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The study of microbial contamination of water and sanitary facilities in the Karaganda regional clinical hospital during different seasons

In modern conditions, the quality of water supply and the state of water management facilities play a key role in maintaining the health of people and animals, as well as the life quality of the population. In this regard, we set the goal of our research to assess the level of microbial contamination of water and sanitary facilities in the Regional Clinical Hospital of Karaganda district as the central and most powerful medical institution in the region in different seasons of the year. Based on the results of our study, the following conclusions can be drawn: during the research period, seasonal variability of indicators in the studied samples of tap water can be traced. The water of the central water supply is characterized by systematic excesses of both total coliform and thermotolerant coliform bacteria. In the city of Karaganda, there is a great stability in the quality of water supply, regardless of the seasons, despite the excess of standard indicators. It can talk about either the low quality of water treatment, or about quality problems in the water supply network at the sampling points (Regional Clinical Hospital of Karaganda). At the same time, it is worth noting the high percentage (almost 98 %) of positive samples in the spring. In winter, there is a lower percentage of positive samples and a significantly lower microbial quantity. The quality of drinking water decreases in the spring, we believe that the most likely reason for the deterioration in the quality of drinking water is the ingress of melt water and rainwater into the source. Violations of the technological conditions for the operation of water treatment facilities, secondary water pollution in worn-out water distribution networks could also be the cause of unsatisfactory results. In the Regional Clinical Hospital of Karaganda, a higher percentage of positive swabs is noted, which is associated with a higher load on the regional hospital, as well as a better supply of antimicrobial disinfectants, which leads to selective selection of more resistant strains.

Keywords: tap water, microbiology, general coliform bacteria, thermotolerant coliform bacteria, swabbing.

Introduction

Drinking water is one of the main environmental factors that can have both a positive and a negative impact on the health of the population, and providing the population with high-quality drinking water is one of the most important factors in protecting health.

Water is one of the main factors in the spread of infectious diseases. The water way of transmission is typical for cholera, typhoid fever, dysentery, leptospirosis, tularemia, infectious hepatitis, adenovirus infections and helminthiases. The cause of morbidity in about 40 % of the population is microbiological contamination of water [1–3].

Drinking water transported through distribution networks will be subject to both chemical and microbiological quality changes. Contamination of drinking water, especially fecal contamination, is a major public health problem.

Exposure to unsafe drinking water can occur in domestic (home) and non-domestic settings, such as healthcare facilities (HCF) [4].

Sanitary and bacteriological control in medical facilities is the creation and maintenance of safe conditions for the treatment and diagnostic process for both patients and medical personnel. Safety is also important, especially in settings with vulnerable populations such as immunocompromised patients in healthcare settings [5].

According to the WHO, drinking water is water that does not pose a risk to health during the entire time it is consumed. The safety criterion is compliance with the requirements of state regulations [6].

The quality of water in water bodies, drinking water in centralized water supply systems is regulated by the requirements set forth in the sanitary rules: "Sanitary and epidemiological requirements for water sources, places of water intake for domestic and drinking purposes, domestic and drinking water supply and places of cultural and domestic water use and safety of water bodies" Order of the Minister of National Economy of the Republic of Kazakhstan dated March 16, 2015 No. 209. Registered with the Ministry of Justice of the Republic of Kazakhstan on April 22, 2015 No. 10774 [7].

Sanitary and bacteriological monitoring is an important criterion for surveillance in addressing water issues. Drinking water must comply with the regulated indicators for microbiological characteristics at all stages of water supply to the consumer [8–13]. Therefore, the actual task of water treatment in providing the population with drinking water is to guarantee its safety in terms of epidemics.

The purpose of our study is to assess the level of microbial contamination of water and sanitary facilities in the Regional Clinical Hospital of Karaganda district in different seasons of the year.

Experimental

In the regional clinical hospital of Karaganda in the spring-summer and autumn-winter periods, samples of tap water and swabs from environmental objects were taken in the following objects (Tab. 1).

Table 1

Number of water sampling and washings from environmental objects

Regional Clinical Hospital of Karaganda (therapeutic and surgical building).	
Autumn-winter period	*Spring-summer period*
22 water samples and 50 swabs from environmental objects.	25 water samples and 38 swabs from environmental objects.

Water sampling was carried out in accordance with the requirements of "Sanitary and epidemiological requirements for water sources, places of water intake for domestic and drinking purposes, domestic and drinking water supply and places of cultural and domestic water use and safety of water bodies", Order of the Minister of National Economy of the Republic of Kazakhstan dated March 16, 2015 Year No. 209. Registered with the Ministry of Justice of the Republic of Kazakhstan on April 22, 2015 No. 10774" [14, 15].

