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TO THE ANNIVERSARY OF GREAT VICTORY К ГОДОВЩИНЕ ВЕЛИКОЙ ПОБЕДЫ

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HISTORICAL EXPERIENCE OF THE USSR LOCAL AIR DEFENCE SERVICE ACTIVITIES DURING THE GREAT PATRIOTIC WAR, 1941-1945

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Abstract. The aim of the study is to reconstruct the main stages of formation and development of medical and sanitary service of the USSR local air defense, to generalize the experience and to analyze the contribution of medical and sanitary service of the USSR local air defense to organization and rendering of medical aid in the Soviet rear during the Great Patriotic War.

Materials and research methods. The sources for the study were the documents of the Russian State Military Archives: orders, statistical reports, normative documents etc. Application of problem-chronological method allowed to reveal stages, factors and problems of development of the medical and sanitary service of the USSR local air defense of the Ministry of Defense, to reveal changes in its structure, as well as its qualitative and quantitative composition during the stated period.

Research results and their analysis. The research results showed that the period of the Great Patriotic War 1941-1945 was the main stage of formation of the medical and sanitary service of the USSR local air defense as a leading state system of medical and sanitary defense.

Keywords: Great Patriotic War 1941-1945, medical and evacuation support, medical and sanitary service, medical support of the population during the war, rescue detachments, USSR local air defense

Conflict of interest. The authors declare no conflict of interest

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ИСТОРИЧЕСКИЙ ОПЫТ ДЕЯТЕЛЬНОСТИ МЕДИКО-САНИТАРНОЙ СЛУЖБЫ МЕСТНОЙ ПРОТИВОВОЗДУШНОЙ ОБОРОНЫ СССР ВО ВРЕМЯ ВЕЛИКОЙ ОТЕЧЕСТВЕННОЙ ВОЙНЫ 1941–1945 гг.

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Резюме. Цель исследования – научная реконструкция основных этапов становления и развития медико-санитарной службы местной противовоздушной обороны (МСС МПВО) СССР, обобщение опыта деятельности и анализ вклада МСС МПВО в организацию и оказание медицинской помощи в советском тылу в годы Великой Отечественной войны.

Материалы и методы исследования. Источники исследования – документы Российского государственного военного архива: приказы, статистические отчеты, нормативные документы и др. Применение проблемно-хронологического метода позволило выявить этапы, факторы и проблемы развития МСС МПВО, показать изменения в её структуре, качественном и количественном составе в течение указанного периода.

Результаты исследования и их анализ. Анализ результатов исследования показал, что период Великой Отечественной войны 1941–1945 гг. явился главным этапом формирования МСС МПВО как ведущей в мире государственной системы медико-санитарной обороны.

Ключевые слова: аварийно-спасательные отряды, Великая Отечественная война 1941–1945 гг., лечебно-эвакуационное обеспечение, медико-санитарная служба, медицинское обеспечение населения во время военных действий, местная противовоздушная оборона СССР

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Introduction. The First World War, the global scale of which led to huge losses among the civilian population, brought qualitative changes into the nature of military threats. The use of means of mass destruction (chemical weapons, bacteriological weapons, military aviation) necessitated the creation of a medical support system for the population during enemy air, chemical and bacteriological attacks. Although the basic measures for establishment of the new qualitative medical service were carried out before the war, the Great Patriotic War of 1941-1945 became the key milestone. In spite of the great contribution of the medical-sanitary service of the local anti-aircraft defense in the defense of the Soviet rear, the military experience of which was used during the creation of the Disaster Medicine Service of the Russian Ministry of Health, so far its work has not been the object of a special scientific research.

The purpose of the study is a scientific reconstruction of the main stages of formation and development of the medical-sanitary service of the local anti-aircraft defense, generalization of experience and analysis of its contribution to the organization and rendering of specialized medical care in the Soviet rear during the Great Patriotic War.

Materials and research methods. The sources were the documents of the Russian State Military Archives: orders, statistic reports, normative documents, correspondence, unpublished memoirs of the medical-sanitary service of the local anti-aircraft defense members. Application of the problem-chronological method allowed us to reveal stages, factors and problems of the development of the medical-sanitary service of the local anti-aircraft defense, to reveal changes in its structure, qualitative and quantitative composition during this period.

Results of the study and their analysis. Despite the great importance of the medical component of civil defense in the USSR up to 1938 there was no special state service of medical and sanitary protection of the rear. The preparation of the population for medical and sanitary self-defense was carried out by public organizations, mainly — the Union of the Red Cross and Red Crescent and the Society for Assistance to Defense, Aviation and Chemical Construction (Osoviakhim). The organization of sanitary squads and posts which played a significant role in the medical and sanitary defense of the rear during the Great Patriotic War began in 1928 under the aegis of the above mentioned organisations.

According to the Regulation on Anti-aircraft Defense of the Territory of the USSR (1932), medical and sanitary defense, like other areas of rear air defense, was a common task of Soviet society, in the implementation of which "all authorities, organizations, institutions, as well as all citizens of the USSR were to participate". [1]. The only specialized agency stipulated by this Statute was the Airborne Observation, Warning and Communication Service, which was to coordinate the work of public air defense formations.

Medical and sanitary protection of specific air defense facilities was entrusted to local air defense groups, formed on a voluntary basis at the place of work or residence of citizens. Training of these groups was to be carried out outside office hours and without special payment; the leadership was limited to "a minimum cadre of permanent commanding staff"; formed from the Red Army reserve fighters [2]. Lack of funding, lack of the necessary number of personnel and of time to prepare for air defense activities inevitably affected the effectiveness of local air defense groups, some of which existed only in documents.

The stage of sectoral development of the USSR medical-sanitary service of the local anti-aircraft defense refers to the 1930s, when the military-industrial potential buildup and the beginning of German aggression lead to a sharp increase in the threat of a new world war. On the eve of the war, there is an urgent need to organize special services of the local anti-aircraft defense: camouflage; order and security; shelters; transport; water supply and sewerage; commerce and catering; restoration of buildings, roads and bridges. As part of this process, the medical and sanitary defense was also singled out as an independent part of the USSR local air defense system. The training of sanitation squads for the work in the medical-sanitary service of the local anti-aircraft defense and the training of the population in the basics of the anti-chemical protection remained among the duties of the Red Cross and Red Crescent Society and the Osoaviakhim.

In the pre-war years the government of the USSR carried out a number of measures for formation of the management, legislative basis and training system for the personnel of the medical-sanitary service of the local anti-aircraft defense. By virtue of the defense and medical purpose of the new service the management functions of the medical-sanitary service were divided between the two departments. The general management of the medical-sanitary service was carried out by the USSR Peoples' Commissariat of Defense (since 1940 — Peoples' Commissariat of the USSR Internal Affairs) with the Main Administration of the Local Anti-aircraft Defence established in 1940. Scientific and methodological support of medical and sanitary defense was delegated to the USSR People's Commissariat of Health. This principle of dual subordination of the medical-sanitary service repeatedly caused discrepancies between the Main Administration of the Local Air Defense and the People's Commissariat of Public Health of the USSR, which made difficult taking of many organizational decisions during the first years of the medical-sanitary service functioning.

The first experience of the normative-legal regulation of the activities of the medical-sanitary service of the local anti-aircraft defense was the approval in 1938 of the Temporary Statute on the medical-sanitary service of the USSR local air defense in the cities of the Soviet Union (hereinafter — the Temporary Statute). As the name of the document implies, the main purpose of the medical-sani-

tary service was the protection of Soviet cities (administrative and economic centers of the USSR) from massive enemy air attacks. An important place in the activities of the service was taken by organization of counter-chemical protection, which was caused by wide use of chemical weapons in the First World War and by growth of warfare agents production in Germany in the 1930s. Significant drawbacks of the Provisional Statute became obvious to the leadership of the Main Department of the Ministry of Defense in August 1940 during the local anti-aircraft defense exercises in the largest cities of the USSR — Leningrad, Kiev, Baku, Minsk. At the meeting of the People's Commissariat of Health of the USSR, which was held following the exercise, a special commission was created to revise a number of organizational provisions of the Ministry of Defense of the USSR. The exercises revealed the following problems in the organization of the medical-sanitary service of the local anti-aircraft defense:

1. The provision did not provide for the rendering of qualified medical aid to the victims in the foci of destruction, which is the main factor ensuring the rescue of people in emergency situations.

2. The main units, acting in the center of the disaster, had to be the public formations of the medical-sanitary service of the local anti-aircraft defense: sanitary brigades and district medical-sanitary teams, the level of preparation of which, as the exercises showed, was extremely low and did not provide effective medical care to the victims.

3. The lack of a single departmental subordination of the formations — the divisional medical and sanitary teams were led by the head of the district of the local anti-aircraft defense; the sanitary brigades were led by representatives of the Red Cross Society. This led to uncoordinated and chaotic actions of the medical-sanitary service of the local anti-aircraft defense in the foci of destruction.

4. The principle of multistage evacuation, carried over into the Provisional Regulations from the experience of the previous wars, turned out to be a superfluous link in the system of medical aid. Thus, the principle of using a mobile dressing station as a mandatory stage of evacuation of casualties turned out to be inappropriate in the system of urban medical evacuation measures and contradicted the principle of priority defense of defending city-points, declared in the Regulation.

As follows from the report of the Main Directorate of the Ministry of Defense of the USSR, the commission, organized to revise the Regulations, did not start its work in full due to the lack of interest in its activities of the People's Commissariat of Health of the USSR. Only part of the members of the commission, consisting of representatives of the Main Directorate of the Ministry of Defense of the USSR, took part in the development of the draft of the updated Regulations. According to the local anti-aircraft defense the draft of the Provision created by them was not completed in time and was not approved by the People's Commissariat of Health which was a serious mistake under the conditions of the growing military danger.

The Great Patriotic War was a great test for the young system of medical and sanitary defense. Among the aims of fascist Germany were: disorganization of the rear, disturbance of military industry and infrastructure of the USSR. From the first days of the war the USSR medical-sanitary service was put into action, which allowed to avoid panic and mass victims among civilians. The appearance of lesion centers in different parts of the country required rapid approach of the first aid to the locations of the victims.

On the basis of the city public health bodies the network of mobile units of the medical-sanitary service was developed: first-aid stations and sanitary-chemical treatment; district and object medical-sanitary teams, sanitary squads and Red Cross posts, stationary and mobile dressing brigades.

In the initial period of the war the medical-sanitary service, as well as the whole Soviet public health care system, encountered a number of problems, the most important of which was a catastrophic deficit of physicians and nurses. The peacetime staff of the medical-sanitary service was insufficient to solve the problems of the war period, and recruitment of new personnel was almost impossible, because of mass mobilization of medical personnel. For these reasons representatives of public sanitary formations dominated in the composition of medical-sanitary service units. According to the data of the Main Department of the Ministry of Defense of Russia, in 1941 the only medical-sanitary team from Leningrad consisting of 16 members, 4 nurses and one doctor came to remote defeat centers on the October railroad. Thus, predominantly pre-hospital medical aid, often of poor quality, was given to the victims. Thus, according to the information of the Leningrad local anti-aircraft defense, only in 74% of cases the necessary tourniquet application was performed. This includes 12% of cases where the tourniquet was applied incorrectly. Medical triage of the wounded was reduced to a minimum, there were frequent cases of medical evacuation without taking into account the nature of lesions in the victims [4].

The main reason for most of the problems of the medical-sanitary service during this period was the lack of adequate legal regulation of the service's activity. The contradiction between the outdated norms of the Provisional Regulations and wartime requirements only exacerbated the grave situation of the early war period. The 1938 Provisional Regulation required the creation of "sanitary positions" — first-aid posts in the affected areas, the organization of which took considerable time and delayed the transfer of casualties to a medical institutions. As early as in 1940 the medical-sanitary service specialists recognized the organization of "cumbersome" dressing station as an unnecessary link in the system of medical and evacuation measures. In addition, the war experience showed that the drawback of the first-aid posts was the impossibility of complying with aseptic requirements, since the victims were extracted from under the debris of buildings covered with a thick layer of dust, construction debris, etc. [5]. In practice, the heads of the medical-sanitary service of large city-points (Moscow, Leningrad, Kiev, Minsk, Odessa) from the first days of the war refused to use first-aid posts, preferring to call an ambulance for direct delivery of victims to the hospital. Interestingly, the few leaders of the medical-sanitary service who observed the requirement of multistage evacuation were later criticized by the Main Directorate of the Ministry of Defense for "blind" adherence to outdated instructions [6].

Against the background of intense enemy raids of the first period of the war, the general shortcomings of the organization of the medical-sanitary service brightly manifested themselves. The lack of experience and insufficient level of coordination between the headquarters and the medical-sanitary service formations led to erroneous instructions, which was aggravated by frequent damage to the telephone line (in Murmansk, for example, during the war communications were damaged 232 times) [6]. The

Main Directorate of the Ministry of Defense of the Russian Federation noted cases of late arrival of the medical-sanitary service to the defeat zones and unequal distribution of forces. As a result, the evacuation time ranged from 30-50 minutes to 1-2 hours after the air raid, in some cases up to 4 hours. The absence or insufficient training of the rescue detachments was a great problem which had an extremely negative influence on the operativeness of the medical aid. Thus, the experience of the Great Patriotic War confirmed the urgent need for radical reforms in the organization and tactics of the medical-sanitary service.

On June 1, 1942 the Defense Committee under the USSR Council of People's Commissars of Defence adopted a version of the medical-sanitary service of local anti-aircraft defense reform, developed with the active participation of the First Deputy People's Commissar of Health of the USSR and the Chairman of the Union of Red Cross and Red Crescent Societies S.A. Kolesnikov [7]. In the creation of the new Provision on medical and sanitary service some proposals of 1940 were taken into account, as well as the practice of the medical-sanitary service activities in the foci of defeat. The realistic nature of the reform was influenced by the professional experience of S.A. Kolesnikov, who by virtue of his activities was well aware of the range of problems of the medical-sanitary service of local anti-aircraft defense.

The new Statute on the medical-sanitary service of the local anti-aircraft defense in the cities of the USSR had to consider an accelerated structural reorganization of the medical-sanitary service of local anti-aircraft defense. The main directions of the reform were: introduction of the principle of evacuation according to the assignment; creation of specialized medical-sanitary formations; improvement of the personnel training system. On the basis of the most effective divisional medical-sanitary teams were created companies and platoons of the infantry defense squads, designed to perform search and rescue operations: reconnaissance in the foci; search and rescue of victims; first aid). they were militarized, transferred to the barracks position; personnel principle of manning; providing with vehicles. These companies and platoons of the medical-sanitary service of local anti-aircraft defense played an important role in increasing the number of rescued, which gave the Main Department of the local anti-aircraft defense grounds for raising the question of the advisability of militarization of all medical-sanitary formations of the medical-sanitary service.

First aid squads consisting of a doctor (squad leader), two nurses and two hospital attendants were organized for the first time to provide emergency medical aid and medical triage of the wounded. The largest polyclinic of the local anti-aircraft defense area became the center of the medical-sanitary service, whose chief physician simultaneously performed the functions of the chief of the local medical-sanitary service. It should be noted, that despite the volume of the work performed, the staff of the medical-sanitary service of local anti-aircraft defense included only 500 physicians. Thus, the problem of shortage of medical personnel was solved by increasing the load on the staff of medical institutions.

The main tasks of the doctor in the affected area were medical triage of the wounded, wound infection control and antishock measures. The proximity of medical care to the lesions, medical triage and evacuation by appointment were decisive factors in improving the quality of medical care. In the reports of the Main Department of the Ministry of War and Peacekeeping Operations the problems of the

work of first-aid squads were also noted: the head of the first-aid squad was responsible for leading the medical and sanitary forces in the affected areas, but the doctors, mostly men of non-conscription age, due to their advanced age, found it difficult to carry out this work" [8]. In practice, the functions of the organization of medical and sanitary forces were transferred to the heads of paramilitary platoons of the medical-sanitary service of local anti-aircraft defense. In large defeat zones, public formations of the Red Cross continued to be used as auxiliary forces: druzhinas, posts and links of self-defense groups.

The most mass public formations were sanitarian brigades, the main task of which was to provide medical and sanitary service to asylums and hospitals and to control public order during the air-raid alarm. In 1942 the number of sanitarian druzhina fighters was reduced from 30 to 15 people, which resulted in their better control and better development of these units. Some of the most combat-ready druzhinas were transferred to the barracks position, and later paramilitary sanitary druzhinas became the core of the system of public formations of the medical-sanitary service.

One of the key factors of dynamic development of the medical-sanitary service during the years of war was the creation of multidisciplinary mass training system for personnel and population which permitted to decrease the tension of personnel problems and to increase the level of medical and sanitary education of citizens. The creation of tens of manuals on the problems of medical and sanitary units, chemical, bacteriological and sanitary protection, methods of rendering self- and mutual aid promoted theoretical generalization of the medical-sanitary service experience and formation of methodological basis of the service activity. Particular importance was given to the qualification of the personnel, which was aided by the strengthening of the practical components of training and the inclusion of special physical training courses in the curricula. On the basis of military experience new training programs for sanitary squads were created, consisting of 330-hour training course followed by final examinations. The continuous nature of the training was ensured by regular drills and annual retraining. The Red Cross Society trained 5,430 cadre sanitation squads and 273,000 sanitation squads, about 40% of whom served in the Red Army. At the same time, according to Lintvarev, head of the medical and sanitary service of the Main Department of the Ministry of Defense, the potential of these brigades was not used to the full extent due to the acute shortage of transport [8]. The result of the medical-sanitary service reform was a significant increase in the number of medical-sanitary formations. The comparison of data for 1942 and 1945 shows that during that period the total number of medical-sanitary units increased by 52%; first-aid detachments — by 460; sanitary brigades — by 84; medical-sanitary links — by 90% [9].

The formation of a narrow specialization in the work of the medical-sanitary service — the creation of first-aid detachments, emergency rescue companies and platoons, various types of sanitary units — became the main direction of the 1942 reform.

At the same time the situation of medical and sanitary service during the war remained extremely difficult. According to the data of the Main Department of the local anti-aircraft defense the sanitary squads were equipped with medical equipment by 65.4%; the sanitary posts — by 53%. There was a shortage of medicines and transport; the

use of gasoline was subject to strict limits. In the report of the Main Directorate of the local anti-aircraft defense it was noted that in the front-line and front-line cities (Leningrad, Stalingrad, Sevastopol, Odessa, Tula etc.) a "peculiar tactical situation was created which had not been anticipated either by military specialists or by the experience of previous wars" [10]. Assistance to the injured continued during raids, shelling and street battles and was associated with daily risk to life. Soldiers of medical-sanitary formations, most of whom were girls, experienced tremendous physical and moral overload. Thus, only in Dzerzhinskiy district of Leningrad on July 17, 1943 there were about 100 lesions, on which soldiers went up to 15 times a day. Baburova, the chief of medical unit, having arrived to the foci on the night of September 8-9, 1943, rendered aid to the injured during 2 consecutive days. Often the soldiers were seriously wounded and died in the process of rendering medical help. During one of the Leningrad earthquakes, which lasted from 5 a.m. to 7:30 p.m., fighter L.N.Kukushkina lost her leg; fighter Kudryavtseva, wounded in the leg, continued to provide care to the injured [11].

The main indicator of heroic work of the medical-sanitary service fighters was a particularly respectful attitude to medical and sanitary service from the part of the civilian population. Analyzing the practice of similar medical units in Great Britain, Lieutenant General V.V. Osokin, the head of the Ministry of Defense, noted that British formations began saving people only after the air raids were over, while the medical-sanitary service fighters had been working in the affected areas since the bombing began. Such rescue tactics greatly accelerated the recovery from the bombing, but resulted in high casualties among the medical-sanitary service staff.

As V.V. Osokin stated, it was the self-sacrifice and heroism of the staff that ensured the absolute authority of the medical and sanitary service among the population [12]. During the war, many medical-sanitary service fighters were awarded the medal "For Combat Merit". Thus, the work of the medical-sanitary service of the local anti-aircraft defense fighters was officially equated to participation in combat operations.

Conclusion

1. The analysis of the experience of work of the medical-sanitary service of the local anti-aircraft defense during the Great Patriotic War was started by the Department of the Ministry of Defense of the People's Commissariat of Health of the USSR and the Main Department of the Ministry of Defense as early as in the spring of 1945.

2. During the war 187,928 persons suffered from the actions of the German aircraft. 51,493 (27 %) of them were killed; 136,435 (73 %) were wounded. In the affected zones the formations of the medical-sanitary service of the local anti-aircraft defense rendered medical aid to 135 224 injured, 60% of which received shrapnel wounds; 25 persons were traumatized; 15% received blast damage.

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Emergency medical aid was rendered on the average within 16 minutes from the moment of injury, death rate during evacuation did not exceed 3,0-3,5%. The percentage of casualties discharged from hospitals with full restoration of the ability to work was 80 %, with disability — 20 % [13]. The results of the war disproved the specialists' pre-war forecasts of the number of losses per raid: the losses were 1% of the total population; the real losses turned out to be 0.0094%.

The analysis of the results of the medical-sanitary service activities during the war testifies to the effectiveness and validity of the medical-sanitary service of the local anti-aircraft defense reform, carried out under extremely difficult conditions and in an extremely short time. Summarizing the results of the military work of the medical-sanitary service of the local anti-aircraft defense, it is important to take into account that on the eve of the Great Patriotic War, the medical and sanitary service was at the initial — according to the head of the Murmansk medical-sanitary service — almost "embryonic" stage of organizational formation [14]. The legislative basis of the service was temporary and incomplete, its personnel was at the stage of formation, and there was practically no experience of real activity.

The turning point in the development of the medical-sanitary service was the renewal of its legal basis, which made it possible to organize the military activities of the medical-sanitary service of the local anti-aircraft defense during the war in the most rational way. The result of the 1942 reform was the completion of formation of the main components of the medical-sanitary service: normative-legal regulation, scientific-methodological basis, specialized branches and units, infrastructure and experienced personnel, which conditioned the formation of the medical-sanitary service of the local anti-aircraft defense as a unified system of forces and means management.

The main result of the activities of the medical-sanitary service of the local anti-aircraft defense was a significant contribution to the Victory, preserving the labor capacity of the home front and the economic potential of the country. Summing up the activities of the medical-sanitary service of the local anti-aircraft defense during the war the head of the Department of the medical-sanitary service of the local anti-aircraft defense the People's Commissariat for Health I.M. Timko wrote that "the medical and sanitary experience of the modern war by far exceeds in its significance everything that medical science and practice accumulated in the previous wars" [15].

The scale and national character of the activities of the medical-sanitary service of the local anti-aircraft defense of the USSR during the Great Patriotic War had no analogues in the world practice of medical and sanitary defense. The activities of the USSR medical-sanitary service of the local anti-aircraft defense became the world's first experience of continuous systematic work of medical and sanitary services in conditions of regular bombardments and transfer of a number of cities to a state of siege.

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SAFETY IN EMERGENCY ENVIRONMENT БЕЗОПАСНОСТЬ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ

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TOPICAL ISSUES OF PROVIDING MEDICAL ASSISTANCE TO VICTIMS OF ROAD TRANSPORT EMERGENCIES IN THE ALTAI KRAI

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Abstract. *The aim of the research was:*

- to elaborate organizational and methodical bases of medical evacuation for the population of the Altai region in cases of traffic accidents including emergency situations, in conditions of healthcare optimization, namely, under the process of merging of the territorial center for disaster medicine with the emergency medical aid station;

- to determine starting points for further development of the Emergency Medicine Service of the Altai Krai.

Materials and research methods. The statistical data of registration and reporting form no.55 "Information on the Activity of Healthcare Institution (Medical Formation) which took part in liquidation of medical and sanitary consequences of emergencies" of Altai Krai Disaster Medicine Service approved by the Order of the Ministry of Healthcare and Social Development of Russia dated February 3, 2005, no.112, and official statistical data of Altai Krai State Road Safety Department were analyzed. The sample included statistical data for 2019-2021.

The study used a set of analytical and statistical methods, which made it possible to process and to analyze the data obtained, to assess the system of medical care and to develop a set of measures to improve the medical evacuation system in Altai Krai using the data about victims of traffic accidents, to predict the duration of their treatment and rehabilitation. The statistical data were processed by means of Statistica 10.0 program complex with the calculation of intensive indices, mean representativeness error ($\pm m$) and significance of differences by Fisher's method.

Results of the study and their analysis. The results of the analysis of organizational and methodological bases of medical evacuation of the population of Altai Krai in road traffic accidents in the conditions of optimization of healthcare in 2019-2021 are presented. The prospects for further development of the regional Disaster Medicine Service, directions of interdepartmental planning and conducting of special tactical exercises, which are one of the basic tools ensuring readiness of managers and personnel of territorial medical institutions for actions on liquidation of consequences of traffic accidents and emergencies, were determined. The necessity of training the population and interested persons in rendering first aid, which is carried out within the framework of the work of the training center of disaster medicine, has been substantiated.

Key words: : Altai Krai, ambulance crews, ambulance station, dead, emergency situations, injured, medical and sanitary consequences, medical evacuation, organization of medical aid, tactic-specific drills, territorial center of disaster medicine, traffic accidents, traffic emergencies, wounded

Conflict of interest. The authors declare no conflict of interest

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АКТУАЛЬНЫЕ ВОПРОСЫ ОКАЗАНИЯ МЕДИЦИНСКОЙ ПОМОЩИ ПОСТРАДАВШИМ В ДОРОЖНО-ТРАНСПОРТНЫХ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ В АЛТАЙСКОМ КРАЕ

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Резюме. *Цели исследования* – разработать организационно-методические основы лечебно-эвакуационного обеспечения (ЛЭО) населения Алтайского края при дорожно-транспортных происшествиях (ДТП), в том числе отнесенных к чрезвычайным ситуациям (ЧС) – ДТП-ЧС, в условиях оптимизации здравоохранения и, в частности, объединения территориального центра медицины катастроф (ТЦМК) и станции скорой медицинской помощи (СМП); определить точки дальнейшего развития Службы медицины катастроф (СМК) Алтайского края.

Материалы и методы исследования. Проанализированы статистические данные о деятельности СМК Алтайского края, содержащиеся в учетно-отчетной форме №55 «Сведения о деятельности учреждения здравоохранения (медицинского формирования), принимавшего участие в ликвидации медико-санитарных последствий чрезвычайных ситуаций», утвержденной приказом Минздравсоцразвития России от 3 февраля 2005 г. №112, а также официальные статистические данные ГИБДД Алтайского края. В выборку вошли статистические данные за 2019–2021 гг.

В исследовании был использован комплекс аналитических и статистических методов, позволивший обработать и проанализировать полученные данные, оценить систему оказания медицинской помощи и разработать комплекс мероприя-

тий по совершенствованию системы ЛЭО в Алтайском крае на примере пострадавших в ДТП, по прогнозированию продолжительности их лечения и реабилитации. Обработка статистических данных осуществлялась с использованием программного комплекса Statistica 10.0 с расчетом интенсивных показателей, средней ошибки репрезентативности ($\pm m$) и достоверности различий методом Фишера.

Результаты исследования и их анализ. Представлены результаты анализа организационно-методических основ лечебно-эвакуационного обеспечения населения Алтайского края при дорожно-транспортных происшествиях в условиях оптимизации здравоохранения в 2019–2021 гг. Определены перспективы дальнейшего развития региональной Службы медицины катастроф, направления межведомственного планирования и проведения тактико-специальных учений (ТСУ), являющихся одним из базовых инструментов обеспечения готовности руководителей и персонала краевых медицинских учреждений к действиям по ликвидации последствий ДТП-ЧС. Обоснована необходимость обучения населения и заинтересованных лиц оказанию первой помощи, осуществляемого в рамках работы учебного центра медицины катастроф.

Ключевые слова: Алтайский край, бригады скорой медицинской помощи, дорожно-транспортные происшествия, дорожно-транспортные чрезвычайные ситуации, лечебно-эвакуационное обеспечение, медицинская эвакуация, медико-санитарные последствия, организация оказания медицинской помощи, погибшие, пораженные, пострадавшие, станция скорой медицинской помощи, тактико-специальные учения, территориальный центр медицины катастроф, чрезвычайные ситуации

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Road safety is one of the strategically important issues in our country. Road traffic injuries cause significant material, physical and moral damage, lead to disability and death of people of different ages. Road traffic accidents with medical and sanitary consequences (dead, injured, disabled) require constant attention to the problems of first and emergency medical care in accidents and emergencies [1]. Improvement of the organization of medical care for victims of road accidents should be carried out after a deeper study of the situation on the roads, taking into account the territorial features of different subjects of the Russian Federation [2].

In the northern and eastern "peripheral" regions of the country, which are characterized by low population density, significant distances between settlements and between medical treatment organizations, road traffic injuries have certain features. And they necessitate different approaches to medical care for victims of traffic accidents [3]. Altai Krai belongs to such regions according to a number of indicators.

In the Russian Federation, when assessing the state system of road safety, it is customary to consider 2004 as the baseline year. In this year goals were set, tasks and main tools to improve road safety were defined, including the program-targeted approach to its provision [4].

The goals and target indicators of the Road Safety Strategy were reflected in the Decree of the President of the Russian Federation of May 7, 2018 № 204, which consolidated the status of the indicator "mortality in road accidents", which is among the indicators that characterize the achievement of national development goals of the Russian Federation^{1,2} [5, 6].

In the Road Safety Strategy, Decree of the President of the Russian Federation (2018), and the National Project, the target is presented only as a "social risk" indicator. At

the same time, federal target programs have established a set of absolute and relative indicators of road safety. This set allows to more objectively assess the state of road safety on a particular territory and to make objective comparisons, taking into account the population and its motorization: social risk — the number of deaths in road accidents per 100 thousand people; transport risk — the number of deaths in road accidents per 10 thousand vehicles; severity of road accident consequences — the share (%) of deaths in the total number of victims (dead + injured) in road accidents per 100 victims³ [7].

In December 2019, in order to implement the Strategy of development of air ambulance in Altai Krai until 2024, as well as to optimize the healthcare system of Altai Krai, the "Regional Clinical Hospital" was reorganized. On its basis there were created a department of emergency consultative medical aid and medical evacuation of "Regional Clinical Hospital" and Altai Krai Center of Disaster Medicine of "Emergency Medical Aid Station"⁴⁻⁷. When territorial centers for disaster and emergency medicine were united, a unified dispatching service of the region was created. This led to a significant reduction in response time, in time of getting to the place of an accident and providing medical aid to the victims of accidents and emergencies [5]. At the same time, there is still no normative legal base regulating the work of the unified center and the ambulance station [1, 5].

³ On Amendments to the Rules of Accounting for Road Accidents: Decree of the Government of the Russian Federation dated November 19, 2008, № 859 (In Russ.)

⁴ On the Reorganization of the Regional Clinical Hospital: Decree of the Government of the Altai Krai dated October 15, 2019, No. 392 (In Russ.)

⁵ On the Establishment of the Department of Emergency Advisory Assistance and Medical Evacuation of the Regional Clinical Hospital: Order of the Ministry of Health of the Altai Krai dated November 11, 2019, No. 302 (In Russ.)

⁶ On the Establishment of the Altai Regional Center for Disaster Medicine: Order of the Ministry of Health of the Altai Krai dated October 31, 2019, No. 286 (In Russ.)

⁷ On the Strategy for the Development of Sanitary Aviation in the Altai Territory until 2024: Decree of the Government of the Altai Krai dated July 03, 2019 No. 250 (In Russ.)

¹ On the Approval of the Road Safety Strategy in the Russian Federation for 2018-2024: Decree of the Government of the Russian Federation dated January 08, 2018, No. 1-р (In Russ.)

² On National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024: Decree of the President of the Russian Federation dated May 07, 2018, No. 204 (ed. dated July 21, 2020) (In Russ.)

It should be noted that failure to provide first aid significantly affects the occurrence of complications after injuries sustained in traffic accidents. In this regard, the organization of regular training in first aid plays an important role. First aid is not medical, it is given before medical specialists arrive or before the injured person is taken to the hospital. First aid can be given by any person who is near the victim at the critical moment. For some categories of citizens (police officers, employees of the Road Traffic Police and the Ministry of Emergency Situations of Russia, drivers, etc.) rendering first aid is an official duty [6].

In modern conditions the exercises held with the participation of forces and means of the Disaster Medicine Service have specific features. They serve as a form of research and verification of methods of solving problem tasks, theory and practice of civil defense, as well as actions for prevention and liquidation of the consequences of emergencies. Exercises and drills are a form of training medical specialists and a method of testing their readiness to perform their assigned tasks in an environment as close as possible to the real one [7].

All of the above aspects that have a significant impact on the organization of the stages of medical evacuation support were taken into account in the study.

The purpose of the study is to develop organizational and methodological bases for medical and evacuation support of the Altai Krai population in case of traffic accidents. Including in accidents referred to emergencies*, in the conditions of optimization of healthcare, and, in particular, uniting the territorial center of disaster medicine and the station of emergency medical care and determine points for further growth of the Service of medicine of catastrophes of Altai Krai.

Materials and research methods. The statistical data on the activities of Altai Krai Disaster Medicine Service included in the registration and reporting form No.55 "Information on the activities of health care institution (medical formation) in accordance with the order of the Ministry of Health and Social Development of Russia dated February 3, 2005 No. 112 as well as the official statistical data of Altai Krai Traffic Police Department were analyzed. The sample included statistical data for 2019-2021.

The victims were distributed by age (adults, children under 18), as well as by lethality (those who died at the scene of the accident, those who died in the hospital). As the primary documentation we used the form № 165/-05 "Report of emergency situation (primary, subsequent, final)" and data of the daily monitoring of the victims of traffic accidents hospitalized in the krai medical organizations.

Theoretical and methodological basis of the study are the works of domestic and foreign scientists in the field of organization of medical care to victims of road accidents, normative legal acts of the Government and the Ministry of Health of the Russian Federation.

