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<https://doi.org/10.33266/2070-1004-2022-1>

Электронная версия журнала «Медицина катастроф»: <http://medkatjorn.ru>; https://elibrary.ru/title_about.asp?id=8824

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Отпечатано в ФМБЦ им. А.И.Бурназяна

Сдано в набор 01.03.22. Подписано в печать 04.04.22. Бумага Kuteхsout, формат 60x90¹/₈ Гарнитура Футура, печать офсетная
Усл. печ. л. 9,25; уч.-изд. л. 13. Тираж 1000 экз. (1-500); (501-1000). 1-й завод; заказ 1001

Адрес редакции: 123098, Москва, ул. Живописная, 46, ФМБЦ им. А.И.Бурназяна. Телефон +7 (499) 190 59 60. E-mail: rcdm@mail.ru
Журнал зарегистрирован в Роскомнадзоре. Рег. номер: ПИ № ФС77-80924 от 17 мая 2021 г.

Подписной индекс 18269 (Каталог «Пресса России» Агентства «Книга-сервис»)

Научный и выпускающий редактор: Макаров Д.А. Ответственный секретарь редакции: Соколова И.К.

Компьютерная верстка: Фролова А.А.

18+

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<https://doi.org/10.33266/2070-1004-2022-1>

Electronic version of the journal: <http://medkatjorn.ru/en/>; https://elibrary.ru/title_about.asp?id=8824

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Printed in Burnasyan FMBC. Paper Kumexcut. Format 60x90¹/₈. Font Futura. Sheets 9,25/13. Edition 1000 copies. Order number 1001

Editorial Office Address: 46, Zhivopisnaya street, Moscow, 123098, Russia, Burnasyan FMBC. Phone: +7 (499) 190 59 60. E-mail: rcdm@mail.ru

The journal is registered by ROSKOMNADZOR. Reg. No.: PI № FS77-80924 dated May 17, 2021.

Index 18269 (Catalog Pressa-RF Agency Kniga service).

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№ 1 • 2022
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Подписной индекс журнала в каталоге «Пресса России» – 18269.

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SAFETY IN EMERGENCY ENVIRONMENT БЕЗОПАСНОСТЬ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ

<https://doi.org/10.33266/2070-1004-2022-1-5-12>
UDC 614.8 «2021/2022»

Original article
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ALL-RUSSIAN CENTER FOR DISASTER MEDICINE "ZASHCHITA" OF FEDERAL MEDICAL AND BIOPHYSICAL CENTER NAMED AFTER A.I. BURNAZYAN OF THE FEDERAL MEDICAL AND BIOLOGICAL AGENCY OF THE RUSSIAN FEDERATION: RESULTS OF WORK IN 2021 AND OBJECTIVES FOR 2022

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Abstract. The need to protect the population of the territories and personnel of the facilities serviced by the Federal Medical and Biological Agency in emergency situations by medical treatment organizations and mobile medical formations sets them an important task – to provide timely emergency and urgent medical care to victims in an emergency in accordance with modern principles of medical evacuation routing.

The aim of the study is to analyze and to evaluate the main results of the activities of the All-Russian Center for Disaster Medicine "Zaschita" as a part of Federal Medical and Biophysical Center named after A.I. Burnazyan of the Federal Medical and Biological Agency of the Russian Federation, to develop proposals and to define objectives for further development and improvement of the system to organize medical care and medical evacuation in emergencies at facilities and territories served by FMBA of Russia.

Materials and research methods. Materials: regulatory, legal and methodological documents governing the procedure for providing medical aid to the victims of emergencies; reports of the structural units of the All-Russian Center for Disaster Medicine "Zaschita", including special exercises held in 2021; scientific papers on topical issues of medical support to the population in emergencies.

Research methods: analytical, statistical, method of direct observation.

Results of the study and their analysis. The results of the first year of operation of the the All-Russian Center for Disaster Medicine "Zaschita" as a part of Federal Medical and Biophysical Center named after A.I. Burnazyan of the Federal Medical and Biological Agency of the Russian Federation in 2021 are presented. The following results are considered and analyzed: special trainings of the Field Multidisciplinary Hospital and Consolidated medical detachment; work on medical support of mass events – "Tavrada" Forum of Young Culture and Arts Workers and "Silk Road" international rally.