When taking samples of water from taps, they were first burned with a flame of a burning cotton swab moistened with alcohol, then they were completely opened and the water was drained for 10 minutes. Water was poured into sterile glass bottles (500 ml) in a sterile manner, without wetting the neck to prevent soaking of the cork.

All water samples and washings taken for the study were numbered, and the accompanying document was filled out. A cooler bag (Thermo-Kont MK, Russia) was used to transport the test samples. The studies were carried out on the day of selection [16, 17].

The selected water samples were examined for microbiological parameters: total microbial number, total coliform bacteria, thermotolerant coliform bacteria [18–22].

The membrane filtration method [23, 24] was used to study water; the method is modern, accurate, and provides quantitative and reproducible detection of contamination traces. The principle of the method is based on filtering a certain volume of water through a membrane that traps bacteria. The membrane is then incubated on an appropriate selective medium, which allows it to multiply and form colonies.

A single-funnel microbiological control system for membrane filtration manufactured by Sartorius was used in the work, using a filtration system for cellulose nitrate filters with a pore size of 0.45 nm and substrates with nutrient agar and Endo medium.

Sampling of swabs: sterile cotton swabs were moistened with 10 ml of sterile saline broth using a template to wipe the surface of the objects in the horizontal and vertical directions. After taking samples from the surface, swabs were immediately placed into test tubes with KODA transport medium [25–29].

Washouts from environmental objects and hands of personnel after a day of incubation in broth culture at a temperature of 36±1ºC for 18–24 hours, subculture was carried out on solid nutrient media: Hi Media Salmonella — Shigellachrom Agar, yolk-salt agar, Endo medium.

Results and Discussion

As a result of microbiological inoculation of tap water samples, fluctuations in CFU/ml are observed according to the seasons of the year, which is associated with weather conditions. In the spring period, an increase in CFU/ml is observed, and in winter, a decrease in CFU/ml, the study results are shown in Tables 2, 3.

Table 2

The results of microbiological indicators of the quality of tap water in the regional clinical hospital of Karaganda (therapeutic and surgical building) in the autumn-winter period

№	Water sampling points	MAFAM / (CFU per 1ml)	GCB (CFU per 1ml)	TCB (CFU per 1ml)
		Norm for ND: no more than 50 CFU / ml	Norm according to ND: absence in 100 ml	Norm according to ND: absence in 100 ml
Surgical building				
1	General surgery Small procedural	3	11	0
2	Gynecology	1,6	52	8
3	Gynecology inventory	1,5	83	1
4	Proctology sanitary room	3	21	7
5	Purulent surgery, small procedural	2,3	4	2
6	Urology Small procedural № 1	3	7	6
7	Urology Small procedural № 2	3	7	6
8	Reception area shower	3	5	5
Therapeutic building				
9	Endocrinology treatment room	3	12	12
10	endocrinology service toilet	3	12	5
11	Endocrinology room	3	7	7
12	Nephrology treatment room	3	0	0
13	Nephrology toilet	2,5	50	4
14	Rheumatology toilet	1,6	20	54
15	Neurology inventory	2,4	10	30
16	Neurology procedural	2	5	40
17	Pulmonology inventory	2,5	25	25
18	Pulmonology procedural	2,6	26	24
19	Inventory room X-ray diagnostics	3	12	16
20	X-ray diagnostics treatment room	2,5	30	16
21	Ward № 1	2	3	4
22	Ward № 2	3	10	4

Table 3

Results of microbiological indicators of the quality of tap water in the regional clinical hospital of Karaganda (therapeutic and surgical building) in the spring and summer

№	Water sampling points	MAFAM / (CFU per 1ml)	GCB (CFU per 1ml)	TCB (CFU per 1ml)
		Norm for ND: no more than 50 CFU / ml	Norm according to ND: absence in 100 ml	Norm according to ND: absence in 100 ml
	Surgical Corps			
1	Ward № 2	1	10	0
2	Dynamic Observation Chamber	2	4	2

3	endoscopy toilet	1	20	2
4	Gynecology emergency room	1	22	3
5	Urology	1	28	1
6	Proctology	2	1	0
7	Thoracic department purulent	1	12	0
8	ICU service toilet	1	7	0
9	General surgery sanitary block	1	30	1
10	Food preparation room gynecology	1	9	0
11	Small procedural gynecology	0	0	2
	Therapeutic building			
12	Inventory reception room	1	15	3
13	Toilet for visitors to the polyclinic	1	1	3
14	Rheumatology razdatka	1	1	2
15	Resident Endocrinology	4	12	0
16	Wc endocrinology	2	5	1
17	Inventory rheumatology	4	30	13
18	Rheumatology dispensing	1	6	4
19	Nephrology treatment room	1	1	0
20	Sanitary room left wing	1	15	0
21	Endocrinology inventory	1	0	0
22	Pulmonology razdatka	3	48	1
23	Inventory neurology	1	3	0
24	Food preparation room gastroenterology	1	14	2
25	Electrotherapy cabinet	1	1	0

In the spring-summer and autumn-winter periods in the studied water samples of the regional clinical hospital in Karaganda, the MAFAM indicators do not exceed the standard (Tables 2, 3).