The study used a set of analytical and statistical methods that allowed: processing and analyzing the data obtained; evaluating the system of medical care; developing a set of measures to improve the system of medical and evacuation support in Altai Krai, to predict the duration of their treatment and rehabilitation on the example of victims of traffic

accidents. The statistical data were processed by means of Statistica 10.0 program complex with the calculation of intensive indices, mean representativeness error ($\pm m$) and significance of differences by Fisher's method.

Results of the study and their analysis. According to the data obtained, in 2019-2021 in the Altai Krai in the total number of emergencies accidents referred to emergencies prevailed. During this period, 146 emergencies occurred in the region, of which 143 were man-made, including 69 accidents referred to emergencies, which is $(50.68 \pm 4.14)\%$ of the total number of emergencies. The rate of traffic accidents in the structure of man-made emergency situations was $(48,25 \pm 4,18)\%$; fire — $(47,55 \pm 4,18)$; the rate of other emergencies — $(2,8 \pm 1,38)\%$. The prevalence of traffic accidents is connected with the fact, that Altai Krai ranks first in the Siberian Federal District by length of roads (16814,028 km); and the distance between victims and medical institutions is from 5-10 km (within such big cities as Barnaul, Biysk, Slavgorod, Rubtsovsk, Aleisk and others) up to 400 km.

In 2021, the total number of victims of emergencies compared to 2019 decreased by 25.54%; compared to 2020 — increased by 16.85%. In 2021, the proportion of fatalities in the total number of victims decreased: compared to 2019, by 21.00%; compared to 2020 — by 6.00%. In 2021, the proportion of medical casualties decreased by 30.95% (1.3 times) compared to 2019 and increased by 44.05% (1.8 times) compared to 2020. In 2021, more affected persons were hospitalized compared to 2019, by 39.68%; compared to 2020 — by 41.26%. In 2021, there was a 242.85% decrease in the number of affected individuals who received medical care on an outpatient basis, a 3.4-fold decrease, compared to 2019; compared to 2020 — increased by 52.38%, a 1.8 – fold increase (Table 1).

The decrease in the number of the injured, killed and wounded in emergencies in 2020 is connected with the implementation of the special order of movement of citizens and vehicles, introduced by the executive authorities of the subjects. It was introduced to ensure a set of restrictive measures for the sanitary and epidemiological well-being of the population, established in accordance with paragraph 1 of Decree No.316⁸ of the President of the Russian Federation of May 11, 2020.

The increase in the number of those injured in emergencies in the mentioned period was due to a 1.2 times increase in the number of people injured in road traffic accidents. Thus, according to Altai Krai traffic police, in 2021 the number of accidents decreased: as compared to 2019 — by 22.52%; as compared to 2020 — by 10.12%; the number of victims decreased by 4.9%; the number of fatalities increased by 0.9%. With a three-year downward trend in the number of reported accidents referred to emergencies cases, the total number of fatalities decreased: in 2021, compared to 2019, by 27.65%; compared to 2020 — by 17.02%. At the same time, the number of children killed in accidents referred to emergencies situations increased: 2.25 times in 2021 compared to 2019; compared to 2020 — by 1.8 times. In 2021, the total number of traffic accident victims decreased by 18.91% compared to 2019; compared to 2020 — by 5.07%. In 2021, the total number of

* According to point 1.1.5. of the Order "On establishment of criteria of information on emergency situations of natural and man-made character" of Ministry of Emergency Situations of Russia from July 5, 2021 № 429 (entered into force on January 1, 2022) the road traffic accident include such road traffic accidents, in which 5 people and more died or 10 people and more suffered harm to health

⁸ On the determination of the procedure for extending measures to ensure the sanitary and epidemiological well-being of the population in the constituent entities of the Russian Federation in connection with the spread of a new coronavirus infection (COVID-19): Decree of the President of the Russian Federation of May 11, 2020 № 316 (In Russ.)

Данные о ЧС, произошедших в Алтайском крае в 2019–2021 гг.
Data on Emergencies that Occurred in the Altai Territory in 2019–2021

Год Year	Кол-во ЧС, абс. Number of emergencies, abs.	Число пострадавших, чел. Number of victims, people	Из них, чел./(%±m) Of them, people/(%±m)		Получили медицинскую помощь, чел./(%±m) Received medical care, people/(%±m)	
			погибли died	сан. потери sanitary losses	в стационаре in hospital	амбулаторно outpatient
2019	51	231	121/52,4	110/47,6	38/34,5	72/65,5
2020	44	153	106/69,3	47/30,7	37/78,7	10/21,3
2021	51	184	100/54,4	84/45,6	63/75,0	21/25,0

accidents referred to emergencies victims increased: compared to 2019, by 15.83%; compared to 2020 — by 23.33% The increase in 2021 of this indicator is associated with an increase in the number of injured children compared to 2020 — 1.9 times; compared to 2019 — 4 times (Table 2).

In 2021 there was an increase in the number of children killed at the scene of a traffic accident, with a decrease in the total number of those killed in traffic accidents. For example, in 2021, the proportion of children killed at the scene of a traffic accident was 2.9 and 2.1 times higher than in 2019 and 2020, respectively.

In 2021, there were 1.8 times the number of medical care cases compared to 2019 and 2 times the number of medical care cases compared to 2020. In 2021, there was a 37.5% increase in the number of victims hospitalized in extremely serious condition from the scene of an accident referred to emergency, compared to 2019.

In 2019-2021, there was a large increase in the number of victims hospitalized in moderate severity condition from the scene of an accident referred to emergency. In 2021, there was a 2.8 and 1.9-fold increase compared to 2019 and 2020, respectively. The number of hospitalizations increased annually. Thus, in 2021, 1.8 times as many accident-affected persons were hospitalized as in 2019. The proportion of children affected in accidents referred to emergencies who received outpatient care was 21% (Table 3).

Thus, we can conclude that in 2019-2021, the number of accidents referred to emergencies remained stable despite a decrease in the total number of accidents, as well as the total number of victims and fatalities in accidents. At the same time, we should note a decrease in the number of deaths in traffic accidents and an increase in the proportion of children killed.

One of the most important indices (indicators) under the section "Improvement of emergency medical care and activities of the Altai Krai Disaster Medicine Service" is the time of ambulance crews' arrival to the place of the accident. Thus, the indicator "time of arrival" (less than 20 minutes) of emergency ambulance crews to the place of accident

achieved +1.16% (plan 2019 - 96.6%) in 2019. In 2020 and 2021 (target - 96.5%) this indicator was not achieved and was: in 2020. -1.38% in 2020 and 2.73% in 2021.

As part of the study, calculations were made on the time of arrival of emergency ambulance crews to the site of the accidents referred to emergencies in 2020 and 2021. Due to the merger of the Territorial Center for Disaster Medicine and ambulance, the statistics for 2019 on the time of arrival of teams of the Territorial Center for Disaster Medicine from 1.12.2019 were not found. The calculation of emergency ambulance crew arrival times for accidents referred to emergencies medical care is based on the calculation of emergency ambulance crew arrival times to the scene of an accident in 2020 — 54.17%, which is 28.7% less than the 2021 figure of 76.0% (Table 4).

Hospital mortality among those injured in traffic accidents was: in 2021, 7.3% (4 persons, including one child); in 2020 — 3.3 (one person, 0 children); in 2019 — 25.0% (8 people, including one child). The decrease in the percentage of fatalities in 2020 is associated with restrictive measures to prevent the spread of the new coronavirus infection COVID-19.

It should be noted that in 2021, the hospital mortality rate decreased 3.4-fold compared to the same rate for 2019 (Figure).

The obtained data indicate an increase in the quality criteria of medical care for accident victims using the developed interaction algorithms in the pre-hospital period.

Discussion

The results of the research showed that the creation of the united dispatching service when uniting the territorial center for disaster medicine and the ambulance service was timely. It reduced the time of response to an emergency by the forces and means of the Disaster Medicine Service and, in particular, the time of arrival of ambulance teams, which in turn allowed to provide medical aid in the shortest possible time and to increase the proportion of survivors among victims of traffic accidents.

Taking into account the data from scientific publications on the issues of timely first aid and its impact on the condition

Таблица 2 / Table No. 2

Данные о ДТП, в том числе ДТП-ЧС, произошедших в Алтайском крае в 2019–2021 гг.
Data on Road Accidents / Road Accidents-Emergences in Altai Territory that Occurred in 2019–2021

Год Year	Кол-во ДТП, абс. Number of accidents, abs.		Число погибших в ДТП, чел. The number of deaths in road accidents, pers.				Число пострадавших в ДТП, чел. Number of victims in road accidents, pers.			
	всего* total	из них ДТП-ЧС of which road accidents - emergency	всего/ total		из них в ДТП-ЧС /of which road accidents - emergency		всего/ total		из них в ДТП-ЧС of which in road accidents - emergency	
			всего* total	в т.ч. детей including children	всего* total	в т.ч. детей including children	всего* total	в т.ч. детей including children	всего* total	в т.ч. детей including children
2019	2796	24	252	12	60	4	3584	414	101	7
2020	2513	25	226	8	55	5	3167	383	92	15
2021	2282	25	228	12	47	9	3014	395	120	28

* Данные ГИБДД Алтайского края / Data from the traffic police of the Altai Territory

Распределение пораженных в ДТП-ЧС по степени тяжести состояния и оказанной медицинской помощи в 2019–2021 гг., чел.

Distribution of Victims in Road Accidents – Emergency of those Affected in to the Severity of the Lesion in 2019–2021, pers.

Год Year	Число пораженных The number of people affected in the emergency		Распределение по степени тяжести состояния Distribution of those affected in to the severity of the lesion								Число пролеченных амбулаторно Number of victims treated on an outpatient basis		Число госпитализированных Number of hospitalized	
			крайне тяжелое extremely heavy		тяжелое heavy		среднее medium		легкое light					
	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children	всего total	в т.ч. детей including children
2019	41	3	5	1	14	0	13	2	9	0	9	0	32	3
2020	37	10	1	0	7	1	19	6	10	3	7	1	30	9
2021	73	19	8	1	13	5	36	9	16	4	18	4	55	15

Таблица 4 / Table No. 4

Доля вызовов бригад СМП, ранжированных по времени доезда (до 20 мин) до места события, в 2019–2021 гг., %

The Share of Calls to Ambulance Teams, Ranked by the Time of Arrival (up to 20 minutes) to the Place of the Event, in 2019–2021, %

Время доезда Time of arrival	Доля указанных вызовов / Percentage of specified calls								
	в общем количестве всех вызовов на место ДТП/ДТП-ЧС in the total number of all calls to the scene of an accident/accident-emergency						в общем количестве всех вызовов бригад СМП in the total number of all calls of ambulance teams		
	2019		2020		2021		2019	2020	2021
	ДТП road accident	ДТП-ЧС road accident - emergency	ДТП road accident	ДТП-ЧС road accident - emergency	ДТП road accident	ДТП-ЧС road accident - emergency			
До 20 мин Up to 20 min	97,76	–	95,12	54,17	93,77	76,00	92,41	90,02	85,46
Целевой показатель Target	96,6	–	96,5	–	96,5	–	89,5	90	90,5

and recovery of victims of traffic accidents, including accidents referred to emergencies, it is concluded that it is necessary to further expand the training of citizens in first aid. In particular, a training center for disaster medicine using the simulation center of Altai State Medical University was opened. Creation of the training center has become a special direction in the activities of the interregional project "University-Region". It is planned to train all categories of citizens interested in obtaining the skills of first aid to victims of road accidents.

When the territorial Center for Disaster and Emergency Medicine was united, specialists of the Center developed and put into practice algorithms of interaction from the

moment of receiving a call to hospitalization of victims in the territorial medical institutions. In January 2022, the interaction algorithms were revised in accordance with the recommendations of the Russian Ministry of Health, adopted at the meeting of the Commission on Emergency Situations of the Government of the Russian Federation on December 28, 2021⁹.

The practice of using these algorithms has made it possible to transmit information clearly and in the shortest

⁹ On Approval of the Response Algorithms of the Altai Krai Disaster Medicine Service of the Altai Krai Ministry of Health: Order of the Altai Krai Ministry of Health of January 24, 2022 #119

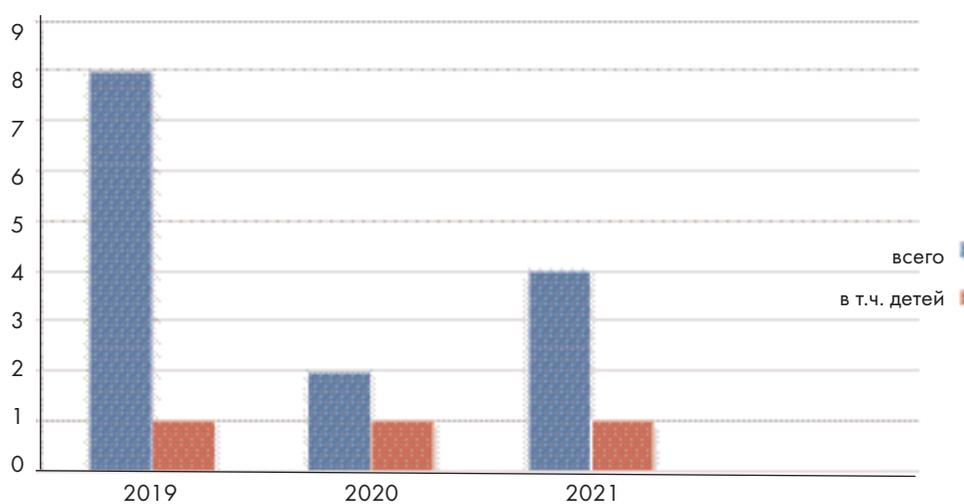


Рисунок. Летальность среди пострадавших в ДТП-ЧС, госпитализированных в медицинские учреждения в 2019–2021 гг., чел.

Figure. Mortality among victims of road accidents hospitalized in medical institutions in 2019–2021, people

possible time. This has increased the speed of rapid response of Altai Krai medical forces to road accidents and reduced time losses in the pre-hospital period. In order to optimize the process of evacuation in the pre-hospital period it is planned to introduce the triage sheet and the reporting form 167/-05 into the automated reporting and accounting program "Open ambulance". The specialists of the Disaster Medicine training center planned to organize training of medical personnel in the framework of additional professional and continuous medical education under the program "Reporting and Record-Keeping Documentation of the Disaster Medicine Service". During the command-staff and tactical-specialized exercises it is planned to practise the skills of applying the above mentioned algorithms by the disaster medicine service at all stages of evacuation.

Conclusion

1. The effectiveness of the unified territorial center for disaster and emergency medicine will be increased by the de-

velopment of a regulatory and legal framework at the federal and regional levels. It has to take into account the specifics of the tasks of the Disaster Medicine Service, including elaboration of functionally precise model of the united center, staff standards and equipment tables for subdivisions.

2. Training programs should be developed for different categories of citizens, taking into account their professional duties (policemen, GIBDD and EMERCOM staff, servicemen, firemen, teachers) as well as for all participants of the road traffic (drivers, passengers, pedestrians) to teach the population first aid skills.

3. Joint inter-agency planning of tactical and special exercises should be carried out in order to practice emergency skills. They are one of the basic tools to ensure the readiness of managers and staff of the regional medical institutions to act to eliminate the consequences of emergencies, as well as to achieve coherence in the work of structural units and management bodies as a whole.

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OCCUPATIONAL RISK FACTORS AND CONSEQUENCES OF MENTAL DISADAPTATION IN MEDICAL SPECIALISTS AND RESCUERS IN EMERGENCY SITUATIONS: CURRENT STATE OF THE PROBLEM

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Abstract. *The purpose of the study* is to analyze modern domestic and foreign publications, devoted to the study of factors of professional risk and consequences of mental disadaptation in rescuers and medical workers in emergency situations.

Materials and research methods. The publications' analysis was performed using the PubMed database, electronic scientific library eLIBRARY.RU, open access statistical reporting data, as well as official websites of relevant scientific journals.

Combinations of specific terms related to emergency services, post-traumatic stress disorder, mental maladaptation and professional risk factors of extreme professions, including medical ones, were used.

Results of the study and their analysis. While performing their service duties, rescuers and medical workers, acting in conditions of emergency with numerous human and material losses, being exposed to the threat to their own life, health or psycho-emotional condition, face a variety of critical incidents. As the number of lived traumatic situations and events increases, individuals involved in rescue operations are at higher risk of developing the pathology known as post-traumatic stress disorder. Throughout the relevant scientific literature, there is a consensus that health care workers in emergencies are at increased risk for high-level stress, anxiety, depression, burnout, addiction, and PTSD, which can have long-term psychological consequences. The specialists developed and implemented new methods and approaches to support medical specialists participating in the liquidation of medical and sanitary consequences of emergencies; substantiated the need for normative legal regulation of psychophysiological examination of personnel during periodic medical examinations, which will allow to maintain "health of the healthy".

Key words: COVID-19 pandemic, emergencies, first aid, medical specialists, mental maladaptation, post-traumatic stress disorder, professional risk, rescue workers, victims

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ФАКТОРЫ ПРОФЕССИОНАЛЬНОГО РИСКА И ПОСЛЕДСТВИЯ ПСИХИЧЕСКОЙ ДЕЗАДАПТАЦИИ У МЕДИЦИНСКИХ СПЕЦИАЛИСТОВ И СПАСАТЕЛЕЙ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ: СОВРЕМЕННОЕ СОСТОЯНИЕ ПРОБЛЕМЫ

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Резюме. *Цель исследования* – проанализировать современные отечественные и зарубежные публикации, посвященные изучению факторов профессионального риска и последствий психической дезадаптации у спасателей и медицинских работников в чрезвычайных ситуациях (ЧС).

Материалы и методы исследования. Выполнен анализ публикаций результатов исследований по заявленной тематике с использованием: базы данных Pubmed, научной электронной библиотеки eLIBRARY.RU, данных статистической отчетности, находящихся в открытом доступе, а также официальных сайтов научных журналов по изучаемой тематике.

Использованы комбинации терминов, относящихся к аварийно-спасательным службам, посттравматическому стрессовому расстройству (ПТСР), психической дезадаптации и факторам профессионального риска служебной деятельности специалистов экстремальных профессий, в том числе медицинских работников.

Результаты исследования и их анализ. В процессе выполнения служебных обязанностей у спасателей и медицинских работников, действующих в условиях ЧС, на фоне многочисленных человеческих жертв, материальных потерь, реальной угрозы для своей жизни, здоровья или психоэмоционального состояния, а также для жизни, здоровья и благополучия окружающих, неизбежно возникают разнообразные критические инциденты. С увеличением количества пережитых травмирующих ситуаций и событий, лица, задействованные в спасательных операциях, подвержены более высокому риску формирования патологии, известной как посттравматическое стрессовое расстройство. Во всей соответствующей научной литературе существует консенсус в отношении того, что медицинские работники в условиях ЧС подвергаются повышенному риску возникновения стресса высокого уровня, тревоги, депрессии, выгорания, зависимости и посттравматического стрессового расстройства, которые могут иметь долгосрочные психологические последствия. Специалистами разработаны и внедрены новые методы и подходы к поддержке медицинских специалистов, принимающих участие в ликвидации медико-санитарных

последствий ЧС; обоснована необходимость нормативного правового регулирования психофизиологического обследования персонала при прохождении периодических медицинских осмотров, что позволит сохранить «здоровье здоровых».

Ключевые слова: медицинские специалисты, пандемия COVID-19, первая помощь, пострадавшие, посттравматическое стрессовое расстройство, профессиональный риск, психическая дезадаптация, спасатели, чрезвычайные ситуации

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Introduction

The modern stage in the development of society is characterized by the rapid development of science and the emergence of new high technologies. A large concentration of industrial production, complication of the technological chain using a significant number of explosive, fire, radiation and chemical hazardous substances, deterioration of industrial equipment, failure to observe elementary safety measures lead to an increase in the number of accidents and man-made disasters. In addition, various natural disasters cause significant damage.

A specific peculiarity of professional activity of specialists of rescue services and medical workers, who provide liquidation of medical and sanitary consequences of emergency situations (ES), is the work under special conditions. It takes place under the influence of a significant number of such stressogenic factors as presence of an explicit or latent threat to life and health, formation of physical and mental overload, suddenness of events, information overload in conditions of lack of time, etc.

Peculiarities of the status of rescuers are determined by their assigned duties within the framework of the work to eliminate emergency situations and the related threat to their life and health¹.

Such activity requires specialists to have a formed set of motives, reliable functioning of their psychophysiological functions, ability to self-regulate mental states, readiness to apply knowledge, skills and abilities.

From the above, **the relevance of this study** follows. It included an analysis of modern domestic and foreign sources on the study of factors of professional risk and consequences of mental disadaptation in medical specialists and rescuers in emergency situations.

Materials and methods of research. Publications of domestic and foreign authors were analyzed, their systematization according to the stated topic using the developed search protocol performed. The PubMed database; the Russian information-analytical portal in science, technology, medicine and education – scientific electronic library eLIBRARY.RU; open-access statistical reporting data, as well as official websites of scientific journals on the studied subject were included in the search protocol.

Combinations of terms related to emergency services/rescue workers, post-traumatic stress disorder (PTSD), mental maladaptation and professional risk factors of extreme professions were used.

Main limitations: publication language was either Russian or English; date of publication was not earlier than 2000.

Recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA – were used as a basis for identification of possible studies.

Research results and their analysis. The activities of a number of professions are associated with the provision of medical emergency care to victims in emergency situations of man-made, natural and other nature and belong to the category of extreme activities. In the process of performing their official duties rescuers and medical specialists acting in conditions of emergency, on the background of numerous human losses, material losses, real threat to their life, health or psycho-emotional state, as well as to life, health and well-being of surrounding people have a variety of critical incidents [1, 2].

A comparative analysis of official statistics data shows a steady increase in the number of threats of various emergencies in the Russian Federation^{2,3}.

Thus, in 2020, compared to 2019, the number of ES increased by 24.44%, and the material damage from ES increased by 94.38%. At the same time, the number of people injured and killed in emergencies decreased by 64.83% and 38.72% respectively.

The number of man-made emergencies in 2020 was 167 (202 in 2019, a 17,7% decrease); natural emergencies – 104 (49 in 2019, a 2,1 times increase); bio-social emergencies – 60 (5 in 2019, a 12 times increase).

Thus, in 2020 the largest share of emergencies consisted of man-made emergencies – 50,5%; followed by natural emergencies – 31,4%; the share of biological and social emergencies was 18,1%.

In 2020, a pandemic of a new coronavirus infection COVID-19 became a biosocial emergency. This required the development of new organizational measures not only for the system of Rospotrebnadzor and the Ministry of Health of Russia, but also for specialists of other extreme professions.

¹ http://www.consultant.ru/document/cons_doc_LAW_388873/#dst100011 (accessed 26.01.2021)

² <https://www.mchs.gov.ru/dokumenty/4602> (accessed 27.01.2022)

³ <https://www.mchs.gov.ru/dokumenty/5304> (accessed 27.01.2022)

Previously, the main concern was such consequences of extreme situations as deaths, physical illnesses, injuries and disabilities. And now there is a growing concern about their consequences for the psychosocial and psychoemotional health of society [3].

As for the term "mental trauma", it is based on the theory of posttraumatic personality disorder and the provisions of crisis psychology that emerged at the end of the 20th century. Life situations and events that a person perceives as a clear threat to his/her existence, which can disrupt his/her habitual life activity, become a traumatic event for him/her. And it lies at the basis of experiences of a special kind, exposing him/her to stress [4].

As the number of traumatic situations and events experienced increases, those involved in rescue operations are at higher risk of developing a pathology known as post-traumatic stress disorder [5, 6].

Specialists of different professions are involved in the elimination of the consequences of emergencies, each of them has certain tasks. These professionals have a different level of preparation for overcoming traumatic events and stress, and, consequently, the risk factors of PTSD development have different significance for them. According to a number of authors, the prevalence of PTSD among representatives of various professional groups (firefighters, police officers, medical workers, etc.) varies from 0 to 46 [7-9].

A significant number of domestic and foreign publications are devoted to the stressogenic impact of the COVID-19 pandemic on emergency medical workers. Thus, the query "The psychological impact of COVID-19" in the PubMed search engine alone yielded 4861 sources. At the same time, there is an "explosive growth" in their number: in 2020 — 1622; in 2021 — 3403. The query for "The psychological impact of COVID-19 the mental health of healthcare professionals" yielded 487 sources (187 for 2020; 320 for 2021) [10-13].

Since the entry gates of COVID-19 are the epithelium of the upper respiratory tract, stomach and intestinal epithelial cells, the infection is transmitted by the airborne, air-dust, contact and fecal-oral routes. Large respiratory particles play a major role here, so personal protective equipment (PPE) has become an important component of the system to protect nursing staff and other patients from cross-contamination.

As a result, health care workers have become potentially most at risk of being infected with coronavirus because they come into contact with the virus in aerosol form during the course of their duties [14].

In the context of the pandemic, one of the main issues discussed in the medical community has been the effectiveness of PPE to protect medical personnel from infection. It is worth noting that their proper use, while not eliminating the risk of virus transmission, significantly reduces it [15].

Researchers cite rapid spread of COVID-19; severity of its symptoms; lack of scientific knowledge about the virus and increased mortality rate among medical colleagues as the main reasons for caution and uncertainty among medical professionals. Additional risk factors include: feelings of inadequate support; fears for one's own health; fear of transmission to family members or others; lack of quick access to testing; isolation; feelings of insecurity and social stigma; excessive workload. Throughout the relevant literature, there is consensus that health care workers

are at increased risk for stress, high levels of anxiety, depression, burnout, addiction, and post-traumatic stress disorder. All of these can have long-term psychological consequences [16].

In the COVID-19 pandemic, significant psychological discomfort is experienced not only by rescue workers, but also by their families.

Thus, in the study carried out by the group of authors, the following were revealed: problems with sleep — in 55% of respondents; appearance of symptoms of stress of mild and moderate severity — in 49; clinically significant symptoms of depression — 12,2; suicidal thoughts — in 8,3% of respondents. Researchers attribute these disorders in family members of rescuers to anxiety for their life and health. And also with disturbance of a habitual course of daily life, reduction of the amount of time spent with the family and children [17].

A number of works devoted to psychophysiological, neurophysiological and subclinical manifestations of cardiovascular diseases can be singled out as a separate independent direction.

The estimation of cortisol level in saliva and its correlation with stress index is given. In this paper, stress was assessed by the Spielberger-Hanin test, designed to determine situational and personality anxiety. A linear regression was used to determine associations between stress indexes and various cortisol parameters, adjusted for age, gender, race/ethnicity, increased waist volume and smoking status. A significant positive relationship was found between stress indices (general stress, physical hazard stress, and lack of support in the past month) and daily cortisol levels [18].

Undoubtedly, professional activity in the conditions of rescue work and emergency medical care entails stress. It is associated with the need to solve a large number of tasks in the shortest possible time. Prolonged exposure to the factor can accelerate the development of processes of body maladaptation to the environment with the subsequent formation of various psychosomatic conditions. This will be characterized by nonspecific changes in the hormonal status in the form of a functional decrease in the production of thyroid hormones, as well as increased levels of cortisol. Changes in the brain neurotransmitter systems result in a sharp inhibition of almost all nonspecific cellular and humoral immune protection factors [19, 20].

In recent decades, intensive work has been done to develop strategies, techniques and algorithms for early pre-diagnosis and timely measures to prevent mental disadaptation in rescue service professionals [21].

In Great Britain a set of measures on support as well as recommendations on communication and reduction of social tension; on self-help strategies (for example, rest, work breaks, sleep, shift work, fatigue, healthy lifestyle) and management of emotions (for example, moral trauma, overcoming difficulties, guilt, grief, fear, anxiety, depression, prevention of emotional burnout and psychological trauma) were developed. All of them are aimed at mitigating the impact of the COVID-19 pandemic on the mental health of medical professionals [22]. It is necessary to use all modern experience in providing psychological and other support to professionals providing medical care in the conditions of the COVID-19 pandemic [23].

It stands to reason that special importance is attached to the preparation of medical students for terrorism, natural

disasters and emergencies. The authors note that often the educational needs of students differ from the needs of practical medicine. A list of basic competencies that medical students should possess in order to provide qualified medical, including psychological, assistance in an emergency situation has been proposed [24].

At the same time, it is proposed to expand the practical part of the classes fostering skills of rendering assistance. Since, according to specialists' estimates, in a number of medical institutions the level of emergency preparedness is quite low and, according to the average calculated indicators, is 45.6%. And the readiness for emergency response and emergency measures is 33.3% [25-27].

Specialists have developed and implemented new methods and approaches to support medical specialists taking part in the liquidation of medical and sanitary consequences of emergencies. The normative legal regulation of psychophysiological examination of personnel during periodic medical examinations has been substantiated, which will allow to keep the "health of the healthy" [28].

The use of a comprehensive program of psychological correction "Shield" makes it possible to improve the functional state of the nervous and cardiovascular system. It increases general work capacity as well as the subjective assessment of the psychological and somatic state of the specialists, which in turn allows to maintain the professional longevity of the specialists [29].

Thus, the given study showed that despite an abundance of scientific literature, the prevalence and level of PTSD in medical professionals and rescue workers is currently understudied. While professionals in professional groups such as police and firefighters prepare for the risk of developing PTSD and learn possible self-regulation techniques to improve mental health during their training, medical professionals often lack such training modules.

The need to develop preventive measures, which should be aimed at helping professionals who are at risk, remains urgent. Also, there is the need to develop more adaptive coping strategies — relaxation training — to manage compulsive symptoms of hypervigilance and re-experiencing.

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ORGANIZATION OF ADMISSION OF THE INJURED IN RADIATION ACCIDENTS: EXPERIENCE OF THE SPECIALIZED ADMISSION DEPARTMENT OF THE OCCUPATIONAL PATHOLOGY CENTER OF THE FEDERAL STATE INSTITUTION "STATE RESEARCH CENTER – A.I. BURNAZYAN FEDERAL MEDICAL BIOPHYSICAL CENTER" OF THE FMBA OF RUSSIA

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Abstract. The main algorithms of actions for the medical personnel of the specialized admission department of the Center for Occupational Pathology at the A.I. Burnazyan Federal Medical and Biological Center of the Federal Medical and Biological Agency when admitting patients injured in radiation accidents and incidents are presented. The authors describe in detail issues of decontamination and priority of medical care, routing of patients within a specialized hospital, problems of sanitary and hygienic safety of personnel.

Key words: algorithm of actions, routing, medical personnel, medical aid rendering, admission of injured, radiation accidents, radiation incidents, sanitary processing, sanitary-hygienic provision, specialized admission department, specialized hospital

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ОРГАНИЗАЦИЯ ПРИЁМА ПОРАЖЁННЫХ ПРИ РАДИАЦИОННЫХ АВАРИЯХ: ОПЫТ РАБОТЫ СПЕЦИАЛИЗИРОВАННОГО ПРИЁМНОГО ОТДЕЛЕНИЯ ЦЕНТРА ПРОФПАТОЛОГИИ ФГБУ «ГНЦ – ФЕДЕРАЛЬНЫЙ МЕДИЦИНСКИЙ БИОФИЗИЧЕСКИЙ ЦЕНТР ИМ. А.И.БУРНАЗЯНА» ФМБА РОССИИ

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Резюме. Представлены основные алгоритмы действий медицинского персонала специализированного приемного отделения Центра профпатологии «ГНЦ – Федеральный медицинский биофизический центр им. А.И.Бурназяна» ФМБА России при поступлении пораженных в радиационных авариях и инцидентах. Подробно рассмотрены вопросы санитарной обработки и приоритетности оказания медицинской помощи, маршрутизации пациентов внутри специализированного стационара, проблемы санитарно-гигиенического обеспечения безопасности работы персонала отделения.

Ключевые слова: алгоритм действий, маршрутизация, медицинский персонал, оказание медицинской помощи, приём пораженных, радиационные аварии, радиационные инциденты, санитарная обработка, санитарно-гигиеническое обеспечение, специализированное приемное отделение, специализированный стационар

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The main task of the specialized radiological clinic is diagnostics and treatment of the injured in radiation accidents. The specialists of Federal State Institution "State Research

Center – A.I. Burnazyan Federal Medical Biophysical Center" of the Federal Medical and Biological Agency of Russia have vast experience in providing medical care to the injured

in radiation accidents. In 1949-2020 they were involved in elimination of consequences of 405 radiation accidents which affected 846 people.

The gained experience is realized by maintaining constant readiness to receive the injured in radiation accidents. And also in a clear system of organization of specialized medical care in radiation accidents in the following directions:

- organization of the work of the specialized admission department and the corresponding sanitary and admission regime;
- organization of the work of the department of acute radiation pathology with an intensive care unit;
- organization of the department for the treatment of local radiation lesions in order to ensure the performance of reconstructive-plastic surgical interventions;
- organization of laboratory-diagnostic support;
- organization of physical dosimetry of patients and control of medical personnel.

A special role is played by the specialized admission department, which is a permanently functioning subdivision of the hospital. Its specialists organize primary admission of the injured, perform dosimetry and decontamination, and, if necessary, provide emergency medical aid.

The radiological team, including 2 doctors, 2 dosimetrists and 6-8 average medical personnel, conducts reception of the patients.

The layout of the premises of the specialized admission unit is shown in Fig. 1.

The head of the specialized admission unit supervises the work of admission and determines the priority of care for in-

coming patients. The order of priority depends on the presence of conditions that require urgent medical care. If the patient's condition is satisfactory, the priority depends on the level of skin contamination — the higher the level of skin contamination, the higher is the priority in the priority list.

Dosimetrists are called to the specialized admission ward to perform radiation monitoring at the entrance to and at the exit from the specialized admission ward. Instruments with γ -radiation, β - and α -particle detection units are used for radiation monitoring. Individual radiation doses of medical personnel are monitored with dosimeters, which are in the stowage kit permanently stored in the specialized admission ward.