The work of the laboratory of scientific and methodical problems of medical support in emergency situations established in the All-Russian Center for Disaster Medicine "Zaschita" within the past year was characterized. Decrease of the Center of sanitary aviation and ambulance services abroad activities due to borders closing, caused by COVID-19 pandemic, is highlighted.

The activities of the All-Russian Center for Disaster Medicine "Zaschita" in the field of civil defense in the interests of FMBA of Russia, are listed. The main tasks for the All-Russian Center for Disaster Medicine "Zaschita" for 2022 are formulated.

Keywords: All-Russian Center for Disaster Medicine "Zashchita" of Federal Medical and Biophysical Center named after A.I. Burnazyan, Consolidated medical detachment, emergency and urgent medical care, emergency situations, Federal Medical and Biological Agency, field multidisciplinary hospital, mass events, medical evacuation, medical support, routing

Conflict of interest. The authors declare no conflict of interest

For citation: Samoylov A.S., Goncharov S.F., Bobiy B.V., Akinshin A.V., Baranova N.N., Chubayko V.G. All-Russian Center for Disaster Medicine "Zashchita" of Federal Medical and Biophysical Center named after A.I. Burnazyan of the Federal Medical and Biological Agency of the Russian Federation: Results of Work in 2021 and Objectives for 2022. *Meditsina Katastrof* = Disaster Medicine. 2022;1:5-12 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-5-12>

<https://doi.org/10.33266/2070-1004-2022-1-5-12>
УДК 614.8 «2021/2022»

Оригинальная статья
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ВЦМК «ЗАЩИТА» ФГБУ «ГНЦ – ФЕДЕРАЛЬНЫЙ МЕДИЦИНСКИЙ БИОФИЗИЧЕСКИЙ ЦЕНТР им. А.И.БУРНАЗЯНА» ФМБА РОССИИ: ИТОГИ РАБОТЫ В 2021 г. И ЗАДАЧИ НА 2022 г.

А.С.Самойлов¹, С.Ф.Гончаров^{1,2}, Б.В.Бобий^{1,2}, А.В.Акиншин¹, Н.Н.Баранова^{1,2}, В.Г.Чубайко¹

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Резюме. Необходимость защиты в чрезвычайных ситуациях (ЧС) населения территорий и персонала объектов, обслуживаемых Федеральным медико-биологическим агентством (ФМБА России), силами лечебных медицинских организаций (ЛМО) и мобильных медицинских формирований (ММФ) ставит перед ними актуальную задачу – своевременно оказывать неотложную и экстренную медицинскую помощь пострадавшим в ЧС в соответствии с современными принципами маршрутизации медицинской эвакуации.

Цель исследования – на основе анализа и оценки основных итогов в 2021 г. деятельности ВЦМК «Защита» в составе ФГБУ «ГНЦ – Федеральный медицинский биофизический центр (ФМБЦ) им. А.И.Бурназяна ФМБА России» (далее – ВЦМК «Защита») разработать предложения и определить задачи на 2022 г. по дальнейшему развитию и совершенствованию системы организации оказания медицинской помощи и проведения медицинской эвакуации при возникновении чрезвычайных ситуаций на объектах и территориях, обслуживаемых ФМБА России.

Материалы и методы исследования. Материалы исследования: нормативные, правовые и методические документы, определяющие порядок оказания медицинской помощи пострадавшим в ЧС; отчеты структурных подразделений ВЦМК «Защита», в том числе о проведенных специальных учениях, за 2021 г.; научные работы по актуальным вопросам медицинского обеспечения населения в ЧС.

Методы исследования: аналитический статистический, метод непосредственного наблюдения.

