromaticity degrees | ≤ 20-35 (for wells – 35) | 40 35 |
| 36 | Taste and aftertaste points | ≤ 2 (for wells – 3) | 4 3 |

**Physico-chemical parameters**

| 37 | Ammonium mg/l | ≤ 0,5-2,6 | 2,6 |
| 38 | Hydrogen index pH | ≥ 6,5 and ≤ 9,0 | ≥ 5,0 and ≤ 10,0 | ≥ 6,5 and ≤ 9,0 |
| 39 | Total iron mg/l | ≤ 0,2-1,0 | 3,0 | ≤ 1,0 |
| 40 | Manganese mg/l | ≤ 0,05-0,5 | 1,0 | ≤ 0,5 | ≤ 0,4 |
| 41 | Sulfates mg/l | ≤ 250-500 | - | ≤ 500 |
| 42 | Chlorides mg/l | ≤ 250-350 | - | ≤ 350 |
In potable water are determined:
1,2-dichloroethane, tetrachloroethylene and trichloroethylene, trihalomethanes - in tap potable water from surface water sources. Disinfection of drinking water and control of residual concentrations of introduced reagents is carried out in accordance with DSanPiN 2.2.4-171. * Substances of hazard class I. ** Substances of hazard class II.

Comments

1. Chlorates and chlorites are determined in potable water if chlorine dioxide is used for its disinfection. It is necessary to aspire after lower levels of chlorates and chlorites in potable water used without compromising disinfection where possible.

2. Pesticides include organic insecticides, organic herbicides, organic fungicides, organic nematicides, organic acaricides, organic algacides, organic rodenticides, organic slimicides, related products (including growth regulators) and their metabolites, reaction and decomposition products. The list of pesticides which are determined in drinking water are established on a case-by-case basis and must include only those pesticides that may be present in the source of potable water.

3. The standard ≤ 0.10 µg/l is set for each individual pesticide. If aldrin, dieldrin, heptachloride and heptachlor epoxide are present in the water source, their content in potable water should be ≤ 0.03 µg/l for each of these substances.

4. The amount of pesticides is defined as the sum of the concentrations of each individual pesticide.

5. The sum of trihalomethanes is defined as the sum of the concentrations of chloroform, bromoform, dibromochloromethane and bromodichloromethane.

6. Chemical oxygen demand is determined in potable water from surface water sources.

According to Table 1, the draft DSanPiN for safety and quality of potable water standards specifies standards that correspond to their maximum levels in the draft DSanPiN 2.2.4-171-22 for tap potable water (Directive 2020/2184/EU [6]), as well as for potable water from wells and capping wells, which proves the safety of such concentrations for humans. For determining the list of safety and quality indicators of potable water were guided by the current list of DSanPiN 2.2.4-171-10 without indicators that due to certain factors are not a priority in Ukraine and are absent in Directive 98/83/EU on water intended for consumption man. New indicators of safety and quality of potable water appeared in the draft DDSanPiN - COD is determined simultaneously with permanganate oxidizability in potable water which is produced from a surface source of drinking water supply, as well as in case of use of weapons of mass or destruction and the following contamination - relevant contaminated water or biological agents by appropriate means of exploration and control (water test kit, military chemical reconnaissance kit, indicator complex for water analysis according to the Colilert method, etc.).

The main chemicals that are part of chemical weapons and can be found in potable water are yperite, lewisite (arsenic derivative), hydrogen cyanide, organophosphorus poisons (sarin), mycotoxin T-2 etc. The degree and nature of contamination of water with toxic substances depends on their properties, method of infection, the size of the water source and the speed of water flow in it. The duration of water contamination depends on the properties and concentration of toxic poisons, the size of the reservoir, the speed of flow and composition of water, weather conditions, as well as the amount of sorption of toxic substances by the bottom of the reservoir and plants.