When entering the specialized admission ward, the patient takes off his/her clothes (first the shoes, then the clothes of the lower and then the upper belt). The staff packs the clothes in plastic bags and labels them with the owner's name and the date of admission. An inventory of the property handed over by the patient for storage in room 1A of the specialized admission department is made. If necessary, contaminated clothing is submitted for measurement in the clinic's laboratories, for special decontamination treatment, or burial.

Patients are swabbed from the conjunctivae of the eyes, mucosa of the nasal passages, external auditory passages and the scalp.

Sanitation is performed at any level of radioactive contamination of patients' bodies. In room N°2 affected people get soap and special detergents (paste "Protection", foaming emulsion "Radez"). Sanitary processing, which begins with a hand wash lasting up to 2 minutes at 30 ° C water

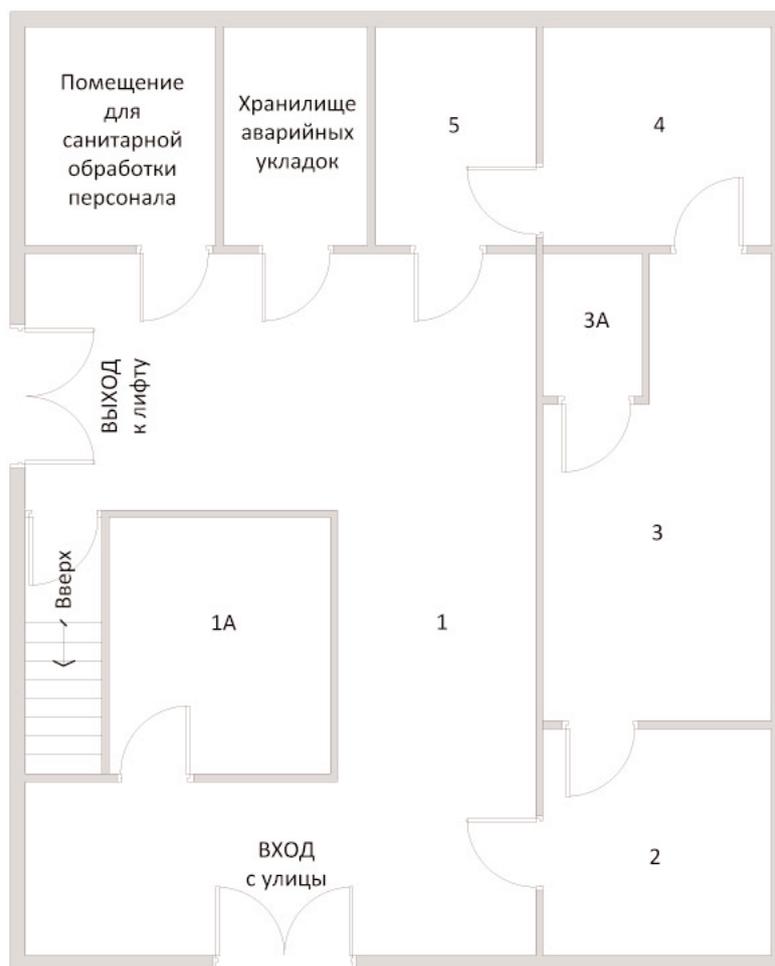


Рис. 1. Схема помещений специализированного приемного отделения
Fig. 1. Scheme of a specialized admission department

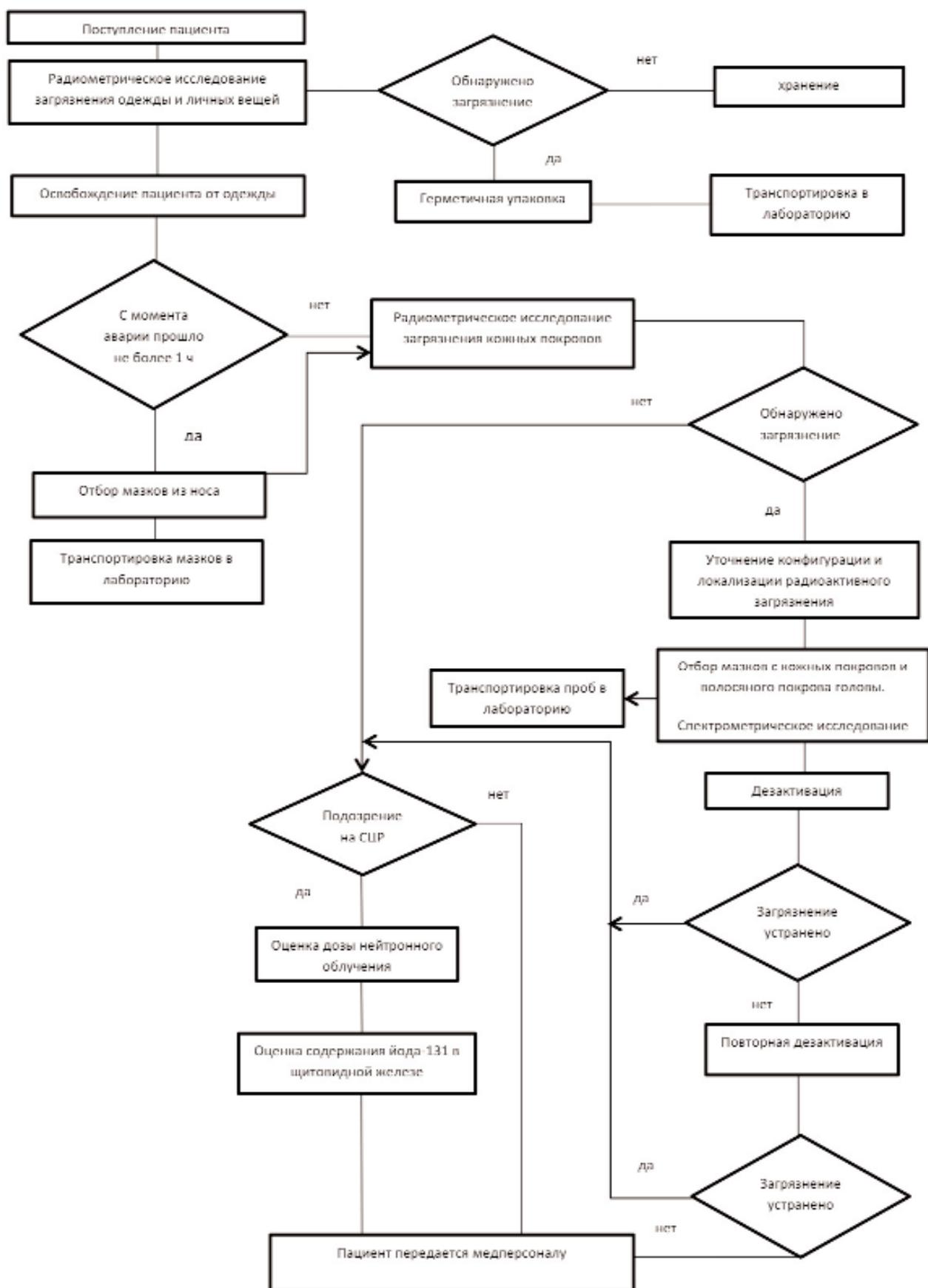


Рис. 2. Схема приема в специализированной клинике пораженного при радиационной аварии
 * СЦР – самоподдерживающаяся цепная реакция

Fig. 2. Scheme of admission of the injured in a radiation accident in a specialized clinic

temperature with a sponge or soft brush, carried out in the washing room number 3. Then the head (three times soaping and rinsing) and other body parts are washed for no more than 8 min. If necessary (residual radioactivity) — the hair is shaved off. Freshly prepared 2% sodium bicarbonate solution is used to rinse the mouth, eyes and external auditory passages.

After the decontamination, a control measurement of the surface contamination of the skin is carried out when the patient leaves the decontamination area and enters the clean area of the specialized admission unit. If residual radioactivity remains (contamination above 100 beta and/or 1 alpha particles/(cm²*min)) the sanitization is repeated, but no more than 3 times. The data obtained are recorded in the measurement protocol and subsequently in the medical records of the subject. Patients with compromised skin integrity (wounds, punctures, abrasions, burns) are sent to the dressing room of the specialized admission department for special surgical treatment of wounds, which is carried out under constant radiometric control. All dressing material and biosubstrates obtained during wound treatment are collected in containers, labeled and sent for radiometric investigation to the appropriate laboratories.

The toilet room (3A) is used to collect the excreta.

After sanitizing and radiometric skin testing, patients go to room 4, where they wear clean hospital clothes.

Then, the initial registration, patient examination, and medical history are performed. In addition, blood is drawn in room 5 for further radiometric and cytogenetic examination. In the case of emergency intake of radionuclides into the body of the affected people, they are examined on the Human Radiation Spectrometer. The conclusion on the content of radioactive substances in the patient's body and preliminary assessment of the radiation dose to critical organs and systems is sent to the attending physician.

Then the affected patients are admitted to the wards of specialized admission department for further observation and additional examinations — final determination of absorbed dose, and in case of radionuclide incorporation — for specific complexon therapy. For this purpose, the department is equipped with special stacks (Fig. 2).

In case of predicted development of acute radiation disease of II-IV stages of severity, patients are admitted to aseptic wards of the Department of Acute Radiation Pathology (Hematology). There they receive the whole complex of necessary treatment measures — bone marrow stimulation (betaleukin, granulocytic colony-stimulating factor), autologous or allogeneic stem cell transplantation, antibacterial, antiviral and antifungal therapy, blood component replacement therapy.

Patients who are predicted to develop acute radiation sickness of severity I may be under outpatient observation for three weeks before the onset of the period of major clinical manifestations of acute radiation sickness.

When carrying out works on the admission, examination and treatment of the affected people a set of measures on the organization of the personal protection of the personnel is carried out. Particular attention is paid to the protection of the respiratory organs from inhalation of radioactive aerosols, as well as the protection of the skin from radioactive contamination.

A set of personal protective equipment recommended for medical personnel working in the area of radioactive contamination includes:

- "Lepetok-200" respirator;
- overalls of mixed fabric;
- cap;
- special decontaminating shoes;
- medical gloves (2 pairs each);
- additional means of personal protection in plastikas (laminated):
 - gown
 - dungarees
 - apron
 - armbands
 - shoe covers.

After completing the work, all personnel of the team undergo radiometric monitoring, remove personal protective equipment at the boundary of the dirty area of the specialized admission unit (room #1) and undergo a complete sanitary treatment.

Radiation conditions in the premises of the specialized admission department are monitored by the radiation safety department after the end of hospitalization of patients.

When decontaminating rooms and surfaces:

- treat with decontaminating solution and then with water the identified places of radioactive contamination of surfaces;
- repeat radiometric control, if necessary — repeat washing of contaminated areas.

During decontamination works, liquid waste is collected in special containers (containers, flasks, barrels), and solid waste — in film bags. Then the radioactive waste is sent by special transport to the processing and burial points.

Thus, the presented algorithm of work of specialists of the specialized admission department allows timely and effective reception and sorting of victims of radiation accidents. It regulates the whole necessary complex of diagnostic and therapeutic measures, which as a result significantly improves the prognosis for this pathology [1-5].

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Review report
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NEW CORONAVIRUS PANDEMIC WORLDWIDE: SOME LESSONS FROM COVID-19 CONTROL

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Abstract. *The aim of the study was to perform a comparative analysis of COVID-19 epidemic process in selected countries of the world during the first pandemic wave in 2020 and during the rise of SARS-CoV2 variant Omicron.*

Materials and research methods. Analysis of the COVID-19 epidemic process was based on data from the Wordometers website (<https://www.worldometers.info/coronavirus/#countries>). In addition, scientific and popular science articles and official documents on the history, epidemiology, and response to the pandemic in different countries of the world in 2020-2022 were analyzed. The authors' own observations were also used.

Results of the study and their analysis. Restrictive measures adopted in the People's Republic of China (PRC), mass screening of the population, observation of those arriving in the country and hospitalization of all those infected made it possible to virtually reduce the circulation of the virus to zero. In the Russian Federation, timely simultaneous epidemic control measures throughout the country resulted in a significant decline in the intensity of the epidemic, both early in the pandemic and after local Omicron transmission, and prevented explosive growth of cases. In the USA, Italy and Sweden, untimely or lenient restrictive measures and low testing during selected periods of the pandemic led to an avalanche of cases and deaths.

Thus the epidemic process of COVID-19 in the analysed countries depended on the timeliness, duration and extent of restrictive and quarantine measures.

Key words: anti-epidemic measures, COVID-19 pandemic, epidemic process, Italy, restrictive measures, People's Republic of China, Russian Federation, SARS-CoV2 Omicron, Sweden, United States of America

Conflict of interest. The authors declare no conflict of interest

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ПАНДЕМИЯ НОВОЙ КОРОНАВИРУСНОЙ ИНФЕКЦИИ В РАЗНЫХ СТРАНАХ МИРА: НЕКОТОРЫЕ УРОКИ БОРЬБЫ С COVID-19

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Резюме. *Цель исследования – выполнить сравнительный анализ эпидемического процесса COVID-19 в отдельных странах мира во время первой волны пандемии в 2020 г. и в период подъема заболеваемости, вызванной вариантом SARS-CoV2 Омикрон.*

Материалы и методы исследования. Анализ эпидемического процесса COVID-19 основывался на данных сайта Wordometers (<https://www.worldometers.info/coronavirus/#countries>). Кроме того, были проанализированы научные и научно-популярные статьи, официальные документы по истории, эпидемиологии и противодействию пандемии в разных странах мира в 2020-2022 гг. При работе над статьей использовались также собственные наблюдения авторов.

Результаты исследования и их анализ. Принятые в Китайской Народной Республике (КНР) ограничительные меры, массовое тестирование населения, обсервация приезжающих в страну, госпитализация всех заболевших позволили практически свести к нулю циркуляцию вируса. В Российской Федерации благодаря своевременному и одновременно начатым на всей её территории противоэпидемическим мероприятиям была существенно снижена – как в начале пандемии, так и после возникновения местной трансмиссии варианта Омикрон – интенсивность эпидемического процесса, не допущен взрывной роста числа больных. В США, Италии и Швеции несвоевременно вводимые или мягкие ограничительные меры и низкий объем тестирования в отдельные периоды пандемии привели к лавинообразному увеличению числа больных и росту количества летальных исходов.

Таким образом, эпидемический процесс COVID-19 в анализируемых странах зависел от своевременности, длительности и объема вводимых ограничительных мер и санитарно-карантинных мероприятий в различные периоды пандемии.

Ключевые слова: SARS-CoV2 Омикрон, Италия, Китайская Народная Республика, ограничительные меры, пандемия COVID-19, противоэпидемические мероприятия, Российская Федерация, Соединенные Штаты Америки, Швеция, эпидемический процесс

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Introduction

The COVID-19 pandemic led to rethinking of human values, putting health as the main criterion for evaluating nation's rating. Strategies and tactics to fight for life and health determined the ability to resist the pandemic in every country [1]. Much of the key to the success of the fight against the new coronavirus infection was related to the counteraction to SARS-CoV2 during the first months of the virus' spread across the planet. These months predetermined the further development of COVID-19 epidemic process.

The fight against the COVID-19 pandemic had its own distinctive features in different countries [2, 3]. On the one hand health, on the other hand socio-economic interests of the state and economic interests of business were put on the scales [1].

The aim of the study was to analyze the epidemic process of COVID-19 in selected countries of the world during the first pandemic wave (2020) and during the wave caused by the SARS-CoV2 Omicron variant.

Materials and research methods. We analyzed our own experience with COVID-19 in the Russian Federation, the World Health Organization (WHO) missions to the People's Republic of China (PRC) in February 2020, the Russian humanitarian mission to Italy in March-April 2020, and scientific articles and publications devoted to the history, epidemiology and organization of pandemic response in different countries in 2020-2022. COVID-19 incidence statistics were taken from the Wordometers website (<https://www.wordometers.info/coronavirus/#countries>).

Study results and their analysis.

People's Republic of China. The first country to face a COVID-19 pandemic was the People's Republic of China. It should be noted that the PRC already had experience with the 2002-2003 SARS pandemic. A major mistake made at that time was the PRC's delay in responding to cases of SARS. This led to the spread of the infection to 29 countries around the world before restrictions were put in place. China was the country most affected by the first SARS pandemic, with 7,083 cases — 87.5% of the world's cases. But lessons have been learned from this mistake. Special hospitals with isolated ventilation systems were built to treat patients with highly dangerous airborne infections (SARS). And other measures have been taken to ensure an anti-epidemic regime [4, 5].

COVID-19 was already being countered in the PRC under a completely different scenario. As of December 30, 2019, there were 27 patients with interstitial pneumonia of unknown etiology in hospitals in Wuhan. All cases of pneumonia were reported in the city during the month. In this regard, the City Health Committee issued a message of special importance with information about cases of pneumonia of unknown etiology. In this way the whole world was informed about the infection that caused the subsequent COVID-19 pandemic [6].

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Transparent reporting of COVID-19, unlike the SARS pandemic, allowed PRC health leaders to avoid a number of strategic omissions. Although there were some miscalculations related to inadequate infection control in the first 2 months of infection control. This led to nosocomial spread of the disease among inpatients and infections among health care workers. As of February 11, 2020, 1,716 healthcare workers were infected in 422 hospitals [7].

In the fight against the new coronavirus infection, PRC authorities have taken unprecedented measures. Strict measures on social distancing and mask compliance have been introduced. COVID-19 management protocols were continuously reviewed and improved. Large-scale PCR testing was deployed. The training of health care workers and the use of telemedicine consultations were introduced. The bed capacity was increased. The production and supply of medicines and personal protective equipment was increased. IT technology, including the WeChat mobile app, tracked contacts down to the sixth in the chain. A huge health education work was conducted among the population. Volunteer movement and the work of public organizations that provided great support to the state in the fight against the pandemic were widely deployed [8]. In the country everybody who fell ill with COVID-19 was hospitalized. That is, the position of "zero tolerance" to the virus was observed. The construction of hospitals out of quick-mounted structures was unfolding. As a result, all measures to counteract the new coronavirus infection had an effect on the epidemic process within one or two weeks (see figure). As early as the beginning of February 2020, the daily detected number of COVID-19 cases went down. This allowed the PRC to lift the national quarantine on March 25, 2020. Thereafter, during the pandemic, all visitors from other countries were required to comply with a strict 14-day quarantine in a hotel-observatory with no leaving the room until the quarantine ended and daily PCR testing. This prevented the spread of other, later variants of the coronavirus to the PRC. Although small outbreaks of COVID-19 (200-250 cases per day), caused by local transmission of the virus, were periodically detected. This led to the introduction of severe restrictive measures in various provinces of the country. Nevertheless, the highly transmissible variant of Omicron could not be avoided in the PRC. However, a significant (by PRC standards) morbidity increase (3602 cases/day) was not recorded until March 15, 2022. By mid-April 2022 the situation with Omicron morbidity had stabilized (see figure).

Thus, stringent and early restrictive measures, strong social mobilization of the population, and a rapid increase in medical resources and testing volumes enabled PRC health care to successfully cope with the COVID-19 pandemic.

Russian Federation. Russian public health care, which incorporated the best of China's pandemic experience, based on its many years of experience in responding to biological threats, was also able to adequately respond to the first wave of the COVID-19 pandemic. Since the end of

January 2020, Russia began to implement a total testing of all arrivals from COVID-19-unfavorable countries. This made it possible to quickly identify the first imported cases. All newcomers were placed in home quarantine. There, they were closely monitored during the incubation period. After local transmission of SARS-CoV2 began to be recorded on March 16, restrictive measures were implemented in all regions of Russia, including distant work and study modes. From March 30, due to the beginning of an increase in the number of local transmission cases, restrictions were imposed nationwide, and a self-isolation regime was introduced. These measures made it possible to increase inpatient capacity, reassign hospitals, and deploy mono-hospitals to treat COVID-19 patients. Construction of hospitals out of quickly erected structures was organized, medical workers were trained, test systems with increased production volumes were developed, and the development of vaccines began. Volunteer work was organized, social support for pensioners and low-income people was provided.

Early sanitary-quarantine control, organization of anti-epidemic measures and social mobilization of the population prevented a rapid increase in the incidence of COVID-19 and significantly reduced the public health burden. Although, as in the PRC, "zero tolerance" to the coronavirus was not fully achieved. In April 2020, the number of patients increased significantly. And in the regions, as the bed capacity was filled, they began to hospitalize only those who had significant risks of developing a severe form of the disease or developing respiratory failure. Medical triage was conducted to identify patients prioritized for inpatient treatment. On May 11, 2020, after more than 2.5 incubation periods since the first thousand COVID-19 patients were registered, Russia reached the first peak in morbidity. The mortality rate was 0.9% (see figure). Beginning May 11, 2020 the country began to gradually lift the COVID restrictions, flexibly regulating their repeal at both the federal and regional levels. They were guided by the rate of increase/decrease in the number of cases and the utilization of hospital beds, while preserving the basic measures of nonspecific prevention [9, 10]. Testing was carried out not only in medical institutions and points of entry into the country, but also in enterprises and educational institutions. On August 11, 2020, the world's first COVID-19 vaccine, Sputnik-V, was registered in Russia. This marked the beginning of mass vaccination of the population. As a result, all anti-epidemic measures allowed to avoid further lockdowns, not to stop the work of enterprises, to restore routine vaccination and to gradually increase the volume of medical care to the population for other diseases. There was no increase in social tension in the country, and business was not seriously affected.

The variant SARS-CoV2 Omicron, first registered in Botswana and the Republic of South Africa (RSA) in November 2021, arrived in Russia in early December. The country's health authorities made thorough preparations for its arrival. From November 28, entry to Russia for tourists from South Africa, Botswana, Lesotho, Namibia, Zimbabwe, Mozambique, Madagascar, Tanzania, Hong Kong and Eswatini was restricted, and a 14-day quarantine was introduced for those entering from South Africa and other countries infected with Omicron [10].

As a result of these anti-epidemic measures, sporadic local cases of Omicron transmission were registered only

at the end of December. A palpable increase in the incidence of the disease began after the New Year holidays, beginning in the second decade of January 2022. Time was bought to deploy beds for COVID-19 patients, mobilize medical personnel and other medical resources, and increase the volume of testing. As a result, the Omicron wave arrived in Russia 1-1.5 months later than in European countries. After stealth-Omicron arrived in the country in early February 2022, there was no new rise as the Omicron and stealth-Omicron waves layered up, and gradually by April 2022 stealth-Omicron had supplanted its predecessor against the background of the continuing decline in COVID-19 morbidity.

Timely and simultaneous restrictive measures and early sanitary-quarantine measures combined with large-scale testing of the population and rapid build-up of medical resources have significantly reduced the incidence of COVID-19 and the activity of the epidemic process in the Russian Federation.

Italy. Italy timely, immediately after the registration of the first imported cases from Hubei Province of China, closed its borders with China on January 31, 2020. But at the same time it did not carry out emergency restrictive measures, being guided by the interests of business [12]. The match in Milan on February 19, 2020, later called "a biological bomb" and the opening of the Venice Film Festival at the same time, led to a catastrophic increase of COVID-19 patients in the provinces of Veneto and Lombardy. There was a shortage of beds (no one over 65 years old was hospitalized), medical personnel (10% of all diseased were health workers). Students and retired doctors were recruited. Cases of hospital-acquired infection in somatic wards, outbreaks in prisons and nursing homes, shortages of personal protective equipment (PPE) and ventilators appeared. Restrictive measures were not imposed all at once. First, on 22-23 February, they were imposed in the "red" regions, and only on 9 March, nationwide. Twelve days later, on March 21, a ban was imposed on movement in Italy, which practically meant a lockdown. As a result of the delay in taking restrictive measures, the growth of COVID-19 was rapid. It took less than one maximum incubation period (see figure) for the first wave to peak from the time the first thousand cases per day were reported. In mid-March 2020, the mortality rate from COVID-19 was 7.7%. Due to overcrowding of hospitals, preference was given to people of working age. Thus, the chances of survival decreased for people over 65-70 years old, who were even denied palliative care [11-14]. The Italian government had to ask for help from outside. Russia, which had successfully coped with the COVID-19 epidemic, came to the rescue first [15]. The situation with COVID-19 in Italy had stabilized by the summer of 2020. But later on, the country would face new morbidity rises, new restrictions for citizens and businesses, and new blows to the economy.

SARS-CoV2 variant Omicron reached Italy in mid-November 2021. This led to new restrictions for citizens and businesses in preparation for the Christmas holidays. The first day of 2022 saw a spike in Omicron cases to 200,000 cases or more per day. They continued to be recorded until mid-January (see figure). The declining Omicron variant was replaced by stealth Omicron in early February. This again led to a rise in the epidemic curve to 98,000 cases per day by the third decade of March 2022

and caused an extension of the emergency situation (in effect January 31, 2020), until March 31, 2022. Thus, further errors in the organization of anti-epidemic measures for the Omicron variant caused new turmoil for society and the economy.

Untimely and ill-timed restrictive measures in Italy, both in the first phase of the pandemic and after the emergence of the Omicron variant, contributed to an explosion of cases, health care overload and deaths.

Sweden. This country chose a particular way to deal with COVID-19, eschewing strict quarantine measures and motivated by the need to protect the economy from shocks. Sweden did not impose strict restrictions. Restaurants, cafes, non-food stores, and schools operated.

Nevertheless, by the end of June 2020 Sweden had the world's 12th highest rate of infection per million inhabitants, but it still had the highest fatality rate at 11.2% (see figure). The rate was even higher (up to 50%) in nursing homes. This was associated with the late introduction of a ban on visiting residents. Among more overcrowded migrants, the mortality rate was as high as 40%. There was also low testing coverage, at 30,000 tests per week against a target of 100,000.

Sweden, however, could not avoid economic problems, as a state of emergency was imposed in the other countries surrounding it. This led to a sharp restriction of cross-border contacts, affecting the country, whose economy depended on production in other states. As a result,

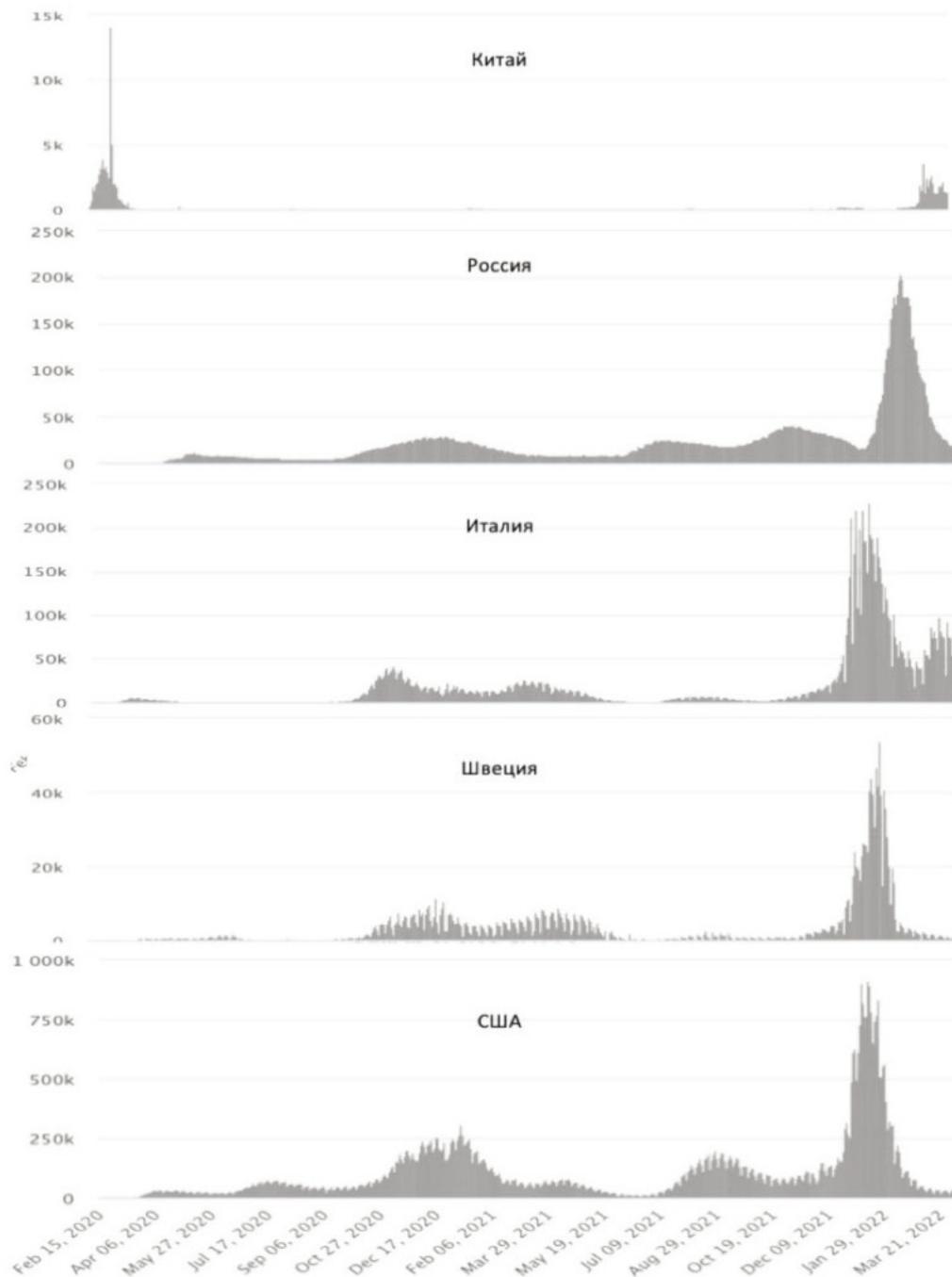


Рисунок Эпидемические кривая заболеваемости COVID-19 в Китае, России, Италии, Швеции и США в январе 2020 – апреле 2022 гг., по данным сайта www.worldometers.info
Picture. Epidemic curve of the incidence of COVID-19 in China, Russia, Italy, Sweden and the USA in January 2020 - April 2022 (according to website www.worldometers.info)

Число заболевших (чел.) на 100 тыс. населения в отдельных странах мира, по состоянию на 10 апреля 2022 г.
Number of Cases per 100 Thousand Population in Selected Countries of the World, as of April 10, 2022

Страна Country	Заболеемость COVID-19 The incidence of COVID-19	95%-ный ДИ 95% CI	Максимальное число заболевших на пике волны Омикрона Maximum cases at the peak of the Omicron wave	95%-ный ДИ 95% CI
США/ USA	24,2	23,0–25,41	272,5	258,9–286,1
Швеция/ Sweden	24,29	22,94–25,42	525,4	498,7–551,1
Италия/ Italy	25,37	24,10–26,61	379,6	360,08–398,4
Россия/ Russia	12,37	11,74–12,98	140,1	133,0–147,1
Китай/ China	11,3	10,71–11,85	0,25	0,237–0,283

the chief state epidemiologist of Sweden, A. Tegnell, admitted that the strategy chosen by the country contributed to a large number of victims from SARS-CoV2 [16].

In Sweden, Omicron arrived two weeks later than in Italy, at the very end of November 2021. Therefore, the peak of the disease occurred in the twentieth days of January 2022 (see figure). Stealth Omicron was also detected in Sweden in mid-January 2022. As a result, the rise in Omicron incidence has smoothly turned into a rise caused by stealth Omicron. The change in circulating strains did not result in a clearly delineated second peak. The incidence then went into a decline. By the second decade of February 2022, it had stabilized at low numbers, leading to the lifting of all few restrictions. Thus, in Sweden, the layering of two waves of morbidity — Omicron and stealth Omicron — has similar features to Russia. But it occurred in an earlier period of time. That's because the initial measures aimed at preventing localized Omicron transmission were weaker and did not include a 14-day observation of those returning from countries unfavorable for the incidence of this variant of SARS-CoV2.

Weak restrictive measures imposed in Sweden to save the economy and low testing volumes resulted in a high incidence of severe COVID-19 in risk groups, but did not prevent economic losses to the state.

United States of America. The United States is the world leader in the number of people infected and the number of deaths. The virus entered the western and eastern U.S. states simultaneously, presumably in mid-February 2020. At that time, there were no more than 100-150 tests per day in the country, allowing SARS-CoV2 to spread unimpeded. Quarantine measures were weak. Restrictions were imposed at different times in different states and were far from complete. The imposition of restrictions mainly depended on which of the two major political parties — Republican or Democratic — the state governor belonged to. In the early days of SARS-CoV2, Republicans imposed restrictions an average of 2.7 days later than Democrats, directly affecting the number of people infected. This approach was dictated by the economy and business, which forced more lenient and less time-consuming restrictive measures than in Europe and China. There was also significant bureaucratic desynchronization. It contributed to the shortage of some medicines, equipment, consumables and PPE [16]. The country reached its first disease peak in early April 2020, 1.5 incubation periods after reaching a daily incidence rate of 1,000. Then, after a slight decline, due to weak restrictions, a second, more powerful wave of infections set in. It peaked at the end of

July (see figure). At this time there was a temporary respite in the vast majority of other countries that had experienced a rise in incidence in the spring. The original CDC PCR tests for the coronavirus used 3 rather than 2 "probes" to detect SARS-CoV2 genomic fragments. The third genome fragment gave an indeterminate result. It took several weeks to correct the error. Initially, the time needed to contain the COVID-19 pandemic was missed. Subsequently, the missed time affected the entire course of the COVID-19 epidemic process, which was the most active in the United States [17].

The Omicron variant was imported into the United States from South Africa on November 22, 2021, and was diagnosed in a patient on November 29 while he was on self-isolation. More lenient restrictions on those returning from Omicron-disadvantaged countries contributed to the rapid spread of the new SARS-CoV2 variant in the United States. It took just over a month for the country to reach the highest incidence rate in the world during the pandemic — more than 900,000 cases per day between 7 and 13 January 2022 (see figure). As a result, the U.S. became the "record holder" for fatalities as well, with more than 1 million deaths during the entire pandemic.

Low testing volumes and problems with test system specificity during the first wave of the pandemic in the United States, weak and inconsistent restrictive measures, and interagency inconsistencies all led to overburdened health care systems and shortages of medical supplies, the highest numbers of patients and deaths from COVID-19.