Результаты исследования и их анализ. Представлены результаты первого года функционирования ВЦМК «Защита» в составе ФГБУ ГНЦ ФМБЦ им. А.И.Бурназяна ФМБА России. Рассмотрены и проанализированы результаты: специальных учений Полевого многопрофильного госпиталя (ПМГ) и Сводного медицинского отряда (СВМО) ФМБА России; работы по медицинскому обеспечению массовых мероприятий – Форума молодых деятелей культуры и искусств «Таврида» и международного ралли «Шелковый путь».

Охарактеризована работа созданной в ВЦМК «Защита» в истекшем году лаборатории научно-методических проблем медицинского обеспечения при чрезвычайных ситуациях. Отмечено сокращение объема деятельности Центра санитарной авиации и скорой медицинской помощи (ЦСА и СМП) по проведению медицинской эвакуации из-за рубежа в связи закрытием границ, обусловленным пандемией COVID-19.

Показана деятельность ВЦМК «Защита» в области гражданской обороны в интересах ФМБА России и др. Сформулированы основные задачи ВЦМК «Защита» на 2022 год.

Ключевые слова: ВЦМК «Защита» ФГБУ «ГНЦ – Федеральный медицинский биофизический центр им. А.И.Бурназяна ФМБА России, маршрутизация, массовые мероприятия, медицинская эвакуация, медицинское обеспечение, неотложная и экстренная медицинская помощь, Полевой многопрофильный госпиталь, Сводный медицинский отряд, Федеральное медико-биологическое агентство, чрезвычайные ситуации

Конфликт интересов. Авторы сообщения подтверждают отсутствие конфликта интересов

Для цитирования: Самойлов А.С., Гончаров С.Ф., Бобий Б.В., Акиншин А.В., Баранова Н.Н., Чубайко В.Г. ВЦМК «Защита» ФГБУ «ГНЦ – Федеральный медицинский биофизический центр им. А.И. Бурназяна» ФМБА России: итоги работы в 2021 г. и задачи на 2022 г. // Медицина катастроф. 2022. №1. С. 5-12. <https://doi.org/10.33266/2070-1004-2022-1-5-12>

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The implementation of many measures of the National Security Strategy of the Russian Federation¹ provides for an increase in the effectiveness of measures to prevent and to eliminate the consequences of emergencies of natural and man-made character, including those associated various infectious diseases.

In the Russian Federation the level of risks and hazards caused by natural and man-made disasters, terrorist acts, armed conflicts and other emergencies remains high. The country's health care system was put to a great test in 2020-2021 due to the wave-like course of the pandemic of a new coronavirus infection COVID-19 caused by mutant strains. The results and analysis of the activities of the All-Russian Disaster Medicine Service in recent years are contained in a number of scientific publications describing the goals, tasks, work experience and prospects for improving the preparedness of the health care sphere to eliminate medical and sanitary consequences of the most probable emergencies [1, 2].

The need to protect in an emergency the personnel of the facilities and the population of the territories served by the Federal Medical and Biological Agency (FMBA of Russia) determines as a priority task the timely provision of emergency and urgent medical care to victims in emergencies in accordance with the procedures of medical care and standards, clinical guidelines and in compliance with modern principles of routing of medical evacuation.

It should be emphasized that the development of organizational technologies for providing medical care to the country's population determines the increased role of medical organizations of the Federal Medical and Biological Agency of Russia in the system of medical and sanitary support for state, public, sport events, humanitarian actions with mass participation of the population, large-scale preventive medical examinations and dispensaries in remote areas of the Russian Federation. In modern conditions during such events special attention is paid to their anti-epidemic support in the conditions of the COVID-19 pandemic [3].

In accordance with the Decree of the Government of the Russian Federation from October 12, 2020 №1671² FMBA of Russia is entrusted with the creation and maintenance of the functional subsystem of the Unified State System of Prevention and Elimination of Emergencies (RSChS), designed to provide medical and sanitary assistance to victims in emergencies that occurred in organizations (at facilities) that are under the jurisdiction of FMBA of Russia.