The autumn-winter period, according to the results of GCB, TCB, indicates a significant level of microbial contamination in objects. According to the study, 21 samples did not meet the hygienic standards in terms of the presence of intestinal bacteria (GCB), in this table (Table 2) only one water sample (Neprology — treatment room) corresponds to ND.

Total coliform bacteria (CFU per 100 ml) in 20 samples exceeded, in the sample (Inventory Gynecology) regional clinical hospital in Karaganda reached 83 CFU per 100 ml.

The autumn-winter period was positive in 95.4 % of samples for common coliform bacteria and the average titer was 19.6 CFU per 100 ml, for thermotolerant bacteria 90.9 % of samples, the average titer was 12.5 CFU per 100 ml.

Analysis of the microbial landscape of tap water at the points of sampling of the regional clinical hospital in Karaganda in the spring-summer period of observation showed an excess in terms of total coliform bacteria and TCB, which indicates an indicator of microbial contamination (Table 3).

In terms of total coliform bacteria, the amount less than >10 CFU/100 ml was found in samples No. 2 (Dynamic Observation Ward), No. 6 (Proctology), No. 8 (ICU service toilet), No. for visitors to the polyclinic), No. 14 (Rheumatology food preparation room), No. 16 (San. node endocrinology), No. 18 (Distributing rheumatology), No. 19 (Nephrology treatment room), No. 23 (Inventory neurology). The highest number of total coliform bacteria ranged from 10 to 48 cfu/100 ml.

When evaluating the results, TCB was found in samples No. 2, No. 3, No. 4, No. 5, No. 9, No. 11, No. 12, No. 13, No. 14, No. 16, No. 18, No. 22, No. 24, and their number was from 1 to 3 CFU/100 ml in the water sample.

Thus, the percentage of positive samples according to GCB was 92 %, and the average titer was 11.8 CFU per 100 ml. Thermotolerant coliform bacteria were positive in 56 % of samples, mean titer 2.8. The leading position in terms of the high indicator for the GCB of the test water sample was shown by a sample (distributed pulmonology) 48 CFU/ml, a sample (inventory rheumatology) by TCB 13 CFU/ml.

Thus, unsatisfactory sanitary and bacteriological indicators for GCB and TCB indicate unsanitary conditions and require measures to be taken to eliminate the unfavorable situation in the Regional Clinical Hospital of Karaganda, especially in the spring.

Results of swabs from environmental objects: In winter, conditionally pathogenic microorganisms were detected from the following washings of the Karaganda Regional Clinical Hospital: strains of *Pseudomonas*

aeruginosa in the gynecological department from the tap and toilet bowl, *Acinetobacter baumanii* from the toilet bowl in purulent surgery. The detection of typical nosocomial pathogens *Pseudomonas aeruginosa* and *Acinetobacter baumanii* in swabs is epidemiologically alarming and requires an objective assessment of the situation.

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Thus, in the Regional Clinical Hospital of Karaganda, the presence of microorganisms characteristic of pathogens of nosocomial infections such as *S. aureus*, *Ps. aeruginosa*, *K. variicola* and *A. baumanii*. In large multidisciplinary hospitals, such as the regional clinical hospital, the formation of its own microbiocenosis of a multidisciplinary hospital is natural, but these pathogens are characterized by high risks of the formation of multi- and pan-resistant strains.

Conclusions

During the study period, seasonal variability of indicators in the studied samples of tap water is traced. The water of the central water supply is characterized by systematic excesses of both total coliform and thermotolerant coliform bacteria.

In the city of Karaganda, there is a great stability in the quality of water supply, regardless of the seasons, despite the excess of standard indicators. It can talk about either the low quality of water treatment or about quality problems in the water supply network at the sampling points (Regional Clinical Hospital of Karaganda). At the same time, it is worth noting the high percentage (almost 98 %) of positive samples in the spring. In winter, there are a lower percentage of positive samples and a significantly lower microbial load.

The quality of drinking water decreases in the spring, we believe that the most likely reason for the deterioration in the quality of drinking water is the ingress of melt water and rainwater into the source. Violations of the technological conditions for the operation of water treatment facilities, secondary water pollution in worn-out water distribution networks could also be the cause of unsatisfactory results.

In the Regional Clinical Hospital of Karaganda, a higher percentage of positive swabs is noted, which is associated with a higher load on the regional hospital, as well as a better supply of antimicrobial disinfectants, which leads to selective selection of more resistant strains.