As a result, the countries — China and Russia — that prioritized preserving the nation's health rather than economic interests from the beginning of the pandemic handled the pandemic much better. They took the last 2 places both among the countries compared in terms of morbidity during the entire pandemic period and in terms of the number of cases at the peak of the Omicron-induced SARS-CoV2 wave (see table). This demonstrates the effectiveness of the anti-epidemic measures implemented in these countries throughout the pandemic period.

Conclusion

The epidemic process of COVID-19 in these countries depended on the timeliness, duration and scope of restrictive and quarantine measures introduced during different periods of the pandemic. Detailed analysis of pandemic management at each stage in different states with different economic and medical circumstances and different government and societal attitudes towards restrictive measures is needed to improve pandemic preparedness plans for respiratory viral pandemics.

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REALIZATION OF THE CONCEPT OF THE RUSSIAN CITIZENS FEDERAL MILITARY SERVICE TRAINING SYSTEM FOR THE PERIOD TILL 2020 ON REGIONAL LEVEL

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Abstract. *The aim of the study is to analyze the results of work of draft commissions of the Orenburg region on the implementation of the Concept of the federal system of preparation of citizens of the Russian Federation for military service for the period up to 2020 in 2011-2020.*

Materials and research methods. Materials of the study — accounting and reporting documents of the department of preparation and enlistment of citizens for military service and of the center of military-medical examination of the military commissariat of Orenburg oblast.

Results of the study and their analysis. In Orenburg oblast, the main provisions of the Concept's forecast indicators have been fulfilled. Notwithstanding a drop in the total number of citizens of conscription age, qualitative changes took place in the structure of their contingent: the indicators of fitness for military service depending on health condition became higher, mainly due to growing number of citizens of fitness category "A" and, to a lesser extent, due to growing number of citizens of fitness category "B".

Timely examination of conscripts in the period between call-ups sharply reduced the number of citizens requiring additional examination during call-ups. Optimization of the timing of examinations and timely expert decisions on the fitness for military service of citizens of this category were of great practical importance.

Key words: *Concept of the federal system of preparation of citizens of the Russian Federation for military service for the period till 2020, draftees, medical examination, military commissions, state of health, military-patriotic education, military service, Orenburg oblast*

Conflict of interest. The authors declare no conflict of interest

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РЕАЛИЗАЦИЯ НА РЕГИОНАЛЬНОМ УРОВНЕ КОНЦЕПЦИИ ФЕДЕРАЛЬНОЙ СИСТЕМЫ ПОДГОТОВКИ ГРАЖДАН РОССИЙСКОЙ ФЕДЕРАЦИИ К ВОЕННОЙ СЛУЖБЕ НА ПЕРИОД ДО 2020 г.

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Резюме. *Цель исследования – проанализировать результаты работы призывных комиссий Оренбургской области по реализации Концепции федеральной системы подготовки граждан Российской Федерации к военной службе на период до 2020 г. (Концепция).*

Материалы и методы исследования. Материалы исследования – учетные и отчетные документы отдела подготовки и призыва граждан на военную службу и центра военно-врачебной экспертизы (ВВЭ) военного комиссариата Оренбургской области.

Результаты исследования и их анализ. В Оренбургской области основные положения прогнозных показателей Концепции – выполнены. Несмотря на уменьшение общего числа граждан призывного возраста произошли качественные изменения в структуре их контингента – увеличились показатели годности граждан к военной службе по состоянию здоровья: преимущественно – за счет граждан категории годности «А» и в меньшей степени – категории годности «Б».

Своевременное обследование призывников в период между призывными кампаниями резко сократило число граждан, нуждающихся в дополнительном обследовании во время проведения призывных мероприятий. Важное практическое значение имела оптимизация сроков проведения обследования и своевременное принятие экспертных решений о годности к военной службе граждан данной категории.

Ключевые слова: *военная служба, военно-патриотическое воспитание, Концепция федеральной системы подготовки граждан Российской Федерации к военной службе на период до 2020 г., медицинское освидетельствование, Оренбургская область, призывники, призывные комиссии, состояние здоровья*

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

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Introduction

The manning of the Armed Forces of the Russian Federation is one of the most important elements of its national security¹.

Military service is a special type of federal public service for young people, which places increased demands not only on professional training, but also on the health and personal qualities of each serviceman [1].

Reduction of the term of military service under conscription (2008) to one year requires a twofold increase in the number of persons called up for military service. In this situation it is necessary to look for new ways and methods of work on comprehensive preparation of young people for military service [2].

By Order No 134-r of the Government of the Russian Federation of February 3, 2010, the "Concept of the Federal System of Preparing Citizens of the Russian Federation for Military Service for the Period up to 2020" (hereinafter, the Concept) was approved. The Concept outlined the main activities aimed at improving health, physical and psychological training, military-patriotic education of citizens subject to conscription, restoration of the system of mass physical training and sports for young people².

The aim of the study is to analyze the results of work of draft commissions of the Orenburg region on the implementation of the Concept of federal system of training of citizens for military service in 2011-2020.

Materials and methods of research. Materials of the research — records and reports of the department of training and enlistment of citizens for military service and the center of military-medical expertise of the military commissariat of the Orenburg region.

Results of the study and their analysis. Citizens are drafted by drafting committees established in municipalities of towns and rural territories. The decision on each recruitment is made by all members of the draft board, which ensures its collegiality.

During the period under study, 46 draft boards operated in the Orenburg Region, including one regional board, 7 urban boards, 7 urban district boards and 31 boards of rural municipalities.

In accordance with the Decrees of the President of the Russian Federation, draft campaigns are held twice a year: spring call-up — from April 1 to July 15; autumn call-up — from October 1 to December 31.

According to the current laws of the Russian Federation, men between 18 and 27 years of age who are fit for military service on health grounds and have no right to deferment of call-up are subject to call-up for military service³.

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Over a 10-year period (2011-2020), draft boards of the Orenburg Region sent 47299 citizens to the Armed Forces for conscription: the highest number of conscripts (5622) was in 2011; the lowest number (3927) was in 2018.

It should be noted that during medical examinations, a number of conscripts were given incorrect decisions on their fitness for military service. Subsequently, they served as grounds for early dismissal of these citizens for health reasons. The highest proportion of enlisted servicemen, who were dismissed early in the first three months of their military service (the reporting return), was recorded in 2011. It amounted to 0.25% of the number of conscripts; the lowest share — 0.02% — in 2016. In 2019 and 2020, there were no early discharged from military service.

The examination of citizens for fitness for military service on health grounds was conducted by specialists: psychiatrist, neurologist, therapist, oculist, surgeon, otorhinolaryngologist, dentist, and dermatologist. If necessary, a narcologist and a medical psychologist were additionally involved [3].

The Federal Law "On Military Duty and Military Service" provides for the following categories of fitness for military service based on health status:

Category "A" — fit for military service — there are no diseases or there are some chronic diseases with stable remission for several years.

"B" — fit for military service with minor limitations — there are chronic diseases with rare exacerbations with minor violations of the functions of organs and systems.

"C" — limited fitness for military service — there is a stable disorder of the vital functions of the organism as a result of illness, which limits the ability to fulfill the duties of military service in peacetime.

"D" — temporarily unfit for military service — temporarily lost the ability to perform the duties of military service as a result of acute diseases. A deferment of call-up for military service is granted for the term of up to 12 months for carrying out rehabilitation measures.

Category "D" — not fit for military service — has impairments to the vital functions of the organism as a result of illness or injury, which have led to permanent loss of the ability to perform the duties of military service in peacetime and wartime — is subject to removal from the military register.

Citizens with fitness categories "A" and "B" are subject to call-up for military service in peacetime⁴.

In 2011, 24646 citizens of call-up age arrived at the draft commissions, and according to forecasts, their number should decrease every year in the future. The share of those fit for military service due to their health (categories "A" and "B") was 63.3%, of which: category "A" — 29.2%; category "B" — 34.1%.

¹ On the National Security Strategy of the Russian Federation. Decree of the President of the Russian Federation Dated July 02, 2021, No. 400. URL: http://www.consultant.ru/document/cons_doc_LAW_389271. (Accessed 10.12.2021) (In Russ.).

² On the Approval of the Concept of the Federal System for Preparing Citizens of the Russian Federation for Military Service for the Period Until 2020. Decree of the Government of the Russian Federation Dated February 03, 2010, No. 134-r. URL: https://www.consultant.ru/document/cons_doc_LAW_149096/. (Accessed 10.12.2021) (In Russ.).

³ On Military Duty and Military Service. Federal Law Dated March 28, 1998, № 53. URL: <https://yandex.ru/turbo?text=https%3A%2F%2Fzakon.ru%2Fflaws%2Ffederalnyy-zakon-ot-28.03.1998-n-53-tz%2F> (Accessed 12.11.2021) (In Russ.).

⁴ On the Approval of the Regulations on the Military Medical Expertise. Decree of the Government of the Russian Federation of July 4, 2013, No. 565. URL: https://www.consultant.ru/document/cons_doc_LAW_149096/. (Accessed 10.12.2021) (In Russ.).

The diseases that served as the reason for exemption of citizens from military service were ascertained. The first place was occupied by diseases of the musculoskeletal system, with a share of 42.6%; the second place was occupied by mental diseases and behavioral disorders — 9.9%; in the third place — by endocrine, nutritional and metabolic diseases — 6.8%. The cumulative share of these diseases was 59.3%.

Next in importance were diseases of the circulatory organs — 6.6%; diseases of the digestive organs — 5.1, eye diseases — 4.2%. The other classes of diseases had a lower prevalence and did not have a significant effect on the fitness for military service.

In the current situation, in order to preserve the necessary human resource ensuring annual fulfillment of the state assignment for conscription of citizens to military service, an accurate system of medical and health-improving measures among citizens of conscription age was established. Improvement of the health of conscripts was closely linked to improvement of the system of sports and physical culture events. Young people were actively involved in physical training and sports, healthy lifestyles were promoted: giving up smoking and alcoholic beverages, and adhering to regimes of work and rest.

In the Orenburg Region during this period of time, there was a rise of military-patriotic work among conscript youth. A regional center of additional education "Podrostok" ("Teenager") and a regional center of military-patriotic education of youth were created and continue to work successfully in the region. Under the leadership of the regional branch of DOSAAF of Russia the All-Russian military-patriotic young men's movement has developed and is strengthening [4].

The number of military-patriotic circles, clubs, associations increased by more than 5 times between 2011 and 2020 (from 114 to 619), and the number of people involved in them — by 9 times (from 1763 to 15616). This work has helped foster a sense of patriotism and friendship among young people and motivate them to serve in the army and fulfil their constitutional duty to their country.

In 2020, there were over 660 Young Army units in the region with over 19,700 Young Army members. The training in the basics of military service received by conscripts allowed them to become worthy defenders of the Fatherland and to successfully serve their conscription in the Special Forces, Airborne Forces, and Navy. After completing military service as a conscript, the young men, as a rule, conclude contracts for further military service and become professionals in the military business.

In the Orenburg region there is an active development of mass sports activities, the number of young people involved in physical culture and sports is growing every year. Over the past 10 years, the number of sports schools increased to 85; 62 thousand children and teenagers take part in them. More than 40 thousand young people met the standards of the All-Russian physical culture and sports complex "Ready for Labor and Defense".

The forecast made in 2011 proved to be correct — over the period from 2011 to 2020, the number of recruits coming to the Orenburg region draft commissions decreased by 16.5% and will amount to 20571 persons in 2020. In 2020, the number of persons drafted to the Orenburg Region draft boards decreased by 16.5% to 20,571 persons.

Over the period under study, there has also been a considerable increase in the degree of fitness for military service of drafted youth.

The share of those fit for military service (categories "A" and "B") was 74.5% in 2020. 74.5%, i.e. there has been an increase by 11.2%. It should be noted that the bulk of the increase in the number of those fit for military service was due to the category "A". Its indicators increased by 7.7%. To a lesser extent, this occurred at the expense of category "B", whose indicators increased by 3.5%.

Analysis of the reasons for exemption from military service due to health conditions (categories "C" and "D") showed that in 2020 there was a significant change in the structure of diseases that caused exemption from conscription. In spite of the fact that the diseases of the musculoskeletal system still occupied the first place, their share decreased by 1.9 times, and amounted to 21.9%. Mental and behavioral disorders continued to occupy the second place, but their share doubled to 19.5%. In third place were diseases of the circulatory system, the share of which increased 2.3-fold and amounted to 15.1%. Next in importance were: eye diseases — 9.0%, — increase by 2.2 times; endocrine, nutritional and metabolic diseases — increase by 1.1 times — 7.6%; diseases of nervous system — increase by 1.4 times (5.9%). Heads of medical treatment organizations of all levels need to pay close attention to the prevention and treatment of this pathology.

It should be noted that during the period under study the dispensary work among conscripts has improved and the period of examination in medical treatment organizations has considerably decreased. The number of laboratory and instrumental examinations carried out for each conscript has considerably increased.

In 2011, the list of obligatory examinations to be conducted before the examination of conscripts included: measurement of height and body weight; chest fluorography; blood tests — determination of hemoglobin and leukocytes; urine tests - determination of specific gravity and the presence of protein.

By 2020, the list of mandatory tests for conscripts was expanded by adding: general blood test, general urine test, blood test for antibodies to HIV infection, chronic hepatitis B and C, electrocardiography.

In 2011, of the total number of citizens of call-up age arriving at draft committees (24646), the share of conscripts sent to medical treatment organizations for outpatient or inpatient supplementary examination to clarify the diagnosis of diseases amounted to 22.4% and only 57.1% of them completed examinations before the end of the draft.

Under the leadership of municipal draft commissions and with the joint work of health care, education and military commissariats, successes were achieved in conducting examinations of conscripts. The period between conscription campaigns was used extensively, resulting in a sharp decrease in the number of citizens sent for additional examination during them.

In 2020, the share of conscripts sent for additional medical examination decreased to 14.5% of the total number of those coming to the draft commissions, and the share of those who completed the examination was 82.4% of the total number of those sent for examination.

Conclusion

1. In the Orenburg Region, the main provisions of the forecast indicators of the Concept have been fulfilled. Despite a drop in the total number of individuals of a call-up age, qualitative changes have occurred in the structure of their contingent. The indicators of fitness for military service due

to health condition have increased: mainly due to citizens of fitness category "A" and, to a lesser degree, category "B".

2. Timely examination of conscripts between call-ups sharply reduced the number of citizens requiring additional examination during call-ups. Optimization of the timing of examinations and timely expert decisions on the fitness for military service of citizens of this category were of great practical importance.

3. In connection with the Decree of the Government of the Russian Federation on the prolongation of the Concept un-

til 2030, the interested structures at the municipal and regional levels will take all measures to solve a number of problems related to its implementation⁵.

⁵⁵ On Approval of the "Concept of the Federal System of Preparation of Citizens of the Russian Federation for Military Service for the Period to 2030": Decree of the Government of the Russian Federation of October 30, 2021 №3082. URL: <https://docs.cntd.ru/document/902197351>. (Accessed 10.01.2022) (In Russ.).

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ANALYSIS OF PERFORMANCE IN ROUTINE OF DAILY ACTIVITIES OF THE OPERATIONAL ADMINISTRATIVE SERVICE OF THE MOSCOW DEPARTMENT OF HEALTH IN PROVIDING QUALITY MEDICAL CARE TO POPULATION IN 2017-2021

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Abstract. The aim of the study is to analyze the effectiveness of the operational administrative service of the Department of Health of Moscow to ensure the health of the population.

Materials and research methods. We analyzed the work of the operational administrative service of the Department of Health of Moscow in 2017-2021 basing on verbal complaints of citizens about shortcomings in the work on the provision of medical care to the population. Materials of the study – reports on the elimination of medical and sanitary consequences of emergencies; orders, instructions and other documents of the Department of Health of Moscow.

Results of the study and their analysis. The work of operational administrative service proved its efficiency: opportunities for the citizens to seek medical assistance expanded, number of cases of operative response increased. Expansion of the operational administrative service staff due to epidemiological situation on COVID-19 increased the number of verbal appeals of citizens in comparison with 2019. Intensive work on detection of errors and their elimination by specialists of medical treatment organizations led to a decrease in number of requests for medical care and to a reduction of validity of verbal complaints about shortcomings of its provision.

It is concluded that it is expedient to create similar services in other megalopolises of the Russian Federation.

Key words: megalopolis, operational administrative service of the Department of Health of Moscow, population, prompt response, quality medical care, routine of daily activities, verbal complaints of citizens

Conflict of interest. The authors declare no conflict of interest

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АНАЛИЗ ЭФФЕКТИВНОСТИ РАБОТЫ В РЕЖИМЕ ПОВСЕДНЕВНОЙ ДЕЯТЕЛЬНОСТИ ОПЕРАТИВНО-РАСПОРЯДИТЕЛЬНОЙ СЛУЖБЫ ДЕПАРТАМЕНТА ЗДРАВООХРАНЕНИЯ г.МОСКВЫ ПО ОБЕСПЕЧЕНИЮ ОКАЗАНИЯ КАЧЕСТВЕННОЙ МЕДИЦИНСКОЙ ПОМОЩИ НАСЕЛЕНИЮ В 2017–2021 гг.

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Резюме. Цель исследования – проанализировать эффективность работы оперативно-распорядительной службы (ОРС) Департамента здравоохранения г.Москвы (ДЗМ) по обеспечению оказания качественной медицинской помощи населению в 2017–2021 гг.

Материалы и методы исследования. Материалы исследования – отчёты о работе оперативно-распорядительной службы ДЗМ по устным обращениям граждан; нормативные правовые акты по вопросам медицинского обеспечения населения.

Результаты исследования и их анализ. Работа оперативно-распорядительной службы показала свою эффективность: расширились возможности обращения граждан по вопросам оказания медицинской помощи, возросло количество случаев оперативного на них реагирования. Ухудшение эпидемиологической ситуации по COVID-19 потребовало расширения штатов ОРС и увеличило количество устных обращений граждан по сравнению с 2019 г. Интенсивная работа по выявлению ошибок и их устранению специалистами лечебных медицинских организаций (ЛМО) привела к уменьшению обращаемости за медицинской помощью и снижению обоснованности устных жалоб на недостатки её оказания.

Сделан вывод о целесообразности создания подобной службы в других мегаполисах Российской Федерации.

Ключевые слова: качественная медицинская помощь, мегаполис, население, оперативно-распорядительная служба Департамента здравоохранения г.Москвы, оперативное реагирование, режим повседневной деятельности, устные обращения граждан

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Introduction

At the present stage one of the priority directions of the Russian Federation healthcare development is the improvement of the system of medical care quality management, ensuring the readiness of the state, municipal and private healthcare systems to work in emergency situations and in wartime¹. The Decree of the President of the Russian Federation of June 6, 2019 № 254 clearly outlines the result to be achieved in the implementation of this strategy: "...the formation of new, including organizational and managerial, solutions aimed at the sustainable development of the healthcare system, the preservation of public health and improving the quality of medical care"².

Based on the tasks set, it is particularly important to create an effective management model in a megalopolis such as Moscow. Because there is a high risk of development of critical situations in the field of life safety of the population.

Currently, the scientific literature discusses the organization and provision of medical care to victims in emergencies [1–9]. At the same time the problem of optimization of the work carried out in the mode of daily activities remains no less urgent [10–12].

In order to effectively solve the issues of optimization of the work of medical organizations in the mode of daily activities the operational administrative service of the Moscow Health Department (DZM) was created.

The tasks of the operational administrative service are to analyze and to summarize operational information about disturbances of life support and the emergence of abnormal situations in medical organizations of the state health care system of Moscow. And the service must also respond in a timely manner to oral communications from citizens on the organization of medical care to the population.

One of the activities of the operative service is the evaluation of work on oral appeals of citizens on issues of medical care (Fig. 1).

The analysis of the data presented in Fig. 1 shows that there is still a high proportion (2021 – 44%) of justified verbal complaints received from the population of Moscow. This dictates the need to continue and to improve the work of operational administrative service in the given mode. The validity of verbal complaints is determined both by the fact of verification of information contained in the appeal, and by the confirmed fact of detection of violation.

The aim of the study is to analyze the effectiveness of the operational and administrative service of the DZM of Moscow on public health in 2017–2021.

Materials and methods of the study. Materials of the study — reports on the work of the operational administrative service on verbal appeals of citizens in 2017–2021; normative legal acts on the issues of medical provision of the population^{3–9}.

Results of the study and their analysis. The results of the study are based on the development of control mechanisms for the provision of medical care to the population of Moscow. One of the main indicators of work control is the solution rate for private verbal questions coming to the operative service.

The Department of Health of Moscow has worked with verbal appeals from citizens before. It was based on the following principles: involvement of medical specialists from subordinate medical treatment organizations, daily round-the-clock operational control of their activities, adoption of urgent measures to address shortcomings in their work. Time has shown that the previous scheme, which existed until 2016, did not justify itself. The work with verbal appeals was mostly of a question-and-answer type of informational and reference nature. In the work of the hotline, there was a one-line operation in accepting appeals and transmitting information. There was no monitoring of the result of the appeal (Fig. 2). In addition, the lack of permanent staff made it impossible to conduct regular monitoring of incoming data.

In order to ensure quality and timely control over the provision of medical care to the population, it was necessary to improve the existing scheme of work. We needed a service that, on the one hand, would interact with the population and, on the other hand, would make decisions remotely. All of this led to the creation in 1997 of the control and administrative service of the Moscow Health Committee. It was entrusted with the functions of remote decision-making on operational issues in the city's health care system. On the basis of the order of the DZM dated March 2, 2017

³ On the Order of Consideration of Appeals of Citizens of the Russian Federation: Federal Law of May 2, 2006 №59-FZ (ed. from 27.12.2018) (In Russ.)

⁴ On the Control and Administrative Service of the Moscow Healthcare Committee: order of the DZM of July 22, 1997 No. 416 (In Russ.)

⁵ On the Work of the Operational Administrative Service of the Department of Healthcare of Moscow: Order of the DZM dated March 2, 2017 № 155 (In Russ.)

⁶ About the Operational Administrative Service of the Department of Healthcare of Moscow: order of the DZM from 29.12.2020 №1511 (In Russ.)

⁷ About Territorial Disaster Medicine Service of the City of Moscow: Order of the DZM from 25.11.2021. № 1171 (In Russ.)

⁸ On Approval of the Regulations for Prompt Consideration of Citizens' Telephone Appeals: Decree of the DZM of 23.01.2018 No. 90-r (In Russ.)

⁹ On the Territorial Program of State Guarantees of Free Medical Care for Citizens in the City of Moscow for 2022 and for the Planning Period 2023–2024: Decree of the Government of Moscow No. 2208-PP of 24 December 2021 (In Russ.)

¹ On the Unified State System for the Prevention and Elimination of Emergency Situations: Decree of the Government of the Russian Federation of December 30, 2003 № 794 (In Russ.)

² On the Strategy of Healthcare Development in the Russian Federation for the Period until 2025: Decree of the President of the Russian Federation from June 6, 2019 № 254 (In Russ.)



Рис.1. Доля обоснованных и необоснованных устных жалоб, поступивших в ОРС ДЗМ в 2017–2021 гг., %

Fig.1. Share of substantiated and unsubstantiated oral complaints received by the Operational And Administrative Service DZM in 2017–2021, %

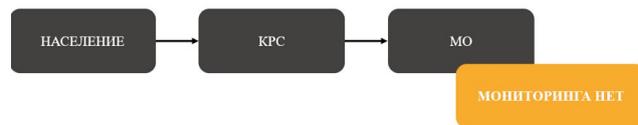


Рис.2. Схема работы контрольно-распорядительной службы Комитета здравоохранения (КРС) г.Москвы до 2016 г. по принятию устных обращений

Fig.2. Scheme of work of the control and administrative service of the Committee of Health of Moscow until 2016 for the acceptance of oral appeals

№155, the control and administrative service was reorganized into the operational administrative service of the Department of Health of Moscow. Currently, the operational administrative service of the DZM operates on the basis of DZM Order No. 1511 of December 29, 2020.

The operational administrative service is a functional unit of the Moscow Health Department. It was created for the purpose of operational management of the forces and means of the state health care system.

The operational administrative service is part of the structure of the special type institution "Moscow Territorial Scientific and Practical Center for Disaster Medicine of the Moscow City Department of Health".

In the day-to-day mode of operation, the operational administrative service interacts with the population according to the following principle. A resident contacts the operational administrative service by telephone, which is indicated on the official website of the Department of Health. The employees of the operational administrative service transfer the incoming information to the medical treatment organization by means of a prompt response. In turn, the medical treatment organization informs the population and the operational administrative service about the measures taken on the applicant's appeal. Thus, appeals are monitored, which was not the case in the previous scheme of work. In view of the above, prompt response can be seen as a way of interaction between the Department of Health and subordinate medical institutions on verbal appeals of the population within a strictly limited period of time: it should take no more than two hours from the receipt of a

complaint to a response from a medical treatment organization (Figure 3).

Creation of the operational administrative service contributed to an increase in the number of oral appeals of citizens to the Department of Health by increasing the number of telephone lines (from one to 35) and the use of information technology (Internet, social networks, websites) to obtain background information on oral appeals (Fig. 4).

As can be seen from the data in Fig. 4, the number of verbal appeals of citizens to the operational administrative service in 2021 exceeded by 2 times the indicators of 2017 and by 3 times the indicators of 2019. This was due to worsening epidemiological situation on COVID-19.

All appeals of citizens were divided into the following groups:

- appeals for the purpose of obtaining reference or additional information;
- appeals-complaints about failure to provide medical care;
- appeals with a positive assessment of the work of specialists of medical treatment organizations;
- appeals from hooliganism, etc.

As can be seen from Table 1, in 2017-2019 reference appeals prevailed. Then came appeals concerning the organization of in-patient and out-patient medical care: violation of the procedure for making an appointment with a specialist, long waiting times for instrumental examinations, difficulties with obtaining an individual rehabilitation plan, etc. Since 2020, appeals in connection with the

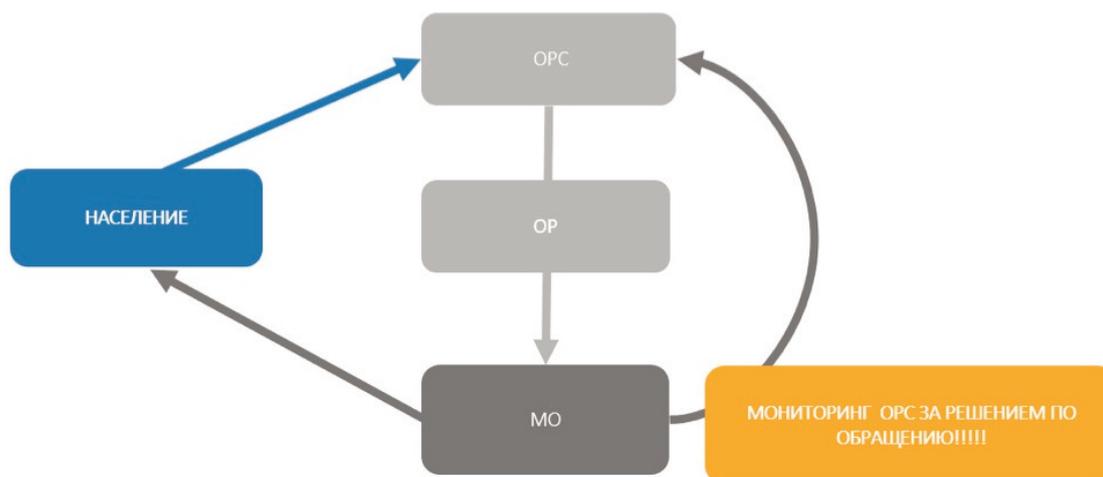


Рис.3. Схема работы ОРС (с 2017 г.) по принятию устных обращений граждан

Fig.3. Scheme of work of the Operational And Administrative Service (since 2017) for the acceptance of oral applications from citizens

Распределение по тематике обращений граждан в ОРС в 2017–2021 гг.

Distribution of Citizens' Appeals By Subject Matter in the Operational and Administrative Service in 2017–2021

Тематика обращения	2017	2018	2019	2020	2021
Коронавирус – с 2020 г.	–	–	–	73 953	97 397
Справочная информация по работе медучреждений, подведомственных ДЗМ	27 854	25 249	21 959	25 793	23 460
Жалобы граждан на организацию медпомощи в медучреждениях, подведомственных ДЗМ (поликлиники, стационары и пр.)	16 225	13 803	5 314	7 473	13 329
Вопросы вакцинации	629	505	1 150	1 682	11 744
Портал госуслуг	989	1 010	154	419	3 796
Адрес, как проехать, часы работы ДЗМ и его приемной – информация предоставлена по сайту ДЗМ	7 239	7 349	4 519	2 733	3 214
Обращение граждан, находящихся в медучреждениях, подведомственных ДЗМ, по вопросам оказания медицинской помощи	360	673	1 022	1 041	2 821
Жалобы на единую справочную службу 8-495-777-77-77	1 797	1 599	2 808	2 518	2 644
Листок нетрудоспособности	809	673	905	1 231	2 358
Трудности с дозвоном граждан по телефонам дирекций по координации деятельности мед. организаций и в отделы по округам	1 078	842	130	1 181	2 252
Как получить квоту	4 492	5 050	3 727	2 521	2 128
Единая медицинская информационно-аналитическая система – ЕМИАС	89	84	459	1 001	2 101
Прочие звонки (срыв звонка, передача факса, ошиблись номером, молчание в трубке)	5 391	8 010	3 740	1 876	2 051
Обращение из мед. организаций, не подведомственных ДЗМ	719	589	2 085	3 146	2 028
Вопросы прикрепления к поликлинике: как прикрепиться – информация размещена на сайте; открепили без согласия	2 695	1 767	1 806	1 879	1 737
Платные медицинские услуги	1 348	842	700	942	1 554
Исполнение индивидуальных программ реабилитации – ИПР; медико-социальная экспертиза – МСЭ	1 797	1 683	1 890	1 485	1 528
Работа службы скорой медицинской помощи – СМП	3 504	2 525	1 293	964	1 503
Стоматологическая помощь (лечение, протезирование, льготы) – информация на сайте в разделе медицинские организации	2 066	1 767	1 573	1 465	1 361
Направление жителя г.Москвы на консультацию и лечение в учреждения, подведомственные Минздраву России	2 515	2 188	1 721	1 813	1 335
Санаторно-курортное лечение, реабилитация	1 528	1 431	1 056	1 336	1 317
Перевод пациента-москвича из региональных стационаров в Москву	180	84	663	527	908
Транспортировка пациента из стационара домой	156	168	426	461	881
Вопросы трудоустройства, зарплаты, целевого направления на учебу	180	1 094	944	1 327	718
Выдача справок в психоневрологическом (ПНД) и наркологическом (НД) диспансере для получения водительского удостоверения, разрешения на ношение оружия и трудоустройство – информация предоставляется по сайту ДЗМ	1 258	1 094	1 138	576	528
Молочная кухня	81	42	647	584	498
Паллиативная помощь – информация предоставляется по сайту ДЗМ	1 797	842	598	585	497
Жалобы на недостаточную укомплектованность медперсоналом медицинских учреждений – врачи-специалисты, участковая служба	449	421	524	507	355
Лекарственное обеспечение	898	833	447	103	93



Рис.4. Количество (абс.) устных обращений граждан в 2017–2021 гг.
Fig.4. Number (abs.) of oral complaints from citizens in 2017–2021

Covid-19 pandemic began to dominate. The work of the operational administrative service to detect errors led to a 2-fold decrease in the rate of referrals for medical care. This demonstrates the effectiveness of the operational administrative service.

Mechanism of formation of operative response is carried out as follows: verification of received information; transfer of received information to the medical treatment organization; receipt from the medical treatment organization evidentiary information on this appeal; registration of conclusion; intradepartmental informing of those responsible for appeals.

The number of cases of prompt response to oral appeals from citizens is shown in Figure 5. 5.

As can be seen in Fig. 5, in 2021 the number of cases of prompt response was 27 times higher than in 2017. The increase was due to the implementation of operational management assignments on citizens' appeals posted on social networks, in the account of the medical treatment organization, as well as the expansion of operational response service in connection with the COVID-19 pandemic. Starting in 2021, the number of urgent response

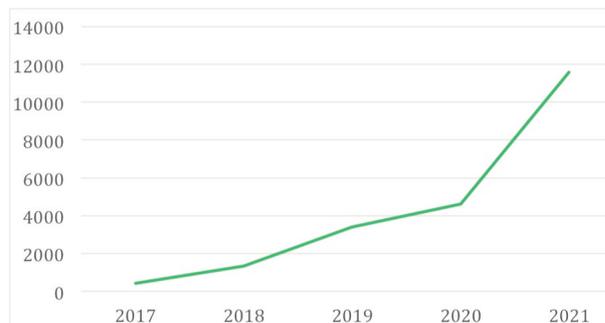


Рис. 5. Количество случаев оперативного реагирования по устным обращениям граждан, абс.
Fig. 5. Number of cases of rapid response to oral appeals of citizens, abs.

cases continues to grow, and is now 2.5 times higher than in 2020.

The quality of medical care in Moscow is based on the "Territorial Program of State Guarantees of Free Medical Care for Citizens in the City of Moscow". It includes: all types, forms and conditions of medical assistance; waiting periods; waiting periods for diagnostic and instrumental examinations, consultations by specialists, etc. This program is improved annually. Any breach of the program requires an immediate response — first of all, from the operational administrative service (Table 2).

Conclusion

The analysis of the effectiveness of the operational administrative service in the mode of daily activity in 2017-2021 showed that the operational administrative service is a modern effective mechanism of response. This service is capable of functioning in different modes, but the mode of daily operation plays a leading role in ensuring the safety of life of the population of the metropolis. Evaluation of the effectiveness of the operational administrative service is based on the analysis of operational information received from citizens in the form of verbal complaints about violations made in the provision of medical care.