In addition, Decree of the Government of the Russian Federation No. 206³ of April 11, 2005 entrusted FMBA of Russia with the protection of personnel of organizations

¹ National Security Strategy of the Russian Federation: Approved by Presidential Decree No. 400 of July 2, 2021

² On amendments to some acts of the Government of the Russian Federation and invalidation of Decree No. 420 of the Government of the Russian Federation of May 3, 1994: Decree of the Government of the Russian Federation of October 12, 2020 No. 1671

³ About the Federal Medical and Biological Agency: Decree of the Government of the Russian Federation from April 11, 2005. no. 206

and the population of the territories served, elimination of the medical and sanitary consequences of man-made emergencies, medical and sanitary measures to prevent and eliminate the consequences of emergency situations, radiation, chemical and biological accidents and incidents, and the prevention of spread of infectious and mass non-infectious diseases.

During implementation of measures to improve the system of organization of medical care to victims of emergencies and their medical evacuation in 2021 from the system of the Russian Ministry of Health to the organizational structure of the "State Research Center - Federal Medical Biophysical Center named after A.I. Burnazyan" the All-Russian Center for Disaster Medicine "Zaschita" was transferred, which, by order 32⁴ of February 25, 2021 of FMBA of Russia, was charged with improving and ensuring the functioning of the system to save lives and preserve public health in case of emergencies at facilities and territories served by the Federal Medical and Biological Agency of Russia.

Undoubtedly, the results of the analysis of the first year of operation of "Zaschita" Disaster medicine Center as part of the State Research Center at the A.I. Burnazyan Federal Medical and Biological Center of the Federal Medical and Biological Agency of Russia are necessary to adjust the activities to maintain and improve the readiness of both the "Zaschita" and the relevant medical organizations of the Federal Medical and Biological Agency of Russia to respond and act in emergencies.

Considering the above, we can state that the study aimed at studying and evaluating the activities of "Zaschita" in 2021 is relevant, and its results will be in demand in practice.

The purpose of the study is to develop and substantiate the proposals on further development and improvement of the All-Russian Center for Disaster Medicine "Zaschita" functioning and in general the system of organization of medical care and medical evacuation of victims in emergencies at the facilities and territories served by the Federal Medical and Biological Agency of Russia on the basis of the analysis and assessment of the main results of "Zaschita" activity in 2021.

Materials and methods. Materials of the study: regulatory, legal and methodological documents determining the procedure for organizing and providing medical care and medical evacuation of victims in emergencies; reports on the activities of the structural units of the All-Russian Center for Disaster Medicine "Zaschita", including the results of scientific work in 2021; reports on special exercises with medical organizations of FMBA of Russia; scientific papers and publications on topical issues of medical care in emergencies. Research methods: analytical statistical, method of direct observation, logical and informational modeling.

Results of the study and their analysis. As the results of the study have shown, the practical and scientific activity of the All-Russian Center for Disaster Medicine "Zaschita" within the A.I. Burnazyan Federal State Budgetary Institution

⁴ On the implementation of organizational measures related to the transfer of the property complex from the Federal State Budgetary Institution "All-Russian Center for Disaster Medicine" of the Federal Medical and Biological Agency to the Federal State Budgetary Institution "State Scientific Center of the Russian Federation - Federal Medical Biophysical Center. A.I. Burnazyan": order of the FMBA of Russia from February 25, 2021 no.32

Federal Medical and Biological Center in 2021 was diversified, focused on maintaining and improving the level of readiness of the Field Multidisciplinary Hospital (FMH), the Center for Medical Aviation and Emergency Medical Care and the Management and Methodical Support Center to perform their tasks in likely emergencies.

In order to increase readiness to take adequate measures in emergency conditions and to study the capabilities of medical formations, including the Joint Medical Detachment (JMD) of FMBA of Russia, a tactical and special exercise "Organization of the Joint Medical Detachment of FMBA of Russia during the liquidation of medical and sanitary consequences of the emergency situation" was conducted, with practicing the formation, nomination and deployment of functional units, implementation of measures for admission, medical triage, provision of medical care and conducting medical treatment.