Toxic substances such as soman and V-gases dissolve quickly in water without changing its smell, color; their hydrolysis in water is slow, especially V-gases. Toxic substances such as yperite do not dissolve in water, and when they enter the reservoir they settle to the bottom, leaving an oily film on the surface; in the presence of yperite above 4 mg/l water acquires a distinct odor of toxic substances. Arsenic compounds, hydrocyanic acid, various alkaloids (strychnine, aconitine, etc.), and heavy metal salts can also be used to contaminate water. Open water sources are practically not infected with vapors of toxic substances.
The document specifies the content of relevant substances and biological agents and minimum frequency of production control of the quality of potable water. It is noted that to ensure control of safety and quality of potable water in case of application of DSanPiN, the enterprise of potable water supply develops a temporary program of industrial control of safety and quality of drinking water, which is developed in accordance with DSanPiN 2.2.4-171 and requirements of DSanPiN. The order of actions in the case when the safety and quality of drinking water on some indicators does not meet the hygienic standards specified in the draft DSanPiN was stated.

During martial law, potable water supply companies should be recommended to have: a larger supply of reagents and backfill; backup power sources; means for connecting pumps to mobile power plants; means for preparation of potable water by special methods; filling of mobile tanks (tank trucks) and bottling of potable water in consumers' containers; means for liquidation of consequences of infection (pollution) of territories, constructions and equipment; personnel protection facilities and personal protective equipment. The aforesaid measures will contribute to more efficient operation of drinking water supply companies in today's conditions.

Conclusions

1. It is established that during the military emergency situation in Ukraine the current DSanPiN 2.2.4-171-10 "Hygienic requirements for potable water intended for human consumption" require significant changes in order to:
   - supplement safety indicators due to the emergence of new risks of drinking water pollution;
   - exclude certain indicators of safety and quality due to non-priority;
   - establish temporary hygienic standards for potable tap water and bottling points in personal containers of consumers and the procedure for their use;
   - adjust the frequency of production control of potable water quality;
   - implement other preventive measures to reduce morbidity and mortality.

2. Nowadays the draft DSanPiN "Safety indicators and some indicators of potable water quality in martial law and emergencies of other nature" is scientifically substantiated and developed, and it was submitted to the Ministry of Justice of Ukraine for state registration.

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Метою роботи було наукове обґрунтування концептуальних підходів до розробки нормативного документу з якості питної від вододопостачання за умов воєнного стану при збройній агресії на території України та надзвичайної ситуації іншого характеру.

Результати. За результатами досліджень встановлено, що в умовах військового часу на підприємства централізованого питного водопостачання лягає тягар проблем через негарантовану якість вихідної води, відсутність стабільних умов проведення технологічного процесу водоподготовки, режиму експлуатації або руйнування вододріжних очисних споруд та мереж тощо. Чинні в Україні ДСанПіН 2.2.4-171-10 «Гігієнічні вимоги до води питної, призначеної для споживання людиною» потребують внесення суттєвих змін з метою: доповнення показників безпечної та якості через виникнення нових ризиків забруднення питної води; включення окремих показників безпечної та якості за рахунок неприоритетних; встановлення тимчасових гігієнічних нормативів для питної води водопровідної та з пунктів розливу у особисту тару споживачів та порядку їх використання; корегування періодичної проведення виробничого контролю якості питної води; впровадження інших превентивних заходів для зменшення захворюваності та смертності населення.

Висновки. Встановлено, що під час надзвичайної ситуації військового характеру в Україні чинні ДСанПіН 2.2.4-171-10 «Гігієнічні вимоги до води питної, призначеної для споживання населенням» потребують внесення суттєвих змін з метою: доповнення показників безпечної та якості через виникнення нових ризиків забруднення питної води; включення окремих показників безпечної та якості за рахунок неприоритетних; встановлення тимчасових гігієнічних нормативів для питної води водопровідної та з пунктів розливу у особисту тару споживачів та порядку їх використання; корегування періодичної проведення виробничого контролю якості питної води; впровадження інших превентивних заходів для зменшення захворюваності та смертності населення. На сьогодні науково обґрунтовано та розроблено проект ДСанПіН «Показники безпечної та окремі показники якості питної води в умовах воєнного стану та надзвичайних ситуаціях іншого характеру», що знаходиться в Міністерстві юстиції України на державній реєстрації.

Ключові слова: ДСанПіН, питна вода, водопровідні станції, пункти розливу.

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