Expanded work of operational administrative service on detection of errors by prompt response and their elimination by specialists of medical treatment organizations resulted in 2-fold decrease of the index of appealing for medical care and decrease of validity of verbal complaints about shortcomings in medical care provision.

Thus, the operational administrative service when working in the mode of daily activities provides effective communication between the Department of Health and the population of the metropolis. This contributes to the elimination of shortcomings in the provision of medical care to the population of Moscow.

Таблица 2 / Table No. 2

Количество подтверждённых и неподтверждённых нарушений, выявленных при оперативном реагировании в 2017–2021 гг.

The Number of Confirmed and Unconfirmed Violations Identified during Prompt Response in 2017–2021

Год	Всего случаев ОР, абс.	Подтвержденные нарушения, абс./%	Неподтвержденные нарушения, абс./%
2017	424	238/56,0	186/44,0
2018	1325	810/61,0	515/39,0
2019	3401	1813/53,0	1588/47,0
2020	4608	1558/34,0	3050/66,0
2021	11592	5085/44,0	6507/56,0

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CLINICAL ASPECTS OF DISASTER MEDICINE КЛИНИЧЕСКИЕ АСПЕКТЫ МЕДИЦИНЫ КАТАСТРОФ

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Review report
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EDEMA-LIKE LESIONS: ACCORDING TO MAGNETIC RESONANCE IMAGING OF THE KNEE JOINT IN HIGHLY QUALIFIED ATHLETES

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Abstract. *The aim of the study is to substantiate the relevance of the problem of edematous changes in knee joint bones in highly qualified athletes.*

Materials and research methods. Materials of the study — relevant literature on edema-like magnetic resonance changes of knee joint bones in highly qualified athletes.

Results of the study and their analysis. Magnetic resonance imaging plays a key role in the differential diagnosis of edema-like bone injuries. It is important to correlate magnetic resonance imaging findings with anamnestic history. In athletes, the peculiarities of diagnosis and treatment of edema-like bone conditions are related to the need to take into account athlete-specific conditions, such as the "athlete's triad", and to comply with anti-doping legislation.

It is concluded that it is fundamental to treat the underlying disease that caused the local metabolic disorder in the bone, while techniques aimed at local reduction of the pressure in the bone and at bone metabolism improvement can be used as a supplement. An important factor is the ability of bone tissue to self-repair, which should be taken into account when choosing a treatment method.

Key words: *anterior cruciate ligament rupture, bone marrow edema, doping, magnetic resonance imaging, edema-like injuries, highly qualified athletes, knee injury, osteopenia, osteoporosis, stress fracture*

Conflict of interest. The authors declare no conflict of interest

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ОТЁКОПОДОБНЫЕ ПОВРЕЖДЕНИЯ: ПО ДАННЫМ МАГНИТНО-РЕЗОНАНСНОЙ ТОМОГРАФИИ КОЛЕННОГО СУСТАВА У СПОРТСМЕНОВ ВЫСОКОЙ КВАЛИФИКАЦИИ

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Резюме. *Цель исследования – обосновать актуальность проблемы возникновения отёкоподобных изменений костей коленного сустава у спортсменов высокой квалификации.*

Материалы и методы исследования. Материалы исследования – релевантная литература по отёкоподобным магнитно-резонансным (МР) изменениям костей коленного сустава у спортсменов высокой квалификации.

Результаты исследования и их анализ. Магнитно-резонансная томография (МРТ) играет ключевую роль в дифференциальной диагностике отёкоподобных повреждений кости. При этом важно соотносить результаты МРТ с анамнезом. У спортсменов особенности диагностики и лечения отёкоподобных состояний кости связаны с необходимостью учёта специфичных для атлетов состояний, таких, например, как «триада спортсменки», и соблюдения антидопингового законодательства.

Сделаны выводы, что принципиальным является лечение основного заболевания, послужившего причиной нарушения местных обменных процессов в кости, а в качестве дополнения могут использоваться методики, направленные на местное снижение давления в кости и улучшение костного метаболизма. Важным фактором является также способность костной ткани к самовосстановлению, которую следует учитывать при выборе метода лечения.

Ключевые слова: *допинг, магнитно-резонансная томография, остеопороз, отёк костного мозга, остеопения, отёкоподобные повреждения, разрыв передней крестообразной связки, спортсмены высокой квалификации, стрессовый перелом, травма коленного сустава*

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The aim of the study is to substantiate the relevance of the problem of edema-like changes in the knee joint bones in highly qualified athletes.

Objectives of the study:

1. To review the relevant literature on edema-like MR changes of the knee joint bones in highly qualified athletes.

2. To present current relevant classifications and diagnostic algorithms, including differential, of edema-like bone changes.

3. To review the main clinical variants of edema-like changes in highly qualified athletes.

4. To characterize the peculiarities of the use of the proposed classifications and algorithms in the context of practical work on medical and biological support of highly qualified athletes.

5. To formulate approaches to the management of athletes with bone swelling of various etiology taking into account the basics of modern anti-doping legislation.

Materials and research methods. Materials of the study — relevant literature on edema-like magnetic resonance changes of knee joint bones in highly qualified athletes.

Results of the study and their analysis. The term "bone marrow edema" was first introduced into the radiological community by Wilson et al. in 1988. [1]. The authors originally used it to refer to the hyperintense on T2-magnetic resonance MR signal in patients with knee and hip joint pain. Standard radiographs showed nonspecific local osteopenia or appeared normal. The co-authors referred to this condition as "bone marrow edema" due to the lack of a better term at the time. However, it should be understood that histologically the focus of the so-called "edema" reveals very heterogeneous abnormalities: necrosis, bone marrow fibrosis and trabecular structure disorders, increased number of microvessels. Although the "edema" itself may be small. Thus, the term "bone marrow edema" is not correct. Based on current views, we believe that in the context of the magnetic resonance imaging (MRI) discussion, it is better to call the entire group of these conditions "edema-like lesions". And the essence of the process taking place in the bone should be called "bone marrow lesion" [2]. For simplicity, the authors will use the terms "edema-like lesion" and "bone marrow lesion" interchangeably.

Classification of "edema-like changes" of knee bones

1. *Traumatic edema — edema due to trauma or microfracture in combination with or without osteoporosis; postoperative edema; complex regional pain syndrome — CRPS.*

2. *Septic edema — edema due to osteomyelitis or infectious arthritis.*

3. *Primary inflammatory edema — edema from arthritis of peripheral joints; spondylitis/sacroileitis; bone edema from enthesitis, chronic nonbacterial osteomyelitis (ang. "CNO")*

4. *Mechanical/degenerative. Swelling in osteoarthritis, insertional tendinopathy, (osteo)chondral defects; changes/instability in stressful bone.*

5. *Neoplastic edema — edema in primary or secondary benign or malignant bone tumors.*

6. *Ischemic/neurogenic edema — edema in avascular necrosis of bone, Charcot neuroarthropathy.*

7. *Metabolic edema — edema in primary osteoporosis, secondary osteoporosis, and osteopathies.*

8. *Diagnosis of exclusion — bone marrow edema syndrome (BMES).*

In everyday practice we are guided by the classification of "edema-like changes" proposed in 2020 by a working group from Ludwig Maximilian University [3]. The classification is based on the probable cause of the "edema". This allows, from the authors' point of view, to form a rational approach to the tactics of patient management. In our daily work, we follow similar tactics of treatment and diagnostic routing of patients, based on this classification.

It should be said that our adopted working classification and approach to the treatment of osteonecrosis do not contradict the draft clinical guidelines of the Russian Medical Association for Osteonecrosis, the Russian Association of Traumatologists and Orthopedists, and the Association of Rheumoorthopedists (2020) [4].

"Edema-like lesions" and their variations are only MR manifestation of the evolution of some pathological process in bone. "Edema" may be the beginning or the end of a process or a stage preceding osteonecrosis. Osteonecrosis may or may not be accompanied by the formation of an osteochondral defect. If the reparative capacity of the bone successfully withstands the damaging factors, the process in the bone is completed without osteonecrosis formation. If reparative processes are insufficient, the natural outcome of such a condition may be bone necrosis in various variants [5].

Causes of osteonecrosis

- Normal bone — normal bone remodeling and repair.
- Bone damage — vascular, mechanical/traumatic, inflammatory, metabolic, etc.

- Disturbance of metabolic processes in bone tissue — local increase in bone metabolism, increased intra-bone pressure, overloading/microfractures.

- "Swelling" of bone marrow — increase in intra-bone pressure /compartment syndrome.

- Reparative mechanisms: if adequate — gradual resolution; if inadequate — bone necrosis.

Taking into account the above, we talk about osteochondral defects in the context of the fact that they can be the outcome (however, far from being obligatory) of various processes in the bone manifested by "edema-like" changes. Although there can be only one outcome — articular surface defect, the preceding changes in the bone can have different causes and, therefore, require different approaches to active monitoring and treatment.

In the context of observation of athletes, another phenomenon that may accompany bone swelling should be kept in mind: stress fracture [6].

As for stress fractures, it seems rational to divide them into 2 groups: fatigue fractures and bone insufficiency fractures. In the case of athletes, we usually talk about the

excessive load on the healthy bone, due to which it undergoes reciprocal changes. In patients with osteoarthritis, we're talking about a fracture due to the bone breaking under no more than a daily load. Both are stress fractures [7].

The MRI protocol for investigating "bone swelling" usually includes fat-suppressed sequences such as STIR or PDW FS in three planes, as well as T1-weighted sequences without contrast enhancement and with the introduction of gadolinium contrast. Fat-suppressed MRI images (STIR or PDW FS) clearly show bone marrow and soft tissue swelling and hemorrhage. In order to understand whether there is osteonecrosis or not, contrast needs to be injected. The introduction of contrast rapidly enhances the bone swelling signal in the MR images. At the same time, there is no enhancement of the osteonecrosis area with this contrast (Fig. 1).

Such diagnosis is possible because as early as in 2001, a group of authors confirmed that osteonecrosis leads to a sharp delay of venous outflow in the affected area. Intraosseous injected contrast was washed out from the zone of necrosis after 17 min, whereas from the femoral condyle affected by arthrosis but without necrosis — after 5 min. Importantly, the study also showed an almost twofold increase in intraosseous pressure in the femoral condyle with the outcome of the edema-like process in osteonecrosis. The authors believe that such an increase is a natural consequence of venous thrombosis with impaired outflow tract. However, it can hardly be said that any edema-like change on MRI is accompanied by the same significant pressure increase. Different diseases underlie the phenomenon of edema-like changes. The described pressure increase characteristic of osteonecrosis does not necessarily accompany, for example, painless transient bone marrow edema [1].

According to some authors, more sensitive in the differential diagnosis of edema and osteonecrosis is perfusion MRI (DCE MRI), in which the plasma flow and the average time of its passage through a certain volume are determined numerically.

To summarize, we can say that "edema-like" changes and their variations are a natural manifestation of the evolution of pathological processes in bone. "Swelling" accompanies the local disturbance of metabolic processes in bone tissue caused by different reasons. If reparative capabilities of bone tissue successfully resist the damaging factors, the process in bone resolves without osteonecrosis formation. If the reparative processes are insufficient, the natural outcome of such a condition can be a stress fracture or bone necrosis in one way or another. Osteonecrosis may or may not be accompanied by the formation of a free bone fragment.

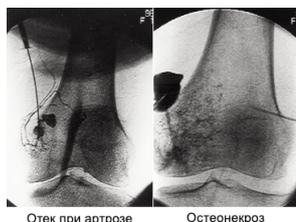


Рис. 1. МРТ с контрастированием. Слева: при внутрикостном введении — прокрашивание русла и выведение контраста через 5 мин. Справа: при внутрикостном введении — нет прокрашивания венозного русла. Выведение контраста через 17 мин

Fig. 1. Magnetic resonance imaging with contrast. With intraosseous administration, staining of the bed and removal of contrast after 5 minutes (left). With intraosseous administration, there is no staining of the venous bed. Contrast removal after 17 min (right)

Treatment

Given that there may be different processes behind the swelling-like changes in the bone, treatment can also vary greatly depending on the cause of the swelling. Moreover, before proceeding to medication, and even to surgical treatment, it is necessary to understand the likelihood of self-healing.

Earlier, we gave the classification of bone edema that we use. According to this classification, we will talk about only two types of bone edema — traumatic and non-traumatic. Obviously, traumatic bone swelling is more common in athletes. Let us consider a habitual tear of the anterior cruciate ligament, and use it as an example to trace the evolution of edema — Fig. 2 [8].

The natural development of posttraumatic bone edema is best studied exactly after anterior cruciate ligament trauma. It is known that such edemas occur in 68-98% of cases and the external condyle of the tibia is more frequently injured [9].

If you turn to the prospect of 5 years or more, the probability of detecting serious osteochondral changes of the knee joint will strongly depend on the size of the initial swelling. For the external condyle of the femur and tibia, the probability of developing such lesions when the swelling spreads to 100% of the area can reach 74% and 32%, respectively, on MRI slices. Thus, in these cases, special attention should be paid to the mode of compliance with the load on the operated joint. In addition, there are studies proving the effectiveness of bisphosphonates and prostaglandins in athletes in these cases. Their use is possible, however, only off label and should, from our point of view, be reserved for cases involving more than 100% of the cut area of the external condyles of the tibia or femur — Fig. 3 [10].

It is important to understand that with the resolution of the edema, the underlying cartilage lesion may continue to exist. Fig. 4 shows an example of bone edema regression according to MRI data in standard sequences. Fig. 5 is color MR imaging data of the same area. The red areas are areas of damaged cartilage that persist for more than one or two years. This may be an important argument for prescriptive supportive treatment, such as chondroprotectors, to athletes after a ligament injury [11].

To summarize the approach to the management of patients with "traumatic edema" we can say the following. In most cases, a stabilizing surgery with a controlled loading dosing regimen is sufficient for complete resolution of the "edema". However, long-term preservation of chondral changes in the edema zone requires chondroprotective treatment with hyaluronic acid or bioorthopedic

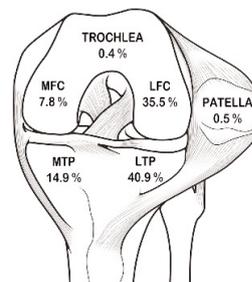


Рис. 2. Вероятность отёка кости после травмы ПКС в различных сегментах сустава
Fig. 2. Probability of bone edema after ACL injury in various joint segments

preparations. Extensive swelling that extends beyond the condyle may require bisphosphonates and Iloprost off label and only approved substances (some bisphosphonates are prohibited substances).

Stress fractures

Basically, all stress fractures can be divided into 2 subtypes: high risk and low risk of complications. Back in 2015, a classification of stress fractures was proposed, implying the timing of bone unloading corresponding to the severity of the fracture. Thus, at stages 1 to 2, the unloading time of the affected segment is about 3 weeks; at stages 3 to 4, it is from 6 to 16 weeks - Table [12–14].

Of the non-traumatic factors, it is necessary to elaborate on the most common cause of metabolic "bone swelling" — the "female athlete's triad". In the most simplified form, these are interrelated eating disorders (anorexia), amenorrhea, and osteoporosis. In sports and beyond, this is a very topical problem. Treatment of this condition may require medications such as antidepressants in addition to standard bone metabolism maintenance regimens.

A special diagnostic problem is caused by edema accompanying "fatigue" fractures against the background of subchondral bone strength insufficiency, which occurs in about 3% of cases. The medial compartment is more frequently involved.

Meniscus tears — radial or root tears — occur in 76-94% of patients [6]. The treatment of these conditions is as follows. Since these conditions are often associated with meniscus damage, they are repaired if possible. If the condition occurred after meniscectomy, it is recommended to reduce the axial load for 3-4 weeks or more. All patients in the nontraumatic group and in the subgroup of non-septic edemas undergo a CT scan to clarify the nature and extent of the process (presence of fracture).

If primary osteoporosis is a probable concomitant condition of edema, it should be treated first in order to prevent progression of the process. If the underlying condition is secondary osteoporosis, treatment should involve correction of pathology such as vitamin D deficiency, diabetes mellitus, etc.

To summarize, we can say the following. The following drugs and methods are suggested in the current literature for the treatment of bone swelling:

1. Unloading for 3-6 weeks or more.
2. Non-steroidal anti-inflammatory drugs — situationally.
3. Wearing a brace that unloads the involved compartment.
4. Bisphosphonates.
5. Monoclonal antibodies (Dinosumab).

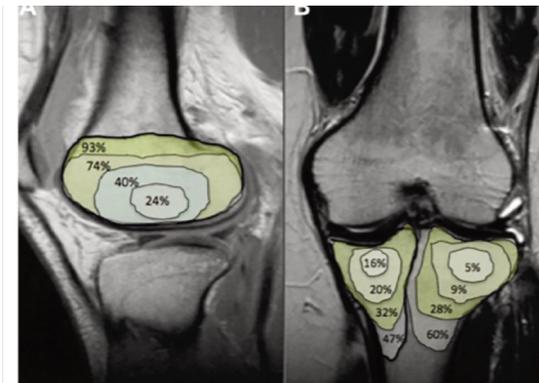


Рис. 3. Вероятность развития хондральных повреждений III-IV ст. через 5 лет после травм ПКС
Fig. 3. The likelihood of developing chondral lesions III-IV st. 5 years after ACL injury

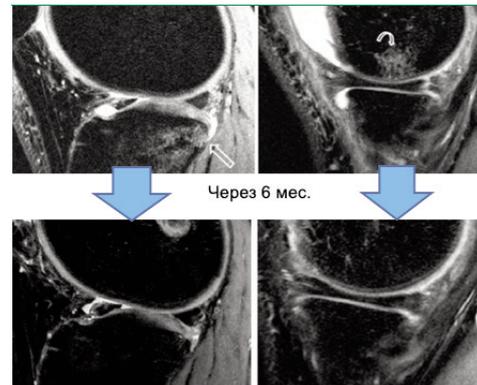


Рис. 4. Пример регресса отёка кости по данным МРТ
Fig. 4. An example of regression of bone edema according to MRI

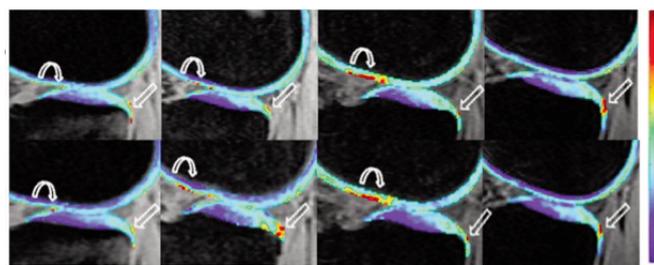


Рис. 5. Цветное МР-картирование. Красные зоны – участки поврежденного хряща
Fig. 5. Color MR mapping. Red zones - areas of damaged cartilage

Модифицированная классификация стрессовых переломов E.Arendt

Таблица

Стадия	Рентген	МРТ	Лечение
1-я	Норма	Патологический сигнал на STIR	Разгрузка – 3 нед
2-я	Норма	Патологический сигнал на STIR+T2	Разгрузка – 3–6 нед
3-я	Нечеткая линия или периостальная реакция	Линия на T1 и T2, но пока без повреждения кортикала	Разгрузка – 6–12 нед
4-я	Линия перелома или периостальная реакция	Четкая линия перелома на T1 и T2	Разгрузка – более 16 нед

6. Vitamin D preparations.
7. Iloprost.
8. Meniscus/osteotomy repair.
9. Subchondroplasty.
10. Decompression with the introduction of bioorthopedic preparations.

Treatment of the underlying disease, which caused the disturbance of local metabolic processes in the bone, is fundamental. As a supplement, local pressure reduction and improvement of bone metabolism can be performed. An important factor is also the ability of the bone tissue to self-repair, which should be considered when choosing the method of treatment. In sports, particular importance should be given to compliance with anti-doping legislation.

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Conclusion

1. It is advisable to use etiological classifications of edema-like changes when choosing treatment tactics in athletes.

2. The main variants of edema-like changes in athletes are traumatic, and in a subgroup of non-traumatic — mechanical/degenerative, metabolic and transient bone edema.

3 The majority of edema-like injuries in athletes have a favorable prognosis.

(4) Female athletes aged 17-18 years are particularly at risk for stress edema formation. Older athletes require more attention.

5. When choosing treatment in athletes, peculiarities of anti-doping legislation should be taken into account.

STUDY OF FUNCTIONAL CEREBRAL CONNECTIVITY FOR THE DEVELOPMENT OF TREATMENT AND PREVENTION STRATEGIES IN PATIENTS WITH ASYMPTOMATIC CAROTID ATHEROSCLEROTIC STENOSIS

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Abstract. The aim of the study was to investigate the condition of the connectome in patients with asymptomatic carotid atherosclerotic stenosis of more than 60% when using hirudotherapy.

Materials and research methods. The examination results of 15 patients aged 60 to 82 years with asymptomatic carotid atherosclerotic stenosis in the range of 60-75% were analyzed. The patients underwent a course of hirudotherapy of 10 sessions. All patients underwent structural and functional magnetic resonance imaging with statistical data analysis at rest, complaints and neurological status were evaluated before and after hirudotherapy course.

Results of the study and their analysis. Within the course of hirudotherapy in patients with asymptomatic carotid atherosclerotic stenosis when analyzing the neurological status and complaints, a significant improvement of well-being was noted. Functional magnetic resonance imaging identified differences in functional connectivity between medial prefrontal cortex and other brain regions. There was activation in the main structures of the network of controlling and revealing significance. The connectivity between the leading areas of the brain increased, which is a sign of the improvement of the brain activity.

Conclusion. The study of connectivity can serve for exploring the work of brain networks and for determining the effectiveness of therapy. A course of hirudotherapy significantly changed the functional connectivity of brain areas, the changes correlated with a decrease in the number of complaints. Such work is a pilot and will be continued in order to further develop treatment and prevention strategies with the inclusion of hirudotherapy in patients with high risk of vascular accidents in sanatorium-resort treatment.

Key words: atherosclerotic stenosis, asymptomatic carotid hirudotherapy, brain, connectome, functional connectivity, magnetic resonance imaging, patients, therapeutic and preventive strategies

Conflict of interest. The authors declare no conflict of interest

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ИЗУЧЕНИЕ ФУНКЦИОНАЛЬНОЙ КОННЕКТИВНОСТИ ГОЛОВНОГО МОЗГА ДЛЯ РАЗРАБОТКИ ЛЕЧЕБНО-ПРОФИЛАКТИЧЕСКИХ СТРАТЕГИЙ У ПАЦИЕНТОВ С АСИМПТОМНЫМ КАРОТИДНЫМ АТЕРОСКЛЕРОТИЧЕСКИМ СТЕНОЗОМ

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Резюме. Цель исследования – изучить состояние коннектома у пациентов с асимптомным каротидным атеросклеротическим стенозом (АКАС) более 60% при применении гирудотерапии.

Материалы и методы исследования. Проанализированы результаты обследования 15 пациентов в возрасте от 60 до 82 лет с АКАС в пределах 60-75%. Пациентам проводили курс гирудотерапии из 10 сеансов. Всем пациентам выполнялась структурная и функциональная магнитно-резонансная томография (МРТ) с анализом статистических данных в состоянии покоя, оценивались жалобы и неврологический статус – до и после проведения курса гирудотерапии.

Результаты исследования и их анализ. На фоне курса гирудотерапии у пациентов с асимптомным каротидным атеросклеротическим стенозом при анализе неврологического статуса и жалоб отмечено значимое улучшение самочувствия. При проведении функциональной МРТ определены различия функциональной связанности между медиальной префронтальной корой и другими областями мозга. Отмечалась активация в основных структурах сети управляющего контроля и выявления значимости. Увеличивалась коннективность между ведущими областями головного мозга, что служит признаком улучшения его деятельности.

Заключение. Исследование коннективности может служить для изучения работы сетей мозга и для определения эффективности терапии. Курс гирудотерапии значимо изменял функциональную связанность областей головного мозга, изменения коррелировали с уменьшением количества жалоб. Подобная работа является пилотной и будет продолжена в целях дальнейшей разработки лечебно-профилактических стратегий с включением гирудотерапии у пациентов с высоким риском сосудистых катастроф в условиях санаторно-курортного лечения.

Ключевые слова: асимптомный каротидный атеросклеротический стеноз, гирудотерапия, головной мозг, коннектом, лечебно-профилактические стратегии, магнитно-резонансная томография, пациенты, функциональная коннективность

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Introduction

Asymptomatic carotid atherosclerotic stenosis (ACAS) is one of the causes of acute vascular episodes such as transient ischemic attack and acute stroke. It is promising to study compensatory mechanisms and functional connectivity of the brain in patients with this diagnosis. It can help to optimize the tactics of management of such patients.

At the beginning of the 21st century, a new direction in neuroscience emerged — connectomics. It is an area of research that includes mapping and analysis of the architecture of neuronal connections [1]. It has been proved that changes in the organization of neural networks (connectome) are the fundamental basis of cerebral pathology [2]. This necessitates a comprehensive study of the mechanisms of compensatory processes of the central nervous system against the background of chronic ischemia. The mechanisms of neuroplasticity underlie the compensation of impaired nervous system functions. Several mechanisms of connectome reorganization have been described which underlie neuroplasticity. Among them are changes in the specific gravity of existing connections, recombination, reconnection, and regeneration. The use of multimodal neuroimaging technique makes it possible to reveal disturbances of structural and functional neuronal connections in patients [3].

The study of neuroplasticity mechanisms in asymptomatic carotid atherosclerotic stenosis, detection of connectome changes in cerebrovascular diseases and during the treatment are topical tasks in the light of development of new preventive and therapeutic strategies, as well as prediction of disease outcomes. Hirudotherapy is a method of complementary medicine, which is widely used in the treatment of patients with vascular diseases and was proven at the pathogenetic level [4].

The aim of the study was to explore the state of the connectome in patients with asymptomatic carotid atherosclerotic stenosis of more than 60% when using hirudotherapy.

Materials and methods of the study. A single-center open uncontrolled study of resting working network status in patients with asymptomatic carotid atherosclerotic stenosis over 60% using hirudotherapy was carried out. The study adhered to the principles of good clinical practice and the Declaration of Helsinki, an extract from the protocol №17 of January 14, 2019 of the ethical committee of the V.A. Almazov National Medical Research Center with approval of the study was obtained. Written informed consent was obtained from all study participants.

The study involved 15 patients, 10 women and 5 men with asymptomatic carotid atherosclerotic stenosis of the internal carotid arteries ranging from 60-75%, the patients' age ranging from 60 to 82 years. Three patients underwent carotid endarterectomy surgery from one internal carotid artery, with persisting stenosis of more than 65% of the contralateral internal carotid artery. All patients had a history of hypertension for more than three years. Two patients had type II diabetes mellitus. The diagnosis of asymptomatic carotid stenosis was made on the basis of complaints, med-

ical history and data of instrumental examination (ultrasonic triplex examination of brachiocephalic arteries on a Logiq Q7 device (Expert General Electric).

Study exclusion criteria:

1. Psycho-organic pathology, brain tumors, epilepsy in anamnesis.
2. Severe comorbidities: acute myocardial infarction, Stage III-IV heart failure, cardiomyopathy, acute infection, etc.
3. Taking medications (barbiturates, anxiolytics, reserpine, antidepressants, narcotic analgesics), which can distort the results of therapy.

During 2 months (1-2 times a week) 10 sessions of hirudotherapy with the use of 2-5 leeches were carried out according to the patent of the Russian Federation № 2327494. Points of installation of leeches: occipital area and a zone above mastoid processes; cervical and lumbar spine, a zone of coccyx; zones of liver, spleen, heart. Against the background of complementary treatment the patients continued taking hypotensive, anti-aggregant, hypolipidemic drugs.

The patients' neurological status and complaints were evaluated before the course of treatment with hirudotherapy and 2 months after its completion.

Before and after the use of complementary methods of treatment, functional magnetic resonance imaging (MRI) was performed at rest. MP-RAGE pulse sequence — isotropic voxel $V=0.8 \text{ mm}^3$ was used to compare functional data with brain structures. Scanning time — 9 min; 29 slices, slice thickness — 4.5 mm, number of repetitions — 120. The patients were informed about the study while awake with their eyes open. Homogeneous resting state conditions were maintained for each patient, which minimized the impact on the auditory and visual networks.

Next, magnetic resonance imaging data, in particular functional MRI at rest, were processed and the results were evaluated. For this purpose, we used the plugin CONN v.1.8 running on MATLAB (a package of applied programs), designed for determining brain connectivity and statistical establishment of active zones. Statistical analysis was performed using nonparametric McNemar criterion for dependent binary variables.

Results of the study and their analysis. All patients reported persistent or paroxysmal cephalgia of a throbbing/aching nature; non-systemic and/or systemic momentary, transient, or prolonged dizziness; noise in the head and and/or in the ears; hearing loss; inability to look at moving objects; flickering of flies before the eyes.

Neurological status: in 5 patients — flaccid pupillary reactions; in 4 patients — nystagmus at the extreme leads; in 3 patients — lack of convergence; in 5 patients — tremor of fingers, fingers stretched out; in 8 patients — asymmetry of tendon reflexes; in 5 patients — elements of dynamic and static-locomotor ataxia; in 7 — vegetative instability.

The patients with asymptomatic carotid atherosclerotic stenosis showed a significant improvement during the course of hirudotherapy (Table 1).

There were no worsening of the patients' condition, adverse and allergic reactions during the treatment.

After hirudotherapy treatment we observed a decrease of dynamic ataxia in 6 patients, statico-locomotor — in three of 5 patients, and autonomic instability in five of 8 patients.

Statistical two-sample t-test analysis between the groups before and after treatment revealed an increase in positive functional connectivity of the medial prefrontal cortex with the vermis and 10th zone of the right cerebellar hemisphere when the medial prefrontal cortex was chosen as the area of interest. These changes in functional connectivity correlated with clinical manifestations in the form of a decrease in the severity of vestibular disturbances. An increase in negative functional connectivity of the medial prefrontal cortex with the left middle frontal gyrus and a decrease

in the expression of negative functional connectivity of the medial prefrontal cortex with the right parahippocampal gyrus were detected.

Comparing the results obtained before and after treatment, an analysis of the data based on graph theory revealed stable connections: between the posterior parts of the middle temporal gyrus; the right anterior parts of the superior temporal gyrus; the left parts of the inferior temporal gyrus; between the visual working network, the lingual working network, the 6th zone of the right cerebellar hemisphere, the cerebellar vermis, the occipital lobe pole and a decrease in the expression of right upper and lower frontal gyrus — the lingual network (Fig. 1, 2; Table 2).

When the cerebellar network of interest is selected, a positive functional relationship with the right and left cerebellar

Таблица 1 / Table No. 1

Оценка эффективности лечения пациентов с асимптомным каротидным атеросклеротическим стенозом, n=15
Evaluation of the Effectiveness of Treatment of Patients with Asymptomatic Carotid Atherosclerotic Stenosis, n=15

Симптом / Symptom	Число пациентов, чел. / Number of patients, pers.		Критерий Мак-Немара / Criterion McNemar, p
	до начала курса гирудотерапии / before a course of treatment	после курса лечения / after a course of treatment	
Головная боль / Headache:			
- пульсирующая / pulsating	5	0	Не применим / Not applicable
- ноющая / aching	12	3	0,008
- постоянная / constant	9	0	Не применим / Not applicable
- приступообразная и постоянная / paroxysmal and persistent	11	4	0,023
- односторонняя / one-sided	10	3	0,023
- двусторонняя / bilateral	9	2	0,023
- головная боль в целом / general headache	14	4	0,004
Головокружение / Dizziness:			
- несистемное / non-systemic	11	4	0,023
- системное / systemic	1	0	Не применим / Not applicable
- мгновенное, с / instantaneous, seconds	10	3	0,023
- кратковременное, мин, ч / short-term, minutes, hours	9	2	0,023
- длительное, дни, недели / long-term, days, weeks	5	0	Не применим / Not applicable
- головокружение в целом / dizziness in general	13	3	0,004
Шум в голове / Noise in my head	8	4	0,13
Шум в ушах / Noise in ears	6	3	0,25
Шум в голове и в ушах в целом / Noise in the head and in the ears in general	10	5	0,073
Снижение слуха / Hearing loss	6	5	1,0
Оптико-вестибулярный синдром / Opto-vestibular syndrome	10	2	0,013
Преходящие зрительные расстройства / Transient visual disturbances	12	3	0,008

Примечание:

1. Ухудшение не зафиксировано ни по одному из наблюдаемых показателей.
2. Улучшение составило от 16,67 до 100%, в среднем – 58,35%.
3. Статистически значимые изменения состояния наблюдались по следующим показателям – ноющая, приступообразная и ноющая, односторонняя, двусторонняя головная боль в целом; головная боль в целом; мгновенное, кратковременное головокружение и головокружение в целом; оптико-вестибулярный синдром и преходящие зрительные расстройства.
4. Улучшение в 100% случаев было достигнуто по следующим показателям: пульсирующая, постоянная головная боль; системное, системное в сочетании с несистемным, длительное головокружение

Note:

1. No deterioration was recorded in any of the observed indicators.
2. The improvement ranged from 16.67% to 100%, on average - 58.35%.
3. Statistically significant changes in the state were observed in the following indicators - aching, paroxysmal and aching, unilateral, bilateral, and in general headache; non-systemic, instantaneous, short-term and in general dizziness; opto-vestibular syndrome and transient visual disorders.
4. Improvement in 100% of cases was achieved in the following indicators: throbbing, persistent headache; systemic, systemic in combination with non-systemic, prolonged dizziness

hemispheres (8 zones), cerebellar vermis, posterior cingulate and angular gyrus areas is determined (Fig. 3).