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С.Б. Ахметова, И.А. Беляев, А.О. Омарова, Ж.Т. Амирханова

Жылдың әртүрлі мезгілінде Қарағанды қаласының Облыстық клиникалық ауруханасында судың және санитарлық пайдалану орындарының микробтық ластануын зерттеу

Қазіргі уақытта сумен жабдықтау сапасы және су пайдалану объектілерінің жағдайы адамдар мен жануарлардың денсаулығын, сондай-ақ халықтың өмір сүру сапасын қолдауда басты рөл атқарады. Мақаланың мақсаты — облыстың орталық және ең ауқымды медициналық мекемесі ретінде Қарағанды қаласындағы Облыстық клиникалық ауруханаңың құбыр суы мен санитарлық пайдалану орындарының микробтық ластану деңгейін жылдың әртүрлі мезгілінде бағалау. Зерттеудің нәтижелері бойынша келесідей қорытынды жасауға болады: зерттеу кезеңінде ағын суының зерттелген үлгілеріндегі көрсеткіштердің маусымдық өзгермелілігін байқауға болады. Орталық су құбырының суы жалпы колиформды және термотолерантты таяқша бактерияларының жүйелі түрде асып кетуімен сипатталады. Қарағанды қаласында нормативті көрсеткіштердің асқанына, жыл мезгілдеріне қарамастан сумен қамтамасыз ету сапасында үлкен тұрақтылық байқалады. Бұл суды тазарту сапасының төмендігін немесе сынама алу пункттеріндегі (Қарағанды қ. Облыстық клиникалық ауруханасы) су құбыры желісінің сапасына қатысты мәселелерді көрсетуі мүмкін. Сонымен қатар, көктем кезінде нәтижесі оң сынамалардың жоғары пайызын (шамамен 98 %) атап өткен жөн. Қыста нәтижесі оң сынамалардың пайызы аз және микробтық жүктемесі айтарлықтай төмен. Құбыр суының сапасы көктем мезгілінде төмендейді, сапасының нашарлауының ықтимал себебі — еріген және жаңбыр суының құбыр суы көзіне түсуі деп санаймыз. Су тазарту құрылыстарын пайдалану кезіндегі технологиялық шарттарының бұзылуы, тозған су құбыры желілеріндегі судың екінші ретті ластануы да қанағаттанарлықсыз нәтижелерге себеп болуы мүмкін. Қарағанды қ. Облыстық клиникалық ауруханасында алынған шайындылардың оң нәтижесінің жоғары пайызы байқалады, бұл облыстық маңызы бар ауруханада жүктеменің жоғарлығы, сондай-ақ микробқа қарсы дезинфекциялық құралдармен жақсы жабдықтаумен байланысты, бұл неғұрлым төзімді штамдарды іріктеп алуға әкеледі.

Кілт сөздер: құбыр суы, микробиология, жалпы колиформды бактериялар, термотолерантты колиформды бактериялар, шайынды.

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Изучение микробного загрязнения воды и мест санитарного пользования в Областной клинической больнице г. Караганды в разные сезоны года

В современных условиях качество водоснабжения и состояние объектов водопользования играют ключевую роль в поддержании здоровья людей и животных, а также качества жизни населения. В связи с этим мы поставили целью нашего исследования — оценить уровень микробного загрязнения водопроводной воды и мест санитарного пользования в Областной клинической больнице (ОКБ) г. Караганды, как центрального и наиболее мощного медицинского учреждения области, в разные сезоны года. По результатам нашего исследования можно сделать следующие выводы: в период исследования прослеживается сезонная изменчивость показателей в исследуемых образцах водопроводной воды. Вода центрального водоснабжения характеризуется систематическими превышениями показателей, как общих колиформных, так и термотолерантных колиформных бактерий. В г. Караганде отмечается большая стабильность качества водоснабжения вне зависимости от сезонов, несмотря на превышение нормативных показателей. Можно говорить о либо низком качестве водоподготовки, либо о качественных проблемах на водопроводной сети в точках отбора (ОКБ г. Караганды). При этом стоит отметить высокий процент (почти 98 %) положительных проб в весенний период. В зимний период отмечается меньший процент положительных проб и значительно более низкая микробная нагрузка. Качество водопроводной воды снижается весной, мы считаем, что наиболее вероятная причина ухудшения качества воды — попадание в источник талых вод и стоков дождевой воды. Нарушения технологических условий эксплуатации сооружений водоподготовки, вторичное загрязнение воды в изношенных водоразводящих сетях также могут явиться причиной неудовлетворительных результатов. В Областной клинической больнице г. Караганды отмечается более высокий процент положительных смывов, что связывается с более высокой нагрузкой на стационар областного значения, а также более лучшем обеспечении антимикробными препаратами дезинфектантами, что приводит к избирательной селекции более устойчивых штаммов.

Ключевые слова: водопроводная вода, микробиология, общие колиформные бактерии, термотолерантные колиформные бактерии, смывы.

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