Discussion. According to the results of the present study, after a course of hirudotherapy in patients there was a statistically significant decrease in the frequency of dizziness, cephalgia, noise in the head and ears. Similar positive dynamics was earlier noted by us and a number of other authors in patients with hypertensive angioencephalopathy and chronic vertebral-basilar insufficiency [5]. Decrease of expression of visual impairments at application of hirudotherapy is proved by ophthalmologists. In the Interdisciplinary Scientific-Technical Complex "Eye Microsurgery"

hirudotherapy is used for about 20 years, more than 300 patients annually receive hirudotherapy courses [6].

The study of functional MRI data at rest determined the activation of the main structures of the control network and revealing significance after hirudotherapy application. Clinically there was an attenuation of vestibular disorders, which was manifested by an increase of functional connectivity of the medial prefrontal cortex by the cerebellum. The weakened connectivity with the left medial frontal gyrus may indicate a decrease in the inhibitory component of the network.

According to some studies, patients with chronic cerebral circulatory disorder showed a loss of inter- and intrahemi-

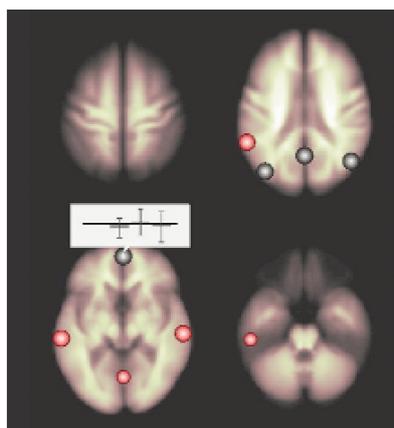


Рис. 1. Результаты внутригруппового сравнения до и после курса гирудотерапии – красным отмечены участки, которые связаны с МПФК положительно, синим – отрицательно

Fig. 1. Results of intragroup comparison before and after the course of hirudotherapy – red marked areas that are associated with MPFC positively, blue - negatively

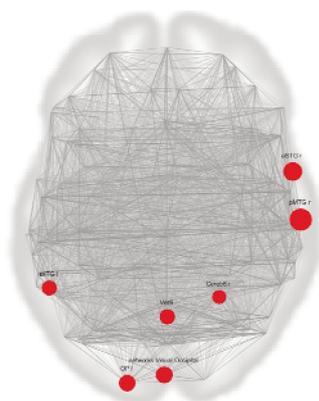


Рис. 2. Картированные данные функциональной связности после курса гирудотерапии – красным отмечено усиление функциональной связности

Fig. 2. Mapped data of functional connectivity after a course of hirudotherapy – red indicates an increase in functional connectivity

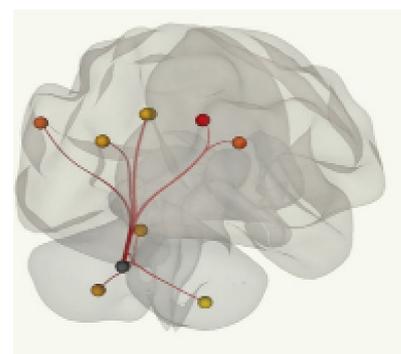


Рис. 3. Мозжечковая сеть: межгрупповое сравнение

Fig. 3. Cerebellar network: intergroup comparison

Таблица 2/Table No. 2

Выраженность функциональных активаций: межгрупповое сравнение

Expression of functional activations: intergroup comparison

ROI*	T**
Network	-0,98
Cerebr	1,85
toITG l	1,98
pMTG r	2,95
aSTG r	2,48
Visual Occipital	2,24
OPI	2,19
Vermis 6	2,03

* ROI –зона интереса / area of interest

**T –коэффициент Стьюдента / Student's coefficient

spheric connectivity between network structures and managing control and relevance detection, which is a disconnection phenomenon [7, 8]. After treatment with the use of complementary methods, the connectivity of the leading structures of the brain increased, which may be a sign of changes in brain functioning in the form of restoration of emotional and behavioral disorders and cognitive impairment in patients with asymptomatic carotid atherosclerotic stenosis.

Conclusion

The available evidence of pathogenetic effects of hirudotherapy inducing a complex of reactions aimed at the sequential elimination of ischemia and hypoxia and microcirculatory disorders was reflected in significant changes of the connectome in patients with asymptomatic carotid atherosclerotic stenosis, which correlated with a reduction of complaints. This work can be considered pilot; continuation of the research will give an opportunity to converge the methodological apparatus of evidence-based medicine with such effective and well-proven method of complementary medicine as hirudotherapy.

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TREATMENT OF PATIENTS WITH CONCOMITANT TRAUMA TO THE ORGANS OF SEVERAL CAVITIES AND TO THE MUSCULOSKELETAL SYSTEM

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Abstract. *The aim of the study was to improve the results of treatment of patients with severe combined trauma of the organs of several cavities (skull, thoracic and abdominal cavities, retroperitoneal space) and of the musculoskeletal system.*

Materials and research methods. The study involved 72 patients treated between 2013 and 2017 in a Level I trauma center established at the Republican Clinical Hospital of the Ministry of Health of the Kabardino-Balkarian Republic.

The Injury Severity Score (ISS) index was used to determine the severity of injury; "department of military field surgery, condition, admission" scale was used to assess the state of the injured.

Results of the study and their analysis. Analysis of the findings showed the following: in severe combined injuries the main causes of death are: shock, cerebral edema and dislocation, posttraumatic pneumonia, multiple organ failure, acute respiratory failure, pulmonary embolism and DIC syndrome.

The most satisfactory treatment outcomes can be achieved only with the use of a care tactic based on the principles of staged surgical treatment "Damage control".

The time frame and the sequence of surgical treatment of injuries depend on their severity, degree of life threatening and prevailing injury.

Key words: *musculoskeletal system, organs of several cavities, patients, severe combined trauma, treatment*

Conflict of interest. The authors declare no conflict of interest

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ЛЕЧЕНИЕ ПОСТРАДАВШИХ С СОЧЕТАННОЙ ТРАВМОЙ ОРГАНОВ НЕСКОЛЬКИХ ПОЛОСТЕЙ И ОПОРНО-ДВИГАТЕЛЬНОЙ СИСТЕМЫ

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Резюме. *Цель исследования – улучшение результатов лечения пациентов с тяжелой сочетанной травмой органов нескольких полостей (череп, грудная и брюшная полости, забрюшинное пространство) и опорно-двигательной системы (ОДС).*

Материалы и методы исследования. В исследовании участвовали 72 пациента, лечившихся в 2013–2017 гг. в травмоцентре I уровня, созданном на базе Республиканской клинической больницы Минздрава Кабардино-Балкарской Республики.

Для определения степени тяжести травмы использовали индекс Injury Severity Score (ISS); для оценки тяжести состояния пострадавших – шкалу «кафедра военно-полевой хирургии, состояние, поступление» (ВПХ – СП).

Результаты исследования и их анализ. Анализ результатов исследования показал: при тяжелых сочетанных повреждениях основной причиной смерти являются: шок, отек и дислокация головного мозга, посттравматическая пневмония, полиорганная недостаточность, острая дыхательная недостаточность (ОДН), тромбоэмболия легочной артерии (ТЭЛА) и ДВС-синдром.

Наиболее удовлетворительные результаты лечения можно получить только при применении тактики оказания медицинской помощи, базирующейся на принципах этапного хирургического лечения «Damage control».

Временные рамки и последовательность оперативного лечения полученных повреждений зависят от их тяжести, степени угрозы жизни и от преобладающей травмы.

Ключевые слова: *лечение, опорно-двигательная система, органы нескольких полостей, пациенты, тяжёлая сочетанная травма*

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Relevance of the study. Combined trauma of the organs of several cavities and the musculoskeletal system is the most severe type of trauma. The peculiarities of this pathology are the greatest severity of concomitant injuries (more than 45 points according to ISS), massive blood loss, and the need to use both Damage control surgery and Damage control orthopedic tactics [1-3]. The urgency of the problem of treatment of such patients is determined by their increasing number and the share of combined injuries in the total structure of trauma, as well as by the duration of treatment, high lethality and disability [4-8].

Despite certain successes in providing medical care to such patients, the problem of their treatment is far from being solved. A limited number of works are devoted to the treatment of this type of injuries, and the treatment methods proposed in them are sometimes directly opposite [9-11]. More than half of patients with concomitant injuries are admitted to the hospital in severe shock, and one in three of them dies. According to different authors, complications in polytrauma develop in 28.0%-94.0% of cases, mortality reaches 70.0%, and disability occurs in 45.0% of cases, mainly as an outcome of musculoskeletal trauma [2, 6, 11, 12].

The aim of the study was to improve treatment outcomes in patients with severe combined trauma of several cavities (skull, thoracic and abdominal cavities, retroperitoneal space) and the musculoskeletal system.

Materials and methods of research. The paper presents an analysis of treatment of 72 patients with combined trauma of multiple cavity organs (skull, thoracic and abdominal cavities, retroperitoneal space) and musculoskeletal system treated at the Level 1 Trauma Center of the Republican Clinical Hospital in 2013-2017. The Level 1 Trauma Center was established on the basis of the Republican Clinical Hospital of the Ministry of Health of the Kabardino-Balkarian Republic on October 1, 2010. The main task of the trauma center specialists is to provide specialized, including high-tech, medical care to polytrauma patients. The Trauma Center provides round-the-clock specialized medical aid to the injured with polytrauma of any complexity. Its staff includes all necessary specialists – traumatologists, surgeons, a neurosurgeon, a neurologist, an ophthalmologist, an ENT doctor, a urologist and a therapist – to provide urgent specialized medical aid and further treatment.

Patients are examined using a range of modern clinical, laboratory, radiological and instrumental methods, including spiral computed tomography, intraoperative (surgical) X-ray systems (C-arc), magnetic resonance imaging, video laparoscopy, video-thoracoscopy, angiography and others.

The tactics of medical care is based on the principles of staged surgical treatment "Damage control". The main strategic task in the treatment of patients is to minimize the time of diagnostics of injuries, causing disturbances of vital functions, by combining it with measures for the elimination of life-threatening conditions. Diagnostic measures primarily

included diagnosis of internal bleeding in the abdominal and thoracic cavities, craniocerebral trauma, pelvic and long tubular bones injuries.

Among 72 patients we observed 40 (55.5%) men and 32 (44.5%) women. The vast majority (77.8%) of patients were between 20 and 50 years of age, i.e., persons of active physical labor. Most of the cases were caused by traffic accidents – 52 (72.2%) and falls from a great height – 17 persons (23.6%). Other causes of injury were in three persons (4.2%). The intensive care team of the Center for Disaster Medicine delivered 45 victims (62.5%) to the trauma center; 10 (13.9%) were delivered by ambulance; 5 victims (7.0%) were transported by auto. Twelve victims (16.6%) were transported from district hospitals. The following patients were hospitalized to the trauma center after the event: within 1 hour – 18 victims (25.0%); up to 2 hours – 27 (37.5%); up to 3 hours – 15 (20.8%); up to 6 hours – 9 (12.5%); over 6 hours – 3 victims (4.2%).

The Injury Severity Score (ISS) was used to determine the severity of injury, and the VPKh – SP (Department of Military Field Surgery scale, S – condition (sostoianie), P – admission (postuplenie) scale was used to assess the severity of the injured. With an ISS of 26-40 points, the trauma was considered to be of average severity (20 patients); 41-49, severe (30 patients); 50 points and more, extremely severe (22 patients). The condition of the victims, assessed at 21-30 points, was considered severe (52 victims), and 31-45 points – extremely severe (22 victims) according to the VPKh – SP scale. Traumatic shock was registered in 52 victims (72.2%), including: 1st degree shock – in 8, 2nd degree – in 6; II-III degree – in 32 victims. Blood loss of 1-2 liters occurred in 21 patients, up to 3 liters – in 15, more than 3 liters – in 4 patients.

The diagnosis of injuries was significantly complicated not only by the severe general state of the victims, but also by pronounced alcohol intoxication, the effect of narcotic substances, and anesthetics administered to the victims while providing them with first aid. In our observations with alcohol intoxication there were 25 victims (34.7%).

Closed craniocerebral trauma was registered in 60 victims, and open craniocerebral trauma was registered in 12 victims. Concussion of the brain was noted in 24 patients (33.3%); mild cerebral contusion – in 10 (13.4%), severe – in 28 patients (38.9%), subarachnoid hemorrhage – in 20 (27.7%); subdural hematoma – in 11 (15.2%); epidural hematoma – in 4 (5.5%); fracture of the cranial roof and base – in 15 (20.8%); fracture of facial bones – in 15 (20.8%); pneumocephaly – in two (2.7%); hemisinus – in one patient (1.3%).

Closed thoracic trauma was noted in 64 victims, and open thoracic trauma in 8 victims. Multiple rib fractures on one side – in 41 (57.0%); multiple rib fractures on both sides – in 16 (22.2%); lung contusion – in 45 (62.5%); lung rupture – in 5 (6.9%); cardiac contusion – in 12 (16.7%); diaphragm injury – in 8 (11.1%); sternum

fracture — in two (2.7%); hemopneumothorax — in 14 (19.4%); pneumothorax — in 13 (18.0%); hemothorax — in 12 (16.6%); hydrothorax — in 13 (18.0%); thoracic aortic rupture — in one victim (1.4%).

The following organs of the abdomen were more frequently injured: spleen — 33 (46.0%) victims, gastrointestinal tract (GIT) — 28 (38.8%); liver — 25 (34.7%). Kidney contusion was observed in 18 (18.7%) cases, rupture of the kidneys — in 5 (6.9%) cases, rupture of the bladder — in 7 (3.7%) cases, hemoperitoneum — in 34 (47.2%), retroperitoneal hematoma — in 19 (26.3%) cases, rupture of the vena cava — in 1 victim (1.4%).

Among the bones of the trunk and musculoskeletal system the vertebral appendages were most frequently injured — 20 patients (27.7%); bones of the pelvis — 14 (19.4%). Closed fracture of the femur was observed in 10 patients (13.8%); closed fracture of tibia bones — in 9 (12.5%), open fracture of tibia bones — in 7 (9.7%), open fracture of femur — in 6 (8.3%), dislocation of femur — in three (4.2%), fracture of clavicle — in 12 (16.6%), fracture of forearm bones — in 7 (9.7%), fracture of scapula — in 5 (5, shoulder — in two (2.7%), fracture of vertebral bodies — in 8 (11, 1%), including 3 (4, 1%) with spinal cord disruption, sacrum — in 6 (8, 3%), hand bones — in 4 (5, 5%), patella — in 2 (2, 7%), tear of both hands — in 1 (1, 4%), bone of foot — in 2 (2, 7%); multiple wounds of the trunk and extremities — 31 (43.0%).

Results of the study and their analysis. At the admission of a patient with combined trauma of the organs of several cavities and the musculoskeletal system the initial examination in the admission room or in the antishock operating room was performed by a surgical team and an intensive care physician. At the same time we performed general clinical examinations — blood and urine tests in dynamics, determination of amylase, diastase level, group and rhesus belonging, etc.

The tactics of care for the injured was based on the principles of staged surgical treatment "Damage control", taking into account the dominant injury. According to it, all the injured were divided into 4 main groups: Group 1 — combined injuries with dominant craniocerebral injury, severe cerebral contusion with subarachnoid or subdural hemorrhage — 28 (38.8%). Group 2 included patients with prevailing thoracic injury — 14 (19.4%); patients with moderate degree cerebral contusion, multiple rib fractures on both sides, accompanied by hemapneumothorax or pneumothorax with lung rupture — 5 (6.9%), with ruptured thoracic aorta — 1 patient (1.4%). Group 3 included patients with predominant abdominal injuries, concussion of the brain combined with spleen or liver injuries with extensive intraperitoneal bleeding — 12 (16.65%), with rupture of the inferior vena cava — one patient (1.4%). Group 4 included 11 people (22.2%) with severe cerebral contusion combined with multiple rib fractures on both sides, liver and bladder rupture, pelvic bone fracture.

The main strategic goal in treating patients was to minimize the diagnostic time of those injuries that cause impairment of vital functions. This was ensured by combining diagnostics with measures to eliminate life-threatening conditions. First of all, the diagnosis of internal bleeding in the thoracic and abdominal cavity, craniocerebral trauma, and pelvic bone injuries was performed. The victims were treated in 2 stages.

Within 6 hours of injury, the cranium, thorax, and abdomen were operated on first. A total of 144 operations were performed on organs and bones. Of these: craniotomy with removal of one subdural and one epidural hematoma, Bulau drainage of pleural cavity — 28; tracheostomy — 3; thoracocentesis — 6; thoracotomy — one; laminectomy — decompression of cauda equina — one; suturing lung wound — two; suturing of diaphragmatic cupula — 5; splenectomy — 28; suturing of liver — 18; suturing of small intestine rupture — 9; suturing of bladder — 3; epicystostomy — 2; nephrectomy — 4; suturing of stomach wound — one; cholecystectomy — 3 operations. Then the operations on musculoskeletal system were performed according to the degree of urgency. The choice of the method and time of osteosynthesis was differentiated depending on the severity of the injured person's condition, the type and localization of the fracture, taking into account the prevention and treatment of general and local complications. In the first hours after admission, along with intensive therapy and life-saving surgeries, the limb was temporarily fixed with external fixation apparatus in two cases of hip fracture and in one case of tibia fracture. Stump formation of both forearms was performed in one case. In the first three days, rod and spoke-rod apparatuses of external fixation were used in three cases of femur fracture and four cases of tibia fracture. Skeletal traction was applied to two patients with hip fracture and two patients with tibia fracture in stable condition. A plaster cast was applied to two patients with a shoulder fracture, four with a forearm fracture, and five with a clavicle fracture. During treatment, after stabilization, hip submerged osteosynthesis was performed in three patients with hip fracture (blocking intramedullary osteosynthesis — 2, plate with screws — 1); in two — with tibia fracture (blocking intramedullary osteosynthesis — 1, plate with screws — 1); plate with angular stability was used in two patients with humeral fracture.

At the time of admission, open fractures were treated in 2 stages — primary surgery and fracture stabilization. Within 6 hours of injury, primary surgical treatment was performed in 20 patients (67.1%). In 15 (32.9%) patients primary surgical treatment was delayed because of the severity of their condition. Two patients with an open femur fracture and one patient with a tibia fracture got external fixation devices. For open fractures at different times after admission, immersion plate osteosynthesis was performed in two patients with a hip fracture, in three patients with a tibia fracture, in one patient with a shoulder fracture and in two patients with a clavicle fracture. Intramedullary osteosynthesis with blocking was performed in four cases (femur — 2, tibia — 2). Repeated osteosynthesis operations were performed in four cases: in two cases — angularly stable plate osteosynthesis for hip fracture; in two cases — blocking intramedullary osteosynthesis with tibia fracture. In two cases the pelvic bones were fixed with a Ganz frame.

Thirty-two patients (44.5%) died in the intensive care unit and in the inpatient departments of the hospital at different terms. Within an hour — 8 patients (25.8%); within 24 hours — 12 (38.8%); within a week — 8 (25.8%); and within more than a week — 3 patients (9.6%).

Complications of the abdominal organs and musculoskeletal system in survivors (Group 1) and deceased patients (Group 2) are presented in Table 1.

Число пациентов с осложнениями со стороны полостных органов и опорно-двигательной системы, чел./%
 Number of patients with complications of cavitory and respiratory organs, pers./%

Клиническая группа Clinical group	Число пациентов, чел. Number of victims	ОНМК* и дислокация головного мозга Acute circulatory disorder and cerebral dislocation	Пневмония Pneumonia	Плеврит Pleuritis	Полиорганная недостаточность Multiple organ failure	Острая дыхательная недостаточность Acute respiratory failure	ТЭЛА Pulmonary embolism	Перитонит Peritonitis	ДВС-синдром Disseminated intra-vascular clotting syndrome	Сепсис Sepsis
1-я	40	1/2,5	9/22,5	7/17,5	1/2,5	2/5,0	–	–	–	1/2,5
2-я	32	9/28,1	6/18,7	4/12,5	4/12,5	2/6,3	2/6,3	2/6,3	1/3,1	–

Окончание таблицы 1/Ending of table No. 1

Клиническая группа Clinical group	Двуст. гнойный бронхит Bilateral purulent bronchitis	Цистит, уретрит Cystitis, urethritis	Панкреатит Pancreatitis	Остеомиелит Osteomyelitis	Нагноение раны Wound festering	Итого пациентов с осложнениями Total number of patients with complications	Число пациентов с шоком, чел. Number of patients with shock, degree			Итого пациентов с шоком, чел./% Total number of patients with shock
							I ст.	II ст.	III ст.	
1-я	1/2,5	2/5,0	–	1/2,5	2/5,0	27/67,5	7	4	15	26/65,0
2-я	–	–	1/3,1	–	–	31/96,8	1	2	23	26/81,2

* ОНМК – острое нарушение мозгового кровообращения / Acute circulatory disorder

Таблица 2 / Table No. 2

Число пациентов с отдаленными результатами лечения
 Long-term results of treatment

Число пациентов, чел. Number of patients	Результат лечения, чел./% Results of treatment, pers./%			Группа инвалидности, чел. Disability group, pers.			Итого пациентов с инвалидностью, % Total, %
	хороший / good	удовлетв. / satisfactory	неудовл. / unsatisfactory	I	II	III	
31	9/29,0	11/35,4	11/35,4	1	3	7	35,4

Table 1 shows that the patients died mainly from shock, cerebral edema and dislocation, pneumonia, multiple organ failure, acute respiratory failure, TELA and DIC, and these parameters were significantly lower in survivors. Thus, in the total number of survivors (40) complications were observed in 27 patients (67.5%); in the total number of deaths (32) – in 31 patients (96.8%).

The proportion of patients with various degrees of shock was 65% and 81.2% among survivors and deceased patients, respectively.

Long-term treatment results (6 months to 4 years) were studied in 31 patients (70.7%). Long-term results of treatment were assessed according to a three-point system: good, satisfactory, unsatisfactory.

A *good result* was the absence of complaints about the functioning of the cavity organs, bone fusion with complete restoration of the segment functions.

Satisfactory result meant presence of minor abnormalities from the cavity organs in the form of recurrent headaches, pain at physical activity, and from the injured limb – not sharply pronounced curvature of its axis and limitations of mobility in the joints.

Poor outcome is the presence of complications on the side of the cavitory organs (often recurrent headaches, postoperative ventral hernia, adhesions, etc.), fracture complications with osteomyelitis or significant limitation of joint mobility. The following table shows the long-term results of treatment (Table 2).

Table 2 shows that the proportion of patients with satisfactory and unsatisfactory treatment results is a total of

70.8%. This can be explained by the severity of the trauma received and the late delivery of the victims from the district hospitals. Group I disability was established for one patient, Group II disability for three, and Group III disability for seven patients.

Thus, the proportion of patients with disabilities in the total number was 35.4%.

Conclusion

1. The main causes of death at severe combined injuries are: shock, cerebral edema and dislocation, posttraumatic pneumonia, multiple organ failure, acute respiratory failure, pulmonary embolism (TELA) and DIC.

2. The primary goals in treatment of such patients are minimization of diagnostic time of those lesions which cause vital functions impairment and early elimination of life-threatening disorders.

3. In treatment of this category of patients the most satisfactory results can be obtained only with the tactics of medical care based on the principles of staged surgical treatment, "Damage control".

4. The earlier resuscitation and antishock measures are started, the more chances for favorable outcome of this category of patients treatment are. One of the causes of high mortality is the late delivery of the injured to the specialized hospital.

5. The time and sequence of surgical treatment of the received injuries depend on their severity, on the degree of threat to life and the prevailing trauma.

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HEALTH DAMAGE ASSESSMENT IN VICTIMS OF NON-LETHAL KINETIC WEAPONS

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Abstract. The aim of the study was to assess the severity of health damage in victims of self-defense non-lethal kinetic weapons.

Materials and research methods. The medical records (form 003/u) of 67 victims of NKO who received medical care in the Arkhangelsk Regional Clinical Hospital in 2009-2019 were studied.

The degree of health damage severity was assessed according to the method approved by the order of the Russian Ministry of Health and Social Development of April 24, 2008 № 194n. For multiple and combined injuries the degree of severity of the injury was determined according to the criterion which corresponded to a higher degree of severity. Quantitative (mean values) and categorical (extensive values) variables were used for statistical analysis. Boundaries of their 95% confidence intervals (CI) were calculated using the WinPepi program.

Results of the study and their analysis. Analysis of the study results showed:

- The damage to health of severe and moderate severity was detected in 34.3% of the victims with predominant wounds to head, neck, chest, and abdomen;
- In chest wounds, including those without penetrating wound channel, CT scanning is indicated from one to three days to diagnose lung contusion, which is not reliably visualized on an overview radiograph;
- In nonpenetrating abdominal wounds, damage to internal organs due to hydrodynamic shock is not excluded. In this case it is necessary to hospitalize victims for one or three days for clinical observation and ultrasound control. In doubtful cases diagnostic videolaparoscopy should be performed.

Key words: damage to health, non-lethal kinetic weapons, victims

Conflict of interest. The authors declare no conflict of interest

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ОЦЕНКА ВРЕДА ЗДОРОВЬЮ У ПОСТРАДАВШИХ ОТ ПРИМЕНЕНИЯ НЕЛЕТАЛЬНОГО КИНЕТИЧЕСКОГО ОРУЖИЯ

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Резюме. Цель исследования – оценить степень тяжести вреда здоровью у пострадавших от применения нелетального кинетического оружия (НКО) самообороны.

Материалы и методы исследования. Материалом исследования были медицинские карты (ф. 003/у) 67 пострадавших от НКО, получивших медицинскую помощь в Архангельской областной клинической больнице в 2009–2019 гг.

Степень тяжести вреда здоровью оценивалась по методике, утвержденной приказом Минздравсоцразвития России от 24 апреля 2008 г. №194н. При множественных и сочетанных ранениях степень тяжести вреда здоровью определяли по критерию, который соответствует более высокой степени тяжести.

Для статистического анализа использовались количественные (средние величины) и категориальные (экстенсивные величины) переменные. По программе WinPepi были рассчитаны границы их 95%-ных доверительных интервалов (ДИ).

Результаты исследования и их анализ. Анализ результатов исследования показал:

- вред здоровью тяжелой и средней степени тяжести был выявлен у 34,3% пострадавших с преимущественными ранениями в области головы, шеи, груди и живота;
- при ранениях в грудь, в том числе и при отсутствии проникающего характера раневого канала, показано выполнение компьютерной томографии в срок от одних до трёх суток для диагностики ушиба легкого, который на обзорной рентгенограмме достоверно не визуализируется;
- при непроникающих ранениях живота не исключается повреждение внутренних органов вследствие гидродинамического удара. При этом необходима госпитализация пострадавших на одни–трие суток для клиническо-

го наблюдения и ультразвукового контроля. В сомнительных случаях следует выполнить диагностическую видеолапароскопию.

Ключевые слова: вред здоровью, нелетальное кинетическое оружие, пострадавшие

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

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Introduction.

In 2010, President V. V. Putin submitted to the State Duma of the Federal Assembly of the Russian Federation a draft law No. 402489-5 "On introducing amendments to certain legislative acts of the Russian Federation on the issue of strengthening control in the sphere of circulation of civilian weapons". As stated in the explanatory note to the document, it was proposed to amend the Federal Law "On Weapons" No 150-FZ dated December 13, 1996. In particular, it was proposed to define a new category of weapons — limited firearms, including short-barrelled and targetless weapons. The mentioned category included pistols, revolvers and firearmsless firing devices, designed to defeat the human force at a distance with a projectile of traumatic effect and not intended to cause human death. The changes allowed to apply a unified procedure of circulation and unified measures of control of weapons and cartridges with high lethal characteristics. The amendments to the aforementioned law came into force on January 15, 2011.

Firearms of limited destruction are also called non-lethal kinetic weapons, designed for self-defense of civilians and fighting of special units of the Russian Ministry of Internal Affairs against criminals. At the same time, in most cases civilians use non-lethal kinetic weapons not as an effective means of protection, but as weapons of attack [1, 2]. Currently in Russia the number of owners of non-lethal kinetic weapons and the number of requests for medical assistance from victims of their use is increasing rapidly. In the first decade of the 21st century the number of injuries from these weapons increased 9-fold [2]. In 2016 alone, there were more than 591,000 applications for the purchase of civilian weapons, of which 550,000 were granted [3].

A shooting distance from non-lethal kinetic weapons of less than 1.0-1.5 m is considered life-threatening. In 2011, rubber bullets with a metal core (reinforcing element) in 18*45T cartridges for Osa PB-4-1 and Guardian MR-461 pistols were banned in Russia due to their significant damaging effect. Modern cartridges of traumatic action, made of elastic rubber and plastisol, have a diameter of 10.0-10.2 mm, a mass of 0.7-0.73 g and an initial bullet flight speed of 300-450 m/s [1, 4]. The severity of injuries from wounding projectiles depends on the mechanical properties of the traumatic elements, the distance of the shot, the localization of the wound, the type of clothing (winter, summer), the muscle mass, the physique and the

physical condition of the victim. When wounds to the head, neck, cardiac area are made from a distance of less than one meter the risk of serious harm to health and death is possible. Life-threatening consequences of wounds received during the use of non-lethal kinetic weapons are profuse external and internal bleeding, asphyxia, acute impairment of cerebral circulation, air embolism [1, 5, 6].

Injuries resulting from the use of non-lethal kinetic weapons are a special kind of wounds that require unified algorithms for the management of the victims. A comprehensive approach is required to systematize and streamline the knowledge required in the provision of medical care to victims of non-lethal kinetic weapons use. At present, the following aspects of the problem of non-lethal kinetic weapons use have been sufficiently studied: medical and biological peculiarities of injuries and wound ballistics; criteria and structure of injuries caused by non-lethal kinetic weapons use, comparative analysis of the contingent of victims from firearms and traumatic weapons [7-9]. In addition, data on the severity of injury resulting from the use of non-lethal kinetic weapons was published [5]. However, to date, there is no detailed analysis of the problem of assessing the severity of injury to the health of victims from the use of non-lethal kinetic weapons in the specialized literature.

The aim of the study was to assess the severity of injury to the health of victims from the use of non-lethal kinetic self-defense weapons.

Materials and methods of research. The material of the research was 67 medical records (form 003/u) of the victims of non-lethal kinetic weapons who received medical care in the Arkhangelsk regional clinical hospital in 2009-2019. The following data were taken from the medical records: date of treatment, age and sex of the victim; severity of condition at the time of treatment; anatomical area of injury; type of projectile (rubber bullet, buckshot); nature of the wound channel; volume of medical care/operative intervention provided; date of patient discharge and outcome of illness.

The average age of the victims was 30.3 years (17-55 years). The following indicators were calculated according to the above data: distribution of the victims according to age, number of wounds in anatomical areas, localization and nature of a gunshot wound, and degree of severity of damage to health. The degree of the injury's severity was

estimated according to the method approved by the Order of the Ministry of Health and Social Development of Russia No. 194n, dated April 24, 2008 [10]. For multiple and combined wounds the degree of severity of the injury was determined according to the criterion that corresponds to a higher degree of severity [6].

Quantitative (mean values) and categorical (extensive values) variables were used for statistical analysis. Boundaries of their 95% confidence intervals (CI) were calculated using the WinPepi program.

Results of the study and their analysis. The research group included 67 victims (65 men and 2 women) aged 17-55 years (mean age — 30,3 years), who received 137 gunshot wounds with rubber bullets, mainly from pistol IZh-79-9TM ("Makarych"). Fifty-one victims (76.1%) were hospitalized (95% confidence interval: 64.1-86.7); duration of hospital treatment ranged from 5 to 19 days, with an average of 12 bed-days. There were no lethal outcomes.

The group of victims was stratified as follows.

According to the number and localization of wounds:

- single wound — 39 victims (58.2%) (95% confidence interval: 45.2-70.2);

- multiple and combined wounds — in 28 victims (41.8%) — (95% confidence interval: 29.8-54.5).

The number of wounds per victim ranged from 2 to 8.

Number of wounds by anatomical region: head — 9 victims (6.6%), neck — 8 (5.8%), spine — 2 (1.5%), chest — 58 (42.3%), abdomen — 22 (16.1%), pelvis and external genitalia — 3 (2.2%), extremities — 35 victims (25.5%).

According to the nature of the wounds:

- shot at point-blank range and close range — 30 wounds (21.6%) — (95% confidence interval: 11.3-35.3);

- blind wound channel 2-10 cm long — 127 (92.7%) — (95% confidence interval: 87.0-96.4)

- through wound (auricle, scrotum and forearm) — 3 (2.2%) — (95% confidence interval: 0.5-6.3)

- tangential wounds to various parts of the body — 7 (5.1%) — (95% confidence interval: 2.1-10.2)

- fracture of bones — 12 (17.9%) — (95% confidence interval: 9.6-29.2), of which cerebral and facial skull — 5 (41.7%) — (95% confidence interval: 15.2-72.3); ribs and sternum — 3 (25.0%) — (95% confidence interval: 5.5-57.2); spinous processes of thoracic vertebrae, 2 (16.7%), (95% confidence interval: 2.1-48.4); finger phalanx and ulna, 2 (16.7%), (95% confidence interval: 2.1-48.4).

The distribution according to the localization and pathomorphology of the injuries and the degree of injury is presented in Tables 1, 2.

All the victims underwent surgical treatment of soft tissue gunshot defects: lavage, extraction of foreign body if any, and primary surgical treatment of deep wound channels. Victims with severe injuries underwent surgical treatment and abdominal operations: skull trepanation, removal of bone fragments and brain detritus — 1, thoracotomy — 4 and video thoracoscopy — 1, laparotomy and video laparoscopy — 6.

During thoracic surgeries, atypical resection and suturing of the lung wound, suturing of the pericardium and diaphragm wounds, bullet and hemothorax removal were performed — 5. Hemostasis, suturing of wounds of ileum and greater omentum were performed during abdominal surgeries by laparoscopy and videolaparoscopy. Also in case of severe injury we performed: metal osteosynthesis of facial skeleton bones — one, ligation of the upper thyroid artery in a deep wound — one, orchiectomy — one.

Victims with moderate injury underwent various variants of medical procedures: sanation bronchofibroscopy, video laparoscopy, abdominal blood removal and endoscopic hemostasis, plaster immobilization of limb segments.

Cardiac and brachial nerve plexus contusions were treated according to cardiology and neurology clinical guidelines.

The annual increase in the number of non-lethal kinetic weapons in the population and, as a consequence, the increasing number of victims' applications for medical care prompted us to correlate the results of our study with the data of other authors.

In particular, the results we obtained for the gender and age structure of the victims, the data on the prevalence of mild degree of severity of injury are comparable with previously published data [2, 5]. In our study, chest wounds predominate by localization — 42.3%, in contrast to the results of a study by Badalov et al. in which the proportion of chest wounds was 21% and that of neck and head wounds — 51% [5]. Blind wound channels prevail in our study and in publications by other authors.

According to the same authors who performed an analysis of 297 protocols of the St. Petersburg City Bureau of Forensic Medical Examination for 2010-2014, grave damage to health occurred in 24% of the victims, medium — in

Таблица 1 / Table No. 1

Распределение огнестрельных повреждений по локализации и степени вреда здоровью
Distribution of injuries from non-lethal kinetic weapons by degree of injury depending on localization

Локализация огнестрельных повреждений Wound localization	Количество ранений, абс./% (95% ДИ) Number of injuries, abs./% (95% CI)	Степень вреда здоровью, % (95% ДИ) Degree of injury, % (95% CI)		
		тяжелая severe	средняя moderate	легкая minor
Грудь / Chest	58/42,3 (33,9-51,1)	6,9 (1,9-16,7)	25,9 (15,3-39,0)	67,2 (53,7-79,0)
Конечности / Limbs	35/25,6 (18,5-33,7)	-	5,7 (7,0-19,2)	94,3 (80,8-99,3)
Живот, таз, наружные половые органы / Abdomen, pelvis, external genitalia	25/8,2 (12,2-25,7)	24,0 (9,4-45,1)	16,0 (4,5-36,1)	60,0 (38,7-78,9)
Голова и шея / Head and neck	17/12,4 (7,4-19,1)	17,6 (3,8-43,4)	41,2 (18,4-67,1)	41,2 (18,4-67,1)
Позвоночник / Spine	2/1,5 (0,2-5,2)	-	100 (15,8-100,0)	-
Всего / Total	137/100,0	9,5 (5,1-15,7)	21,9 (15,3-29,8)	68,6 (60,1-76,3)

Распределение пострадавших по степени вреда здоровью и патоморфологии огнестрельных повреждений, чел./% (95% ДИ)

Distribution of victims depending on the pathomorphology of injuries, pers. % (95% CI)

Степень вреда здоровью / Degree of injury Патоморфология огнестрельного повреждения / Pathomorphology of injuries	Число пострадавших, чел./% (95% ДИ) Number of victims, pers.% (95% CI)	% (95% ДИ) % (95% CI)
<i>Тяжелая / Severe</i>	12/17,9 (9,6-29,2)	–
Проникающее ранение грудной клетки / Penetrating chest wound	–	33,4 (9,9-65,1)
Проникающее ранение брюшной полости и забрюшинного пространства / Penetrating wound of abdomen and retroperitoneal space	–	33,4 (9,9-65,1)
Огнестрельный перелом теменной кости с повреждением головного мозга / Gunshot fracture of the parietal bone with brain damage	–	8,3 (0,2-38,5)
Перелом носоглазничного комплекса лицевого скелета / Fracture of nasopharyngeal complex of facial skeleton	–	8,3 (0,2-38,5)
Ранение щитовидной железы и верхней щитовидной артерии / Injury of thyroid gland and upper thyroid artery	–	8,3 (0,2-38,5)
Размозжение яичка / Testicular crush	–	8,3 (0,2-38,5)
<i>Средняя / Moderate</i>	11/16,4 (8,5-27,5)	–
Изолированный перелом костей / Isolated bone fracture	–	36,6 (19,9-56,1)
Ушиб 2-3-х бронхолегочных сегментов / Contusion of 2-3 bronchopulmonary segments	–	26,7 (12,3-45,9)
Ушиб селезенки и сальника / Contusion of spleen and omentum	–	16,7 (5,6-34,7)
Ушиб сердца / Heart contusion	–	13,3 (3,8-30,7)
Ушиб плечевого нервного сплетения / Contusion of brachial nerve plexus	–	6,7 (0,8-22,1)
<i>Легкая / Minor</i>	44/65,7 (53,1-76,8)	–
Раневой дефект кожи и подкожной клетчатки, ушиб подлежащих мышц / Wound defect in skin and subcutaneous tissue, contusion of underlying muscles	–	100,0 (85,8-100,0)

15 and light — in 47% of the victims. Damage to health was absent in 13% of observations. The cited work did not investigate harm to health depending on the localization of wounds, pathomorphology of injuries to organs, soft tissues, and bone and joint structures [5].

A number of publications [1, 2, 5, 6] indicate that 19.0-24.1% of the observations were life-threatening from wounds sustained from non-lethal kinetic weapon shots penetrating the chest. Our data indicate that in Arkhangelsk, wounds to the chest with minor and moderate injury predominate. Wounds to the abdomen, pelvis, and external genital organs in 40 % of cases, and gunshot wounds to the head and neck in 58.8 % of cases cause average and serious harm to health.

Of particular interest are ileum ruptures and spleen ruptures in two observations of non-penetrating wounds in which a rubber projectile was lodged in the preperitoneal tissue. The gunshot projectile has a piercing, wedging, and bruising effect on tissue. The elastic bullet of non-lethal kinetic weapons is characterized by contusion — the zone of necrosis is usually weakly expressed [11]. We believe that the cause of ruptures in the ileum and spleen in non-penetrating wounds was the hydrodynamic effect on internal organs adjacent to the abdominal wall in the zone of bullet stopping. The fracture of the nasolacrimal complex of the facial bones with hemorrhage into the accessory sinuses — in one victim — and the destruction of the testicle from the penetrating wound of the scrotum — also in one victim — were also classified as grave harm to health.

The main medical criterion for damage to health of moderate severity is a temporary disturbance of the functions of organs and systems that lasts for more than three weeks [10]. According to our data, every fifth wound inflicted by

non-lethal kinetic weapons caused moderate damage to health. In this group, 26.7% of injuries were to contusions of the bronchopulmonary segments. Pulmonary contusions were diagnosed by chest CT one to two days after a non-penetrating wound. Pulmonary contusions in victims with gunshot lung wounds were not included in this group, since according to the criterion — lung wounds cause "serious harm to health". There are no data on the frequency and volume of lung contusions due to non-penetrating wounds to the chest from non-lethal kinetic weapons available to us in the publications. This type of lung injury is subject to timely — within two to three days after the wound — diagnosis and treatment. Otherwise the lesion may be complicated by traumatic pneumonia with subsequent pneumofibrosis.

Blind, not penetrating into natural cavities, and tangential wounds of soft tissues without damage to vessels, nerves and bones resulted in short-term (less than three weeks) impairment of function. An isolated single bullet wound from a non-lethal kinetic weapon results, at a minimum, in a circular skin defect at least 1 cm in diameter, a wound canal 2 cm deep or more with muscle contusion. A point-blank and close-range shot results in a skin defect of up to 5 cm with lacerated burned edges and hemorrhage in the adjacent skeletal muscle. Healing requires primary surgical treatment of the wound, functional rest of the injured part of the body and bandaging until the soft tissue defect heals. Such an injury can be rightly considered to be a harm to health of a light degree of severity.

The obtained results on a number of positions have differences from the previously published data and, therefore, further accumulation and analysis of materials for the evidentiary assessment of the damage to health depending on the localization and pathomorphology of

the injuries inflicted with non-lethal kinetic weapons is necessary.

Conclusions

1. The damage to health of a heavy and moderate degree of severity was revealed in 34,3% of the victims with wounds mainly in the region of the head, neck, chest, and abdomen.

2. CT scanning is indicated at one to three days for the diagnosis of lung contusion, which is not reliably visualized

on the observational radiograph if wounds to the chest are wounds, including those without the penetrating character of the wound channel.

3. In nonpenetrating abdominal wounds, damage to internal organs due to hydrodynamic impact cannot be excluded. In this case the hospitalization of victims for one or three days for clinical observation and ultrasound control is necessary. In doubtful cases diagnostic videolaparoscopy should be performed.

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IMPEDANCE SPECTROMETRY AS A PROMISING METHOD TO ASSESS THE EFFECTS OF PARAMETRIC AND SHOCK-ACOUSTIC EFFECTS OF NON-LETHAL WEAPON SYSTEMS

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Abstract. *The aim of the study is to adapt the method of impedance spectroscopy as applied to the assessment of possible effects of acoustic impact of various parameters.*

Materials and research methods. The study was carried out using 70 rabbits (chinchilla) weighing 2.5-3 kg. Five experimental and control groups were formed based on a preliminary examination of the animals in order to cull individuals with altered acoustic stem evoked potential and other parameters. The experimental animals were exposed to five series of 160 acoustic pulses with low-frequency spectrum each.

Results of the study and their analysis. The study showed the promising prospects of using the method of impedansometry in experimental work to assess the impact of acoustic factors on the functional state of the body.

High sensitivity of the method was also proved, allowing to identify difference in the negative impact of acoustic factors of different parameters, which were not identified, in particular, in the analysis of the altered acoustic stem evoked potential.

The results of this work confirmed the need for further research on this phenomenon and for the search for methods of assessing the functional state at the organ and organism levels, correlating with impedance parameters.

Key words: *acoustic stem evoked potential, effects, impedance polarization, impedance spectrometry, intensity, lung biophysical parameters, non-lethal weapon systems, parametric emitter, parametric exposure, peak level, phase angle, probabilistic and temporal characteristics, shock-acoustic effect*

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ИМПЕДАНСНАЯ СПЕКТРОМЕТРИЯ КАК ПЕРСПЕКТИВНЫЙ МЕТОД ОЦЕНКИ ЭФФЕКТОВ ПАРАМЕТРИЧЕСКОГО И УДАРНО-АКУСТИЧЕСКОГО ВОЗДЕЙСТВИЯ СИСТЕМ НЕЛЕТАЛЬНОГО ОРУЖИЯ

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Резюме. *Цель экспериментального исследования – адаптация метода импедансной спектроскопии применительно к оценке возможных последствий акустического воздействия разных параметров.*

Материалы и методы исследования. Исследование проводили на 70 кроликах (шиншилла) массой 2,5–3 кг. Формирование пяти экспериментальных и контрольной группы основывалось на предварительном обследовании животных с целью отбраковки особей с измененным акустическим стволовым вызванным потенциалом (АСВП) и другими показателями. Экспериментальные животные были подвергнуты воздействию пяти серий из 160 акустических импульсов с низкочастотным спектром в каждой серии.

Результаты исследования и их анализ. Исследование показало перспективность использования метода импедансометрии в экспериментальных работах для оценки влияния акустических факторов на функциональное состояние организма.

Показана также высокая чувствительность метода, позволяющего выявить разницу в негативном воздействии акустических факторов разных параметров, не выявленную, в частности, при анализе АСВП.

Результаты данной работы подтвердили необходимость проведения дальнейших исследований этого феномена и поиска методов оценки функционального состояния на органном и организменном уровнях, коррелирующих с параметрами импеданса.

Ключевые слова: *акустический стволовой вызванный потенциал, биофизические показатели легких, вероятностно-временные характеристики, импедансная спектрометрия, интенсивность, кролики, параметрический излучатель, параметрическое воздействие, пиковый уровень, поляризация импеданса, системы нелетального оружия, ударно-акустическое воздействие, фазовый угол, эффекты*

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Introduction

The variety of acoustic noise to which humans are exposed in a variety of situations is not limited to hearing impairment in the form of temporary or permanent hearing threshold reductions. Under moderate and very strong, but not destructive (above 120 dB) noise exposure, even at small rates, people may experience stress in different manifestations [1, 2].

Acoustic impacts of different intensity and different probability-time characteristics can cause not only violations of the auditory system up to rupture of tympanic membranes, but also pathological changes in the lungs and brain. Morphological manifestations of acoustic effects are usually associated with exposure to acoustic pulses with a peak level above 160-170 dB. However, (unlike a shock wave characterized by a direct supersonic impact and a throwing action leading to a secondary impact on the obstacles) acoustic pulses can also cause disorders in lungs and brain, from functional to pathological ones [3].

The main requirement for special means of acoustic influence is the possibility of psycho-emotional influence by blinding and stunting, simulating the danger of health damage and death, in order to form fear as a basic emotion. Such stress reaction is possible with the use of parametric acoustic and light emission means.

Currently, the development and implementation of non-lethal weapons require justification of their purposeful use, as well as the assessment of possible undesirable consequences, i.e., safety of use [4].

Thus, the assessment of justified risk of using complexly organized and extremely intense acoustic oscillations generated by pulse or parametric impact systems is an urgent task. It can be solved by experimental studies on two or three species of animals, which allows applying the technique of extrapolation of the obtained data on real objects.

Experimental study of the effects of acoustic pulses at a peak sound pressure level of 5-50 kPa revealed a number of features of acoustic effects on lungs, different from the impact of a shock wave.

The effectiveness and safety of the acoustic pulse cannot be evaluated by overpressure parameters. Because the biological effectiveness is composed of amplitude-frequency characteristics and time parameters of the pulse. At present, no regularities determining the nature and degree of changes in the functional state of lungs and brain have been revealed. This determines the need for experimental expert evaluation of each promising special means.

As a result, a method of quantitative assessment of the functional state of lungs was developed by a complex of indices, such as specific density of air lungs, collapsed lungs, ratio of air and collapsed lung densities, difference of air and collapsed lung volume [5, 6]. This complex allows to describe the clinical picture of lung lesions.

Changes in lungs are often combined with brain stem structures lesions even when acoustic impulses of different

temporal characteristics and positive phase amplitude of only 10-20 kPa are applied. These changes have been revealed by acoustic stem evoked potentials registration method. This method is used in clinical practice, in particular, to assess the degree of brain lesions – lesions from medium severity to extremely severe lesions according to the classification of types of acoustic brainstem evoked potential disturbances [7, 8].

Chemical analysis of the brain stem elements of sheep with changes in acoustic stem evoked potentials of a severe degree showed an increase in the specific content of sodium by 27.9% on average and a decrease in the specific content of potassium by 28.0% (table).

The data presented in the table indicate swelling of the brain stem part, which was reflected in the character of acoustic stem evoked potentials.

In clinical practice, when analyzing acoustic stem evoked potentials, considerable attention is paid to the latency indices of the main peaks and inter-peak intervals. They characterize the presence of changes in the state of the central nervous system in various diseases, including hearing disorders [9].

The advantage of recording acoustic stem evoked potentials in the experiment before and after exposure is the possibility of individual analysis of changes in the amplitude values and latency and connection with the factor parameters.

The analysis of the chemical composition of the brain to a large extent serves as a supplement to the results of acoustic stem evoked potentials registration. However, it is a labor-intensive method, which makes it difficult to perform the necessary amount of analyses.

The above indicates the need to expand the methodological apparatus for assessing the biological effects of the acoustic effects of developed and existing special devices.

At present in biology and medicine for measuring the electrical properties of biological tissues the method of impedance spectroscopy is increasingly used [10-14]. This

Таблица /Table

Удельное содержание некоторых элементов в стволе мозга овец контрольной группы с изменениями АСВП тяжелой и крайне тяжелой степени после воздействия акустического импульса
Specific Content of Some Elements in the Brainstem of Sheep in the Control Group with Changes in Severe and Extremely Severe ASVP Degree after Exposure to an Acoustic Pulse

Элемент Element	Контроль Control	Опыт Experience
Na, мг/г (mg/g)	1,29±0,04	1,65±0,04
K, мг/г (mg/g)	3,65±0,05	2,85±0,11
Zn, мг/г (mg/g) × 10 ⁻²	1,3±0,02	1,05±0,17
Fe, мг/г (mg/g) × 10 ⁻²	1,58±0,05	1,4±0,04
Cu, мг/г (mg/g) × 10 ⁻³	3,94±0,14	3,46±0,07
Mg, мг/г (mg/g) × 10 ⁻¹	1,19±0,02	1,29±0,03

method allows differentiation of tissues and recognition of pathological processes, primarily related to the condition of cell lipid membranes. In the region of ω -dispersion (0.1-100 kHz) the polarization of whole cells occurs as a result of ion diffusion. Currents enveloping cells through electrolyte solutions predominate there.

The normal state of lipid cell membranes is characterized by a sharp decrease in impedance when frequencies change from 0.1 to 100 kHz. Smoothing of the dispersion curve of impedance is indicative of negative changes in cell formation.

The aim of the study is to adapt the method of impedance spectroscopy as applied to the assessment of the possible effects of acoustic effects of different characteristics.

Research objectives:

- Adaptation of digital meter LRC AM-3125 to determine the electrical properties of biological tissues;
- Evaluating the sensitivity of the adapted methodological complex of registering electrical impedance under acoustic influences;
- determination of impedance parameters of the organs of rabbits of the control group after euthanasia;
- determination of brain impedance parameters in rabbits of 5 experimental groups which were exposed to acoustic influence of different parameters.

Materials and research methods. The investigation was carried out using 70 rabbits (chinchilla) weighing 2.5-3 kg. Formation of 5 experimental groups and the control

group was based on a preliminary examination in order to cull individuals with altered acoustic stem evoked potentials and other indicators. Experimental animals were exposed to 5 series of 160 acoustic pulses with low-frequency spectrum. The peak levels of groups 1, 2, and 3 were 119, 125, and 112 dB, respectively, and groups 4 and 5 were 117 and 121 dB, respectively. In terms of the spectrum the 1st, 2nd and 3rd groups were identical, and differed from the 4th and 5th groups, which were similar to each other in the nature of the spectrum.

Before and after exposure, acoustic stem evoked potentials were recorded in rabbits of the control and experimental groups [12]. Euthanasia was performed by decapitation without crossing the trachea in accordance with the method of autopsy and macroscopic examination and measurement of lung biophysical indices [7].

Brain, blood and internal organs impedance sampling was carried out with a digital meter LRC AM-3125 adapted for biological research.

Digital meter Aktakom LRS AM-3125 is intended for measurement of inductance L, capacitance C, resistance R, total resistance Z, equivalent series resistance ESR, dissipation factor D, quality factor Q and phase angle in operation of radioelectronic equipment. The instrument provides measurements at working frequencies of 100 and 120 Hz; 1, 10 and 100 kHz. The basic relative error of measurements is $\pm 0,25\%$.

In the experiment, we used a standard measurement cable with Kelvin clips, which were connected to the

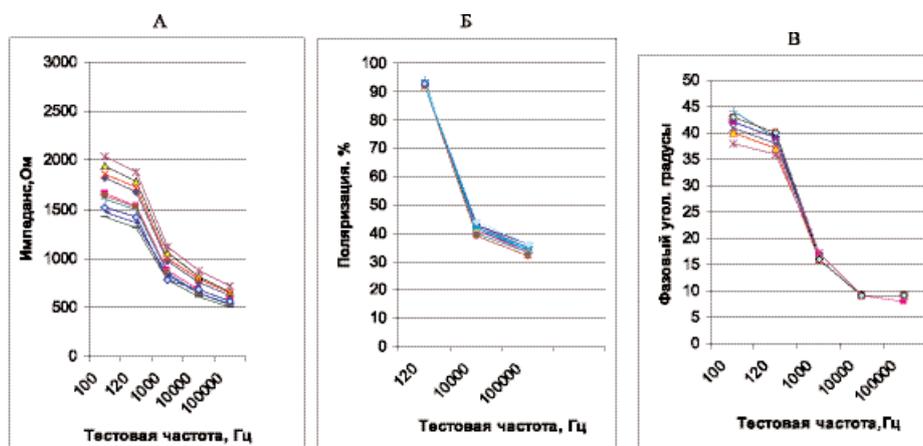


Рис.1. Импеданс головного мозга у кроликов контрольной группы
Fig. 1. Brain impedance of control group rabbits

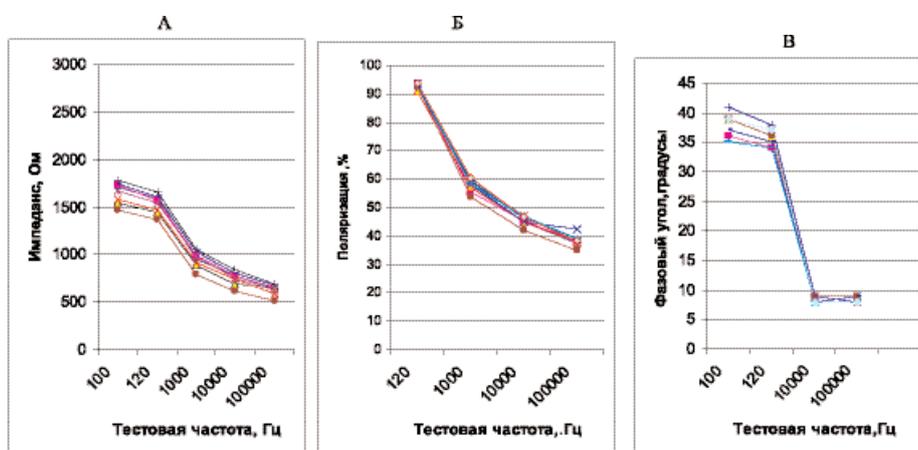


Рис.2. Импеданс головного мозга у кроликов 2-й группы
Fig. 2. Brain impedance of group 2 rabbits

contacts of the electrode holder, which were immersed in the biomaterial.

Injection needles 1 mm in diameter fixed in the holder and providing the same (10 mm) depth of immersion into the biomaterial at a distance of 10 mm were used as electrodes.

The measured initial parameters were: electric impedance dispersion and phase angle. Calculation of polarization in the group was performed.

Results of the study and their analysis. Digital meter LRC, designed to obtain the technical characteristics of radio equipment, is not equipped with electrodes suitable for measuring the electrical characteristics of biological tissues. In order to use impedansometry in a biological experiment we tested different options for installing electrodes in the measured organ. We settled on the holder providing the same immersion depth and the same distance between the electrodes. Functionality of the obtained measuring system was tested on plant objects (potato, aloe, apple) and on rat organs at different times after euthanasia. The obtained curves of impedance dispersion and phase angle and the dynamics of their transformation as a result of the natural process of tissue death showed the possibility of using this scheme for a biological experiment.

Comparative individual analysis of the parameters of acoustic stem evoked potentials of rabbits of experimental and control groups, registered before and at different times after exposure, did not reveal changes in the latency and inter-peak intervals of all major peaks, which could be associated with the influencing factor. Autopsy revealed no external macroscopic changes in the brain and internal organs, including the lungs. Biophysical indices of the lungs of the experimental animals did not differ from those recorded in the control groups.

Brain impedance of control and experimental animals was recorded between hemispheres in the vertex projection. Individual impedance dispersion curves of the brain of the control group show a difference of approximately 600 ohms at frequencies of 100-120 Hz and a smaller difference in the range 1-100 kHz (Fig. 1a). At the same time, impedance polarization in animals of this group is almost the same even at low frequencies (Fig. 1b) The difference in the value of the phase angle is only 5.6° only at 100 Hz (Fig. 1c).

Measurement of brain impedance of the animals of groups 1, 3 and 4 revealed no changes in electrical characteristics of brain tissue compared with the control and no difference in individual recorded and calculated parameters between the groups.

It seemed important to evaluate the impedance of rabbits of groups 2 and 5 subjected to acoustic influences with different frequency spectrum and peak sound pressure levels.

Comparison of the measurement results in the 2nd and control groups revealed a slight narrowing of the range of individual values and the absolute values of impedance at a frequency of 100-120 Hz (Fig. 2a, 2b, 2c). Polarization of impedance and phase angle did not differ from the control.

At the same time, in group 5 brain impedance dispersion of different rabbits differed significantly, which in turn affected the polarization curves at frequencies of 10-100kHz (Fig. 3a, 3b). The peak level of acoustic influence on rabbits of the 2nd group was higher by 4 dB than in the 5th group, but in the 2nd group no such negative processes in the brain of experimental animals as in the 5th group were detected.

The results of measurements of brain impedance parameters of the 5th group showed different acoustic sensitivity of the experimental animals. Thus, only 60% had serious deviations from the control of dispersion, polarization and phase angle (Fig. 3c). Correspondingly, in 40% of the animals no significant changes in impedansometry parameters were detected (Fig. 3d).

Thus, the study showed the prospects of using the method of impedansometry in experimental studies to assess the impact of acoustic factors on the functional state of the body.

High sensitivity of the method was shown, allowing to identify the difference in the negative impact of acoustic factors of different parameters, not detected, in particular, in the analysis of acoustic stem evoked potentials.

From the results of this work follows the need to expand studies of this phenomenon and the search for methods of assessing the functional state at the organismal and organ levels, correlating with impedance parameters.

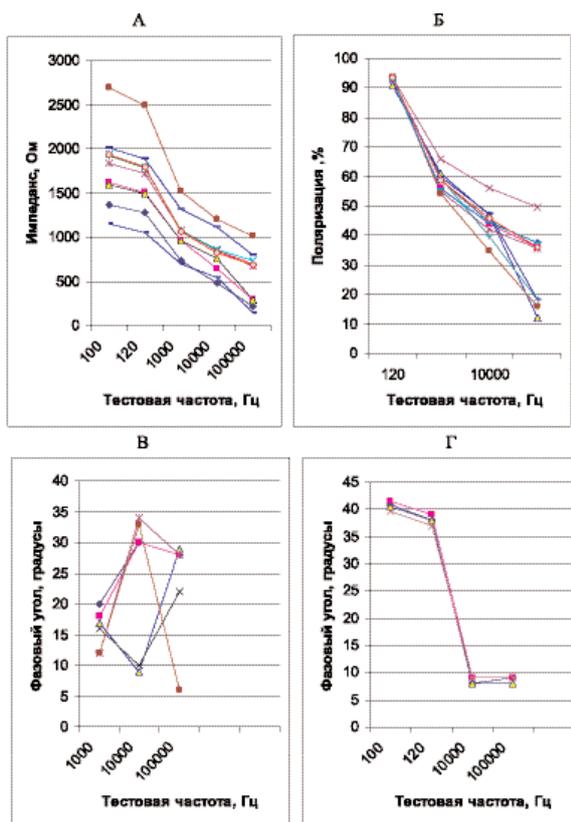


Рис.3. Импеданс головного мозга у кроликов 5-й группы
Fig. 3. Brain impedance of group 5 rabbits

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ACTUAL PROBLEMS OF MEDICAL EVACUATION АКТУАЛЬНЫЕ ПРОБЛЕМЫ МЕДИЦИНСКОЙ ЭВАКУАЦИИ

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Review report
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MEDICAL EVACUATION OF EMERGENCY SITUATION VICTIMS BY RAILWAY TRANSPORT: HISTORY AND PROSPECTS

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Abstract. *The aims of the article* are to define the world tendencies of medical evacuation by railway transport in the 21st century on the basis of analysis of scientific publications, Internet articles and mass media reports, including those carried out during SARS-COV-2 pandemic; to specify the problems and prospects of development of medical evacuation by railway in Russia taking into account global trends and local specifics.

Materials and research methods. A content analysis of 15 scientific articles, 20 Internet articles, and 31 press communications devoted to individual issues of medical evacuation by railway was performed using the method of nonrepeat sampling.

Selection criteria were: message time – later than January 1, 2001; article should have contained the description of a case/evidence of medical evacuation by railway or the discussion of the possibilities of application of the railway transport for medical evacuation in the 21st century.

Results of the study and their analysis. The world has been conducting medical evacuation by railway for over 150 years. Traditionally, the need for medical evacuation by railway has arisen in case of armed conflicts or large-scale natural disasters, which result in great medical and sanitary losses. In the second half of the 20th century the priority importance of medical evacuation by railway was lost due to the development of automobile roads and aerodrome network and the accompanying development of automobile and air medical transport. The occurrence of emergencies in hard-to-reach areas or the inability of public health systems to organize medical care with a sharp increase in the number of victims in emergencies, including those of infectious nature, determine the need to develop additional mechanisms of medical evacuation. The use of medical evacuation by railway can become this compensatory mechanism. In this connection there has been a shift in the world's focus in the field of medical evacuation by railway from the use of sanitary trains and flying cars to the formation of mobile medical detachments on the basis of re-equipped passenger trains. The use of re-equipped high-speed electric trains for this purpose has its advantages – it makes possible to avoid organizational difficulties and complications in patients, which are typical for sanitary aviation evacuation, as well as to provide mass medical evacuation of victims without overloading highways with sanitary vehicles. An alternative trend in the development of the medical evacuation by railway is the creation of modern civil sanitary trains and medical carriages. It has been noted that so far Russia does not have technical facilities capable to ensure the up-to-date level of the medical evacuation by railway. The future will show in what way the organization of medical evacuation by railway will develop in our country.

Key words: COVID-19 pandemic, emergencies, medical evacuation, medical trains, medical wagons, railway transport, victims

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МЕДИЦИНСКАЯ ЭВАКУАЦИЯ ЖЕЛЕЗНОДОРОЖНЫМ ТРАНСПОРТОМ ПОСТРАДАВШИХ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ: ИСТОРИЯ И ПЕРСПЕКТИВЫ

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Резюме. *Цели исследования* – на основе анализа данных научных публикаций, интернет-статей, сообщений в прессе определить мировые тенденции проведения медицинских эвакуаций железнодорожным транспортом (МЭЖД) в XXI в., в том числе на фоне пандемии SARS-COV-2; обозначить проблемы и перспективы развития МЭЖД в России в связи с мировыми тенденциями и местными условиями.

Материалы и методы исследования. Методом бесповторной выборки проведен контент-анализ 15 научных статей, 20 интернет-статей, 31 сообщения в прессе, посвященных частным вопросам МЭЖД.

Критерии выборки: время сообщения – позже 1 января 2001 г.; наличие в тексте статьи описания случая/ев МЭЖД или обсуждения возможностей применения железнодорожного транспорта для проведения медицинской эвакуации в XXI в.

Результаты исследования и их анализ. В мире уже более 150 лет проводятся МЭЖД. Традиционно необходимость в МЭЖД возникает при вооруженных конфликтах или крупномасштабных природных катастрофах, сопровождающихся большими санитарными потерями. Во второй половине XX в. МЭЖД потеряла свое приоритетное значение в связи с развитием автомобильных дорог и сети аэродромов и сопутствующим им развитием автомобильного и авиационного санитарного транспорта. Возможность возникновения чрезвычайных

ситуаций (ЧС) в труднодоступных районах или неспособность систем общественного здравоохранения организовать медицинское обеспечение при резком увеличении числа пострадавших в ЧС, в том числе инфекционного характера, определяют необходимость выработки дополнительных механизмов медицинской эвакуации. Использование МЭЖД способно стать таким компенсаторным механизмом. В связи с этим в мире в сфере МЭЖД происходит смещение акцента с применения санитарных поездов и летучек к формированию мобильных медицинских отрядов (ММО) на базе переоборудованных пассажирских поездов. Применение для этих целей переоборудованных скоростных электропоездов имеет свои преимущества – позволяет избежать организационных трудностей и возникновения осложнений у пациентов, что характерно для санитарно-авиационной эвакуации, а также обеспечить массовую медицинскую эвакуацию пострадавших без перегрузки шоссейных дорог санитарным автотранспортом. Альтернативной тенденцией развития МЭЖД является создание современных гражданских санитарных поездов и медицинских вагонов. Отмечено, что в России пока нет технической базы, способной обеспечить современный уровень МЭЖД. Каким путем будет развиваться организация МЭЖД в нашей стране – покажет будущее.

Ключевые слова: железнодорожный транспорт, медицинская эвакуация, медицинские вагоны, медицинские поезда, пандемия COVID-19, пострадавшие, чрезвычайные ситуации

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There has been a practice of using military-sanitary trains in the world for more than 150 years [1]. Traditionally, the need for medical evacuation by rail of the wounded and injured arose during armed conflicts or large-scale natural disasters [2]. However, after World War II, it became clear that military-sanitary trains were of little use in peacetime due to the length of their mobilization and difficulties in manning them.

A peculiar response to these challenges was the organization of mobile medical formations on the basis of medical wagons in the second half of the 20th century. This idea was most developed in Germany and Switzerland, where such medical complexes were included in rescue tunnel trains [3, 4] (fig. 1). Medical wagons have a filter-ventilation unit, which ensures clean air inside the wagon both when in the fire zone and when under poisonous substances attack. Thus, they can be used during wars and armed conflicts. The medical block of the car is equipped with everything necessary for medical evacuation and treatment of 15 patients on the way. In our country they tried to put this concept into practice in the late 1980s. It was suggested to staff the medical detachments on the basis of medical and nursing brigades. Technically, the solution of this issue in Russia was limited to the inclusion of a medical



Рис. 1. Локомотив и первый вагон спасательного туннельного поезда (Германия). Контейнерная концепция медицинского вагона [6]
Fig. 1. Locomotive and the first car of the rescue tunnel train (Germany). Container concept of a medical wagon [6]

compartment in the recovery train (Fig. 2). At the same time it should be noted that the medical compartment could not meet the demand for medical evacuation by rail. The reasons for this were its low evacuation capacity, difficulties in loading seriously wounded people into it, and the attachment to the recovery train, which would remain at the site of the emergency until the elimination of its consequences. Thus, in case of large-scale disasters, the whole burden of medical evacuation was supposed to be placed on other modes of transport [5].

However, despite the development of a network of highways and sanitary aviation, there was still a danger of catastrophes in which the volume of losses would exceed the possibilities of medical evacuation of victims by road and air transport [8-10].

The aim of the research is to determine the world tendencies of medical evacuations by railway transport in the 21st century, including during the SARS-COV-2 pandemic; to define the problems and prospects of medical evacuations by railway transport in Russia in connection with the world



Рис. 2. Учения с привлечением восстановительного поезда в Алданском районе Якутии, 16 декабря 2015 г [7]
Fig. 2. Exercises involving a recovery train in the Aldan region of Yakutia, December 16, 2015 [7]

tendencies and local conditions on the basis of analysis of scientific sources, Internet articles and mass media reports.

Materials and methods of the study. A content analysis of 15 scientific and 20 Internet articles, 34 press communications devoted to private matters of medical evacuation by rail transport was performed by the method of non-recurrent sampling.

Results of the study and their analysis. The prerequisites for changing the nature of medical evacuation by rail at the beginning of the 21st century were: qualitative change in the development of the railroad network, change in the nature of military conflicts and improvement of transport medical equipment [11-13]. Modern trends in the development of rail transport are: growth of the suburban network of electrified railroads, increasing the share of high-speed railways, formation of transcontinental rail corridors [14-16]. The peculiarities of modern military conflicts include: emergence of conflicts in a relatively limited territory within one theater of military action; their great ferocity and, in some cases, complete destruction of the state system of one of its participants; conflicts between parties that are at different stages of technical development and qualitative state of the armed forces; tactics of small mobile armed units and absence of fronts as such. The lack of centralized management of the lower combatants, who are forced to make their own decisions and to violate international conventions, as well as the use of long-range precision-guided weapons and aviation as the basic means of warfare in the early stages of the war, often play a role here [17].

The combination of these phenomena predetermined new trends in medical evacuation by rail.

We have not encountered a description of the practice of using military-sanitary trains of the traditional type for medical evacuation of victims and patients by rail in the first quarter of the 21st century. There is a practice of interaction between specialists from the Center for Medical Aviation and Emergency Medical Care of the All-Russian Center for Disaster Medicine "Zaschita" of the Federal State Budgetary Institution A.I. Burnazyan Federal Medical and Biological Center and a subdivision of the Russian Ministry of Defense, which performed mass medical evacuations of the wounded using a temporary military-sanitary train during a special military operation in Ukraine in 2022. There is also information about the use of Hyundai high-speed trains by the Ukrainian Armed Forces in 2015 for medical evacuation of the wounded during the local armed conflict in Donbass [18].

An alternative trend in the development of medical evacuation by rail is the creation of civilian medical trains. They are able to solve the practical tasks of providing medical assistance for public health systems in the mode of daily op-

eration. Such a concept has been successfully implemented in India, China, Iran. The so-called "Life Trains" perform the tasks of providing specialized, including high-tech, medical care in remote regions [19-21]. The existing health trains in Russia play the role of mobile polyclinics and can be used for these purposes only after a significant reorganization [22].

The concept of a modern medical train was implemented by the Italian Civil Defense Service in March 2021. This train has not only a full set of equipment for treating and transporting seriously injured people, but it also has the ability to carry out rapid, low-trauma loading of the injured and is equipped with a powerful computer control center (Fig. 3). The medical train is staffed by regional emergency medical service personnel. In the European Union, research is being conducted to create an innovative medical train equipped with a modern resuscitation unit [22].

Options for field deployment of a medical train during the COVID-19 pandemic were: a medical train functioning as a mobile hospital (India, Italy); a mobile mass vaccination unit (Italy) - [24-25].

Highly mobile formations based on rail buses are involved in the delivery and movement of transplant teams and cargo in Iran and India [26] (Fig. 4). In an emergency situation, these medical formations are capable of performing the tasks of timely medical evacuation of victims both in the pre-hospital period and as a base for inter-hospital medical evacuations of victims.

The experience of All-Russian Center for Disaster Medicine "Zaschita" staff in the field of medical evacuation by rail in the Russian Federation shows a gradual increase in the share of interhospital medical evacuations of patients by high-speed electric trains (Fig. 5).

Global trends in medical evacuations by rail in emergency situations are also characterized by a shift in emphasis from the use of military-sanitary trains to the formation of mobile medical detachments on the basis of converted passenger trains.

On May 21, 2019, an emergency medical casualty exercise was held in Metz, France, under the auspices of SAMU [28]. Thanks to the support of the SNCF, the TGV high-speed train participated in the exercise. It was to simulate a medical evacuation by rail to Paris after a major event with a large number of medical casualties, to test its feasibility, and to train doctors and paramedics to carry it out [29]. The exercise included simulating the dispatch of ambulance crews and equipment, loading the victims at the train station in Metz, their medical transportation on the train, practicing medical manipulation during the trip, unloading them, and, upon arrival in Paris, directing them to the Gare d'Est and then to hospitals. All this within a limited time span.



Рис. 3. Штабной вагон медицинского поезда, Италия, 2021 г. [23]
Fig. 3. Staff car of the medical train, Italy 2021 [23]



Рис. 4. Рельсовый автобус «Rail ambulance», Иран [27]
Fig. 4. Rail ambulance bus, Iran [27]

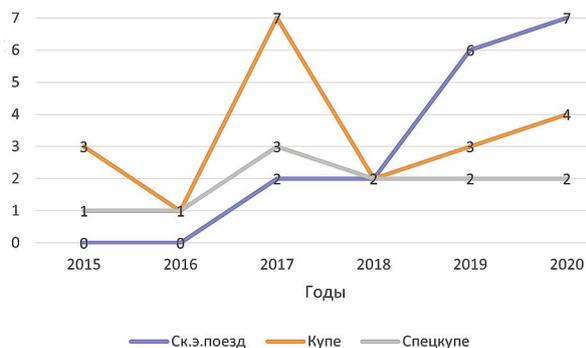


Рис. 5. Распределение количества МЭЖД, выполненных специалистами ВЦМК «Защита» в 2015–2020 гг., в зависимости от условий транспортировки пациентов, абс.

Fig. 5. Distribution of the number of MEIs performed by VTsMK specialists in 2015–2020, depending on the conditions of patient transportation, abs.

The TGV cars provided by the SNCF can transport between 500 and 1000 emergency victims in 1 hour. The task of using an unmodified TGV for medical evacuation by rail, which is used routinely, has been implemented (Fig. 6).

The experience gained during the exercise was implemented in 2020 in the medical transportation of COVID patients in France and Spain [31-34]. The use of double-deck high-speed trains made it possible to divide the carriage space into clean and dirty zones. The patients were accommodated on the first floor, personnel outside their duties — on the second floor. The working conditions were close to those of regular air ambulance evacuations (Fig. 7).

In Spain, this concept was changed due to the narrowness of aisles in the cars of the Talgo high-speed trains (in Russia, the Strizh). Part of the seats were dismantled, and patients were transported on lying gurneys. For this purpose technologies similar to those used for fixing patient accommodation devices on scheduled air flights were used. This allowed to speed up loading of the train and to provide variable bed geometry, which is important for patients in consciousness (Fig. 8).

The organizational peculiarities of the use of converted high-speed trains were as follows: possibility of timely medical evacuation by the railway in emergencies; attraction of



Рис. 6. Размещение транспортировочных средств в скоростном электропоезде для МЭЖД. Учения SAMU, Мец, Франция, 2019 г [30]

Fig. 6. Placement of transportation facilities in a high-speed electric train for the International Railways. SAMU exercise 2019, Metz, France [30]



Рис. 7. МЭЖД пациентов с SARS-COV-2, Франция, 2020 г. [35]

Fig. 7. MEI of patients with SARS-COV-2, 2020, France [35]



Рис. 8. Вагон скоростного электропоезда, переоборудованный для МЭЖД, Испания, 2020 г. [36]

Fig. 8. High-speed electric train car converted for MEI, 2020, Spain [36]

ambulance medical personnel for forming the staff of mobile medical formation; minimal volume and high speed of the rolling stock conversion; readiness for quick mass medical evacuation of patients in critical condition by the railway.

Conclusion

1. At the beginning of the 21st century the main tendencies in the development of technical basis for medical evacuation by the railway transport are as follows:

- medical trains capable of operating both in the mode of daily activities and in emergency situations, having a powerful base to accommodate lying patients (Medical train);
- mobile medical teams based on rail buses (Rail ambulance);
- mobile medical teams based on converted passenger cars (Medicalised train).

2. The main trends in the development of the organizational basis of medical evacuation by rail should include:

- creation of emergency medical assistance teams on the basis of the staff of ambulance crews on the railway transport;
- placement of critically ill patients in modified passenger cars and the possibility of conducting intensive therapy en route;
- inter-agency cooperation for the rapid conversion of cars for the needs of medical evacuation by rail;
- introduction of digitalization in the process of medical evacuation by rail.

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PRINCIPLES OF PROVISION OF EMERGENCY, INCLUDING SPECIALIZED EMERGENCY, MEDICAL CARE WITH THE USE OF AIR AMBULANCE IN THE CONSTITUENT ENTITIES OF THE RUSSIAN FEDERATION

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Abstract. *Actuality.* A tenth of the Russian population lives in the remote territory of the country. The priority task of healthcare is to ensure accessibility and the need for medical care to the population, and taking into account territorial features, data on the possibilities for collecting air ambulance should be increased.

The aim of the study was to explore the activity of regional medical organizations providing emergency medical assistance and medical evacuation with the use of sanitary aviation in field forms of work.

Materials and research methods. Materials of the research were the registration forms filled in by experts of territorial centers for disaster medicine in information system "Monitoring of the centers for disaster medicine" (smk.minzdrav.gov.ru).

The research methods were analytical and statistical.

Results of the study and their analysis. The work of the structural subdivisions of territorial centers for disaster medicine applying sanitary aviation in rendering emergency medical aid and carrying out medical evacuation in the subjects of the Russian Federation was considered. The participation of the specialists of different medical organizations in rendering emergency and consultative medical aid and carrying out medical evacuation was explored. The daily indicators of the work of the outreach teams of territorial disaster medicine centers working in the mode of day-to-day activity are analyzed. The data on the participation of territorial disaster medicine centers specialists in the air ambulance evacuation of patients on life support are presented.

Key words: *air ambulance, air ambulance evacuation, emergency medical assistance, emergency specialized medical assistance, medical evacuation, medical organizations, subjects of the Russian Federation, territorial disaster medicine centers*

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АНАЛИЗ СИСТЕМЫ ОКАЗАНИЯ СКОРОЙ, В ТОМ ЧИСЛЕ СКОРОЙ СПЕЦИАЛИЗИРОВАННОЙ МЕДИЦИНСКОЙ ПОМОЩИ С ПРИМЕНЕНИЕМ САНИТАРНОЙ АВИАЦИИ В СУБЪЕКТАХ РОССИЙСКОЙ ФЕДЕРАЦИИ

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Резюме. *Актуальность.* Десятая часть населения России проживает на труднодоступной территории. В настоящее время, когда приоритетной задачей здравоохранения является обеспечение доступности и своевременности оказания медицинской помощи населению, достигнуть указанных целей можно только с учетом территориальных особенностей регионов и с применением санитарной авиации.

Цель исследования – проанализировать деятельность региональных медицинских организаций (МО), осуществляющих оказание экстренной медицинской помощи (ЭМП) и проведение медицинской эвакуации с применением санитарной авиации при выездных формах работы.

Материалы и методы исследования. Основным материалом исследования – учетные формы, заполняемые специалистами территориальных центров медицины катастроф (ТЦМК) в информационной системе «Мониторинг центров медицины катастроф» (smk.minzdrav.gov.ru). Методы исследования – аналитический и статистический.

Результаты исследования и их анализ. В исследовании представлены структурные подразделения ТЦМК, которые, в зависимости от климато-географических особенностей территорий, развития дорожной сети и наличия инфраструктуры для использования воздушного транспорта, оказывают экстренную медицинскую помощь с применением санитарной авиации в субъектах Российской Федерации.

Рассмотрено участие специалистов различных медицинских организаций в оказании экстренной и консультативной медицинской помощи и проведении медицинской эвакуации. Проанализированы среднесуточные показатели работы выездных бригад ТЦМК в режиме повседневной деятельности. Представлены данные об участии специалистов ТЦМК в проведении медицинских эвакуаций с применением санитарной авиации.

Ключевые слова: медицинская эвакуация, медицинские организации, санитарная авиация, санитарно-авиационная эвакуация, скорая медицинская помощь, скорая специализированная медицинская помощь, субъекты Российской Федерации, экстренная медицинская помощь

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Introduction

More than 80.0% of the population of the Russian Federation compactly resides in the European part of the country with a developed infrastructure and system of organization of medical care. At the same time, a significant part of Russia is located in permafrost areas. There are practically no automobile roads there, which requires the state to make great efforts to develop the infrastructure of air transport in order to organize the provision of timely medical care to the population.

In addition, in 14 subjects of the Russian Federation the area of mountain cover makes up more than 75.0% of the territory. A typical distinction of these regions is the presence of hard-to-reach settlements. In some remote settlements there is no regular transport communication due to seasonal rains, mudflows, natural fires, etc. Our country has more than 1 thousand islands, 700 of which are populated. Such islands are mostly hard to reach, and in storms and bad weather they are completely inaccessible. Megacities also have their own peculiarities, the use of air ambulance there when providing emergency medical aid to the victims of road accidents leads to a significant reduction in the time of medical evacuation of victims to medical treatment organizations [1-6].

In accordance with the Decree of the President of the Russian Federation as of June 6, 2019 № 254¹ one of the main objectives of health care is to ensure the availability and timeliness of medical care to every resident, regardless of their location on the territory of Russia.

In order to develop the system of emergency medical care using air transport, the Russian Ministry of Health has adopted a model strategy for the development of ambulance aviation in the subjects of the Russian Federation until 2024². It defines the goals and principles of implementation of national priorities in providing emergency medical care. Within the framework of the implementation of the strategy of development of air ambulance in the subjects, the main current task is to organize the work of air ambulance in the "24/7" format by the end of 2024.

Currently, the provision of emergency medical care is organized at the federal and regional levels.

¹ On the Strategy for the Development of Healthcare in the Russian Federation for the Period up to 2025: Decree of the President of the Russian Federation dated June 6, 2019 No. 254 (In Russ.)

² Standard Strategy for the Development of Air Ambulance in a Constituent Entity of the Russian Federation until 2024, approved by the Ministry of Health of Russia: letter of the Department for the Organization of Emergency Medical Care and Expert Activities of the Ministry of Health of Russia dated March 29, 2019 No. 14-3 / 543 (In Russ.)

The system of emergency medical care at the regional level includes emergency consultative medical care departments of territorial disaster medicine centers and regional clinical hospitals – level 3 medical organizations – with visiting consultative teams of specialized medical care, emergency response teams, ambulance teams and aviation medical teams [7].

The coronavirus pandemic in 2020-2021 has placed new demands on the organization of emergency medical care for the population of the Russian Federation and the world community as a whole. The need to minimize the contacts of medical workers caused the need to develop video conferencing systems and telemedicine technologies. At the same time, the need for medical evacuation of patients who require specialized medical care in an emergency has not decreased.

The aim of the study is to analyze the activities of medical organizations of the regional level providing emergency medical care and medical evacuation using air ambulance in off-site forms of work.

Materials and research methods. The research was performed in the Federal Center for Disaster Medicine at the National Medical and Surgical Center named after N.I. Pirogov of the Ministry of Health of Russia, in 2021. In the course of the study the existing regulatory legal acts, publications in various scientific editions were studied, the experience of the territorial center for disaster medicine, regardless of the presence of the emergency consultation and emergency medical care departments in their structure was analyzed. The studied information was entered by the specialists of the territorial center for disaster medicine into the following sections of the information system "Monitoring of Disaster Medicine Centers" (smk.minzdrav.gov.ru): "Information about the activities of medical organizations providing emergency medical aid and medical evacuations in field forms of work", "Daily indicators of the work of field teams of the territorial center for disaster medicine in the mode of daily activity", "Information about the forces and means of the Disaster Medicine Service in the subject of the Russian Federation". This information system was developed by the Central Research Institute of Health Organization and Informatization in 2021 for specific tasks of the Disaster Medicine Service of the Ministry of Health of Russia.

The study also used data from statistical reporting forms of the territorial center for disaster medicine No. 55 "Information about the activities of the Disaster Medicine

Service of the subject of the Russian Federation" and No. 56 "Information about the activities of medical organizations providing emergency medical care and medical evacuation in field forms of work".

Since the functionality of the information system smk.minzdrav.gov.ru did not allow us to obtain data in the format required for the study, to extract the available data we wrote a program in Python programming language using open frameworks Numpy, Pandas, BeautifulSoup, Selenium, OS. Data collection and preprocessing were carried out in the analytical program Tableau³.

The object of the study is the system of emergency medical assistance and medical evacuation using air ambulance in the subjects of the Russian Federation.

Results of the study and their analysis. As a result of the analysis of the activities of regional medical organizations that provide emergency medical care and medical evacuation with the use of aeromedical aviation in the regions of the Russian Federation, the following was revealed.

Within the framework of the strategic planning of the organization of medical care and the formation of a three-tier system of medical support, carried out by the Ministry of Health of Russia since 2018 the process of combining the stations of emergency medical care and the territorial centers for disaster medicine into one legal entity – the regional center of emergency medical care and disaster medicine – takes place. This will allow a more rational use of common forces and means – medical formations of the Disaster Medicine Service of the Russian Ministry of Health to provide emergency medical care both in day-to-day activities and in an emergency situation. It should be noted that the Ministry of Health of Russia has not included these institutions in the nomenclature of medical organizations.

The analysis of the structure of the Disaster Medicine Service at the regional level shows different organizational models of functioning: territorial center for disaster medicine as an independent medical organization; territorial center for disaster medicine within the leading regional clinical hospitals – medical organizations of the 3rd level; united regional center for emergency and disaster medicine. In large regions the model of the territorial center for disaster medicine prevails as an independent legal entity – at the beginning of 2022 there were 35 such territorial centers. The tendency to the organizational unification of the territorial centers for disaster medicine and the stations of emergency medical care is preserved – the number of united regional centers of emergency medical care and disaster medicine is 34. Within the leading regional clinical hospitals – medical organizations of the 3rd level – there are 16 territorial centers for disaster medicine.

At present in Siberian, Ural and Far Eastern Federal Districts the territorial centers for disaster medicine are large medical organizations, performing both the functions of the daily management body of the regional disaster medicine service and solving problems under various modes of operation. This includes optimal routing during medical evacuation with the use of sanitary aviation (Sverdlovsk region, Khabarovsk territory, Khanty-Mansi Autonomous Okrug-Yugra, Kemerovo region, etc.). Such territorial centers for disaster medicine fully monitor the vic-

tims of emergencies who are being treated in the medical organizations of the subject.

In the central regions of the Russian Federation territorial centers for disaster medicine, with rare exceptions, do not have the authority and capacity to promptly resolve the day-to-day tasks of the Disaster Medicine Service. As a rule, they do not have on-site emergency response teams. Therefore, the functions of operative response to emergencies in the daily mode of operation have to be performed by the operative dispatcher department and field ambulance brigades.

Analyzing the activities of joint centers, which include ambulance service and disaster medicine service, it is necessary to note both positive and negative sides of their unification.

In our opinion, the positive aspects of the work of the united centers are:

1. Creation and functioning of a single center, responsible for organization and provision of emergency medical aid and medical evacuation, including air ambulance. At the discretion of the executive authority of the subject in the sphere of health protection of citizens, this center may operate as part of a single legal entity, or as part of a functional association.

2. Creation of a unified regional information system – formation of a single information space for the management of emergency medical care, Disaster Medicine Service and sanitary aviation, integrated with the medical information system of the subject, including the Unified State Health Information System. Information becomes transparent at any stage of control over patients and victims.

3. Provision of the Disaster Medicine Service with forces and means with the ability to respond promptly to various emergencies throughout the region.

The negative sides of the work of the joint centers include:

1. Loss of functions of the territorial center for disaster medicine as a body for day-to-day management of the region's Disaster Medicine Service.

2. Consolidation of territorial centers for disaster medicine and city emergency stations, which do not have the status (powers) of a regional medical organization, which significantly limits the possibilities of management in case of an emergency on the whole territory of the region.

3. Use of outreach emergency response teams (specialized teams) of territorial disaster medicine centers to service urgent emergency medical calls and medical evacuations of patients not included in the category of "emergency" leads to a decrease in the qualifications of specialists. As a result, the tasks facing the ambulance service are solved at the expense of the teams of territorial disaster medicine centers.

4. Outflow of specialist doctors from territorial centers for disaster medicine to other medical organizations, where they will work in accordance with their profile and level of qualification.

According to item 21 of "Provisions on development, approval and realization of departmental target programs" approved by the Decree of the Government of the Russian Federation from April 19, 2005 239 and for realization of the State program "Development of Public Health" the Departmental target program "Improvement of emergency, including specialized emergency medical aid and activity of the All-Russian Disaster Medicine Service" was developed

³ Tableau Analytics App Link: 2021 Emergency Medical Advisory and Medical Evacuation Activity Details. https://public.tableau.com/shared/F72HBS5DC?:display_count=n&origin=viz_share_link

by the Ministry of Health of Russia. It was approved by Order No. 827 of the Ministry of Health of Russia "On Approval of the Departmental Target Program "Improvement of Emergency, including Specialized Emergency, Medical Care and Activities of the All-Russian Disaster Medicine Service" of October 2, 2019 (hereinafter – the Program).

The goal of this Program is to reduce the time of arrival of outreach ambulance crews to emergency calls (less than 20 minutes) and to reduce the hospital mortality rate of victims of emergencies admitted to medical organizations.

To achieve the target indicators of the Program by 2024, it is possible, in our opinion, to select among them the most promising for the long-term assessment of their implementation: equipping emergency medical care stations with medical information systems; developing inpatient emergency departments; improving the routing of patients in need of specialized emergency medical care; improving interaction between medical organizations that provide emergency, including specialized emergency, medical care

According to statistical reporting forms, in 2020. 63.0% of the departments of emergency consultative medical care, providing medical care to the adult population, functioned within the regional clinical hospitals – medical organizations of the 3rd level. During the last four years the number of emergency consultative medical care departments providing medical care to children has increased by 40.9%. In 2020. 65.9% of these departments worked as part of regional children's clinical hospitals – medical organizations of the 3rd level [15].

It is an undeniable fact that the subjects differ from each other in the level of economic development, the availability of infrastructure for the use of air ambulance, and the capabilities of the health care system.

Thus, taking into account the peculiarities of some regions with low population density and aviation infrastructure, they use continuous staged air ambulance evacuation from hard-to-reach settlements; hard-to-reach settlements are overcome using helicopters; long distances – using planes [8].

The system of providing emergency, including specialized emergency, medical care to the pediatric population with the use of air ambulance requires special attention. The use of pediatric aviation medical teams in the pre-hospital period makes it possible to quickly deliver specialists to the scene of the event, to begin medical care in the pre-hospital period, and to perform aviation evacuation immediately to the specialized level 3 hospital [9].

For children with life-threatening conditions and in need of inter-hospital medical evacuation, the priority is the use of air ambulance. At the same time, special attention is paid to the preparation for the medical evacuation of children who are in a critical condition. Target indicators for stabilizing the condition of children in the next 6 hours after medical evacuation have been developed [10].

Currently, there is no official unified statistics on the activities of medical organizations providing emergency medical care and conducting medical evacuations during field forms of work in the Russian Federation. In this connection in 2019 on the basis of the All-Russian Center for Disaster Medicine "Zaschita" of the Ministry of Health of Russia a form for collection of relevant information was developed, tested in five pilot subjects and approved for further implementation in the regions at the meetings of profile commissions on disaster medicine (protocol №17 of May 30,

2019) and on emergency medical care (protocol of June 30, 2019) of the Ministry of Health of Russia.

According to the information system for monitoring disaster medicine centers, territorial disaster medicine centers have 973 ambulances, of which 41.0% are "C" class, and 195 mobile medical complexes in daily operation and in emergency mode. They are intended for providing emergency medical aid in emergency situations, for medical support of cultural and sports events, for organization of temporary emergency medical aid stations on highways. In order to provide medical care in emergency the regional Disaster Medicine Service currently uses 140 helicopters, including 109 medical ones, and 27 aircrafts, including 6 medical ones.

According to the data of the average daily work of the outreach teams of the territorial centers for disaster medicine in the mode of daily activity for a month, outreach teams are available in 64 territorial centers for disaster medicine/regional centers for emergency and disaster medicine (75.2%), in which on average 400 teams work, of which 10.0% work with children. In the structure of all the teams of the territorial centers for disaster medicine the share of specialized teams is 65.5%, of which 85.0% are anesthesiology and reanimation teams and emergency consultative teams; 15.0% are aviation medical teams.

Territorial disaster medicine centers have no visiting teams in 25.0% of the subjects, including Arkhangelsk, Belgorod, Vladimir, Vologda, Kirov regions; in the republics of Udmurtia, Bashkortostan, etc.

On average daily outreach teams of territorial disaster medicine centers provide medical aid using all types of sanitary transport to 400 patients, including resuscitation measures performed by 2.0% of patients; 8.0% of patients are on artificial pulmonary ventilation or oxygen support during medical evacuations. More than 70.0% of calls are performed for emergency indications; from 2.0% to 6.0% for emergencies; 4.0% of the calls are for medical support of cultural and sporting events. Up to a quarter of the calls of the territorial disaster medicine center teams are calls for traffic accidents, injuries, vascular pathology, as well as for chronic patients in life-threatening conditions.

Of the total number of calls performed, more than 70.0% are medical evacuations; about 80.0% are performed by ambulance transport; 20.0% are performed by air transport.

Within regions, 95.0% of medical evacuations are performed, every fourth of them using air transport.

In 2021 the specialists of medical organizations providing emergency medical care and medical evacuations in the territory of the Russian Federation performed 904250 calls, including 126817 calls to children. On the average 75354 calls are performed every month, including 14.0% for children (Table 1).

The structure of the calls made by the specialists of medical organizations in 2021 for emergency and consultative medical aid and medical evacuation with the use of air ambulance:

- share of calls and medical evacuations with the use of air ambulance was 5.0% of the total number of performed calls, including in emergency situations – 0.4%;

- share in the total number of calls performed with the use of air ambulance provided by specialists of territorial centers for disaster medicine was 71.6%; specialists of regional clinical hospitals, including children's hospitals – 23.1%;

- least of all, air ambulance teams (0.3%) and perinatal centers (2.8%);

- in the hospital period, as compared to the pre-hospital period, air ambulance is used 3.5 times more often, mainly during inter-hospital medical evacuations;

- in the pre-hospital period, 78.0% of the calls with the use of air ambulance are provided by the specialists of the territorial disaster medicine centers; 20.6% are provided by the specialists of the regional clinical hospitals; 0.3% of the calls are provided by the ambulance crews;

- in the hospital period 70.0% of the calls with the use of sanitary aircraft are provided by specialists of the territorial disaster medicine centers; 20.2% by specialists of the regional clinical hospitals; 4.8% of the calls are provided by ambulance crews.

- When eliminating medical and sanitary consequences of emergencies with the use of sanitary aviation specialists of territorial centers for disaster medicine and emergency consultative medical care departments of regional clinical hospitals – medical organizations of the 3rd level – are involved; specialists of perinatal centers, children regional hospitals and federal medical organizations located in the regions are not involved at all.

There is a direct correlation between the share of calls made with the use of air ambulance within the region and the climatic and geographical conditions, the area of the territory, the development of transport infrastructure and the density of the population. Thus, in the total number of medical evacuations the share of air ambulance evacuations was: in the Republic of Sakha (Yakutia) – 96.9%; in the Yamalo-Nenets Autonomous District – 90.5; in the Arkhangelsk Region – 76.7; in the Trans-Baikal Territory – 62.8%.

Out-of-region medical evacuations with the use of ambulance aviation are performed: in the Komi Republic – in 100.0% of cases; the Buryat Republic – in 80.0%; the Murmansk Region – in 74.6; the Chechen Republic – in 58.3; the Orenburg region – in 41.1; the Tyumen region – in 31.2; the Pskov region – in 13.4; the Tver region – in 12.3%.

A third of the subjects use air ambulance evacuations outside the subject in no more than 10.0% of medical evacuations. And a quarter of the subjects do not practice medical evacuations to neighboring regions at all. The main reasons for this are: well-developed network of highways; optimal location of medical organizations of the 3rd level for providing medical care to adults and children. Such subjects include the republics of Tatarstan and Bashkortostan, the Sverdlovsk region, the Krasnodar Territory, etc.

27 regions (31.0%) use air ambulance to provide emergency medical care in the pre-hospital period.

The hospital period of emergency medical care accounts for 78.3% of air ambulance calls [11].

In 2021, 29722 patients were evacuated on life support, which was 3.3% of the total number of calls performed.

The number of patients on ventilator or on oxygen support during air ambulance evacuations was 2578 – 5.7% of all the calls performed using air ambulance. Such patients were: in Transbaikalian Territory – 87,2%; Chelyabinsk region – 53,5; Republic of Buryatia - 49,1; Irkutsk region – 35,0; Republic of Komi – 30,3; Tver region – 28,9; Altay Territory – 22,9; in Republic of Karelia – 20,2%.

One of the priority tasks of health care is the compliance with the routing of patients during medical, including air ambulance, evacuation to specialized medical organizations of the 3rd level [3, 8].

Clearly developed routing systems that ensure the highest proportion of medical evacuations to Level 3 medical organizations are presented in Table 2.

Conclusion

1. Currently, it is possible to ensure the availability and timeliness of medical care to the population in the subjects of the Russian Federation only with the active use of information technologies and the inclusion of sanitary aviation in the logistics of routing of patients with life-threatening diseases and conditions.

Таблица 1/ Table No. 1

Количество вызовов для оказания экстренной и консультативной медицинской помощи и проведения медицинской эвакуации, выполненных специалистами медицинских организаций в субъектах Российской Федерации в 2021 г., чел.

Number of Calls for Provision of Emergency and Advisory Medical Care and Medical Evacuation

Made by Specialists of Medical Treatment Organizations (HMOs) in the Constituent Entities of the Russian Federation in 2021, abs.

Медицинская организация/ Medical organization	Всего вызовов/ Total calls		Из них с применением санитарной авиации/ Of which with the use of air ambulance								
	всего/all	из них к детям / of them for children	в догоспитальном периоде / in the prehospital period			в госпитальном периоде / in the hospital period			в т.ч. в ЧС / including in emergency	в т.ч. в ЧС / including in emergency	в т.ч. в ЧС / including in emergency
			всего/all	в т.ч. в ЧС / including in emergency	из них к детям / for them for children	всего/all	из них к детям / of them for children	в т.ч. в ЧС / including in emergency			
ТЦМК ¹	166509	20959	32653	90	4981	7678	1328	21	24975	3653	69
РКБ ²	110542	11611	9269	91	779	2033	176	83	7236	603	8
ДРКБ ³	26488	26100	1280	0	1166	79	79	0	1201	1087	0
ПЦ ⁴	10240	4326	282	0	224	25	8	0	257	216	0
ССМП ⁵	593853	63534	1744	22	138	31	2	0	1713	136	22
ДМО ⁶	8280	770	355	0	26	0	0	0	355	26	0
Всего/Total	904250	126817	45583	203	7314	9846	1593	104	35737	5721	99

¹ территориальные центры медицины катастроф / territorial centers for disaster medicine

² региональные клинические больницы / regional clinical hospitals

³ детские региональные клинические больницы / children's regional clinical hospitals

⁴ перинатальные центры / perinatal centers

⁵ станции скорой медицинской помощи / ambulance stations

⁶ другие медицинские организации, включая федеральные медицинские организации, расположенные в регионах / other medical organizations, including federal medical organizations located in the regions

**Маршрутизация пациентов, находившихся в угрожающих жизни состояниях,
в специализированные медицинские организации 3-го уровня в 2021 г., %**

Routing of Patients in Life-Threatening Conditions to Specialized Medical Organizations (MO) of the 3rd Level in 2021, %

Регион / Region	Доля медицинских эвакуаций в ЛМО 3-го уровня Share of medical evacuations to MO of the 3rd Level	Доля санитарно-авиационных эвакуаций в ЛМО 3-го уровня Share of air ambulance evacuations to MO of the 3rd Level
Томская область / Tomsk region	100,0	100,0
Чувашская Республика / Chuvash Republic	100,0	100,0
Забайкальский край / Zabaykalsky Krai	98,7	100,0
Краснодарский край / Krasnodar region	100,0	100,0
Курганская область / Kurgan region	98,0	100,0
Кировская область / Kirov region	85,4	100,0
Республика Дагестан / The Republic of Dagestan	95,8	99,4
Воронежская область / Voronezh region	97,8	99,0
Ямало-Ненецкий автономный округ / Yamalo-Nenets Autonomous Okrug	97,6	98,2
Алтайский край / Altai region	87,4	97,2
Республика Бурятия / The Republic of Buryatia	98,0	94,8
Архангельская область / Arhangelsk region	93,3	92,7

2. Territorial centers for disaster medicine with the status of a legal entity or being a part of the regional clinical hospital – medical organization of the 3rd level – as a rule, have emergency consultative medical aid departments and specialized visiting brigades, including aviation medical ones, in their structure. In these medical organizations, a high proportion of calls are made by air ambulance calls. Territorial centers for disaster medicine, united with the ambulance stations, do not have departments of emergency consultative medical aid. The few integrated centers have specialized mobile teams. In the work of these centers there is a very small share of calls with the use of air ambulance.

3. Brigades of territorial disaster medicine centers actively work in the daily mode of activity. They perform more than 70.0% of emergency calls, including 20.0% with the use of medical aviation, including consultations and medical evacuations of the most "complicated" patients.

4. The share of calls and medical evacuations performed with the use of air ambulance at the regional level was 5.0% of the total number of emergency calls, including 95.0% of medical evacuations performed within the regions.

5. In the total number of calls performed with the use of sanitary aviation the share of the calls provided by the specialists of the territorial centers for disaster medicine amounted to 71,6%; specialists of the regional clinical hospitals – 23,1%; the use of sanitary aviation by the teams of emergency medical services and perinatal centers is minimal.

6. When eliminating medical and sanitary consequences of emergencies with the use of sanitary aviation, specialists from territorial disaster medicine centers and regional clinical hospitals – medical organizations of the 3rd level – are involved.

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