The exercise revealed a number of problematic issues that need to be resolved. Among them: the insufficient readiness of the JMD personnel for the operational response to the emergency, due to the fact that most of the involved medical specialists for the first time participated in such an event and, as a result, it was difficult to qualitatively and fully perform their tasks; the need for regular similar exercises involving medical specialists not only of JMD, but also medical health care organizations of FMBA Russia, specialists of which will participate in the liquidation of the medical and sanitary consequences. The experience of the exercise made it possible to take appropriate measures to equip the FMH with special equipment, medical diagnostic and treatment devices, to clarify the level of professional training of hospital staff and adjust a number of measures to maintain and improve it, taking into account the most likely structure of sanitary losses arising in an emergency and the specifics of work carried out in the emerging conditions. Proposals for changes in the reserve of consumables (medicines, medical devices) are being developed.

During the year, specialists of "Zaschita" participated in 8 command-staff exercises (CSE) and tactical-special exercises conducted jointly with the Ministry of Health, Rospotrebnadzor and the Ministry of Emergency Situations of Russia. The most significant of them were:

- A command-staff exercise at the National Defense Control Center (NDCC) of the Russian Federation with a software and hardware complex to practice the issues of improving the system of information interaction in the field of national security of the Russian Ministry of Defense and other security agencies and executive authorities of the subjects of the Russian Federation (hereinafter referred to as the subjects);
- "Organization and conduct of civil defense on the territory of the Russian Federation" with the testing of measures to improve the efficiency and consistency of civil defense forces when carrying out civil defense activities and conducting rescue and other emergency work;
- Checking the readiness of multidisciplinary medical units of the Center for Hygiene and Epidemiology of the Department of Rospotrebnadzor for the Samara Region and the territorial Disaster Medicine Centers of the regions to fulfill their tasks";

Development of the Arctic Zone of the Russian Federation (hereinafter — the Arctic Zone) is carried out

within the framework of the realization of the Presidential Decree of October 26, 2020 № 645⁵, which determines the need to develop and improve the medical forces and means of FMBA of Russia for the organization of medical and evacuation support for the population and personnel of the facilities located in this area and in the waters of the Northern Sea Route, in various emergencies.

It should be noted that the organization of emergency and urgent medical aid to the victims of emergencies in the Arctic zone is influenced by the significant remoteness of medical organisations of the 2nd and 3rd levels from the waters of the Northern Sea Route and from the coastal zone — from 500 km to 1.5 thousand km and more. Such a situation requires to be ready to perform a great volume of sanitary-aviation evacuation with the use of aviation equipment, equipped with medical airplane and helicopter modules, etc. At the same time, a number of difficulties associated with the timely provision of medical care to victims have been overcome through the use of telemedicine consultations. In 2019-2021 specialists of "Zaschita" organized and conducted more than 35 thousand telemedicine consultations in the Arctic regions (Table 1).

An important measure aimed at providing emergency and urgent medical aid to the patients and victims of emergencies is the creation of mobile medical formations (mobile medical aviation complexes) in the organizational structure of the Arctic rescue centers of the Russian Emergencies Ministry, which will allow to move quickly to the emergency area, to conduct comprehensive emergency and rescue activities, if necessary — to deploy evacuation reception, medical triage, emergency medical aid and preparation

As a part of the interdepartmental research exercise in September 2021 on elimination of the consequences of a fire on a cruise liner in the Kola Bay on the Northern Sea

Route, a harbor evacuation receiver was deployed at the expense of the Murmansk Medical Center, FMBA of Russia, to fulfill the above tasks. At the same time during the exercise in Norilsk a multidisciplinary medical complex for COVID-19 patients with thermal burns of varying severity was deployed by the Rapid Response Team of the Krasnoyarsk District Medical Center of FMBA of Russia.

The results of the exercise showed the need to develop a system of interagency cooperation in organizing medical assistance and — first and foremost — medical, sanitary evacuation, evacuation of victims, as well as to create a system of special training for medical personnel in the appropriate mobile medical formations (MMF) in the Arctic zone.

On behalf of the Russian Federal Medical and Biological Agency, work was carried out in 2021 on a set of civil defense measures. "Zaschita" specialists took part in the development and revision of drafts of the Plan for civil defense preparedness in the Federal Medical and Biological Agency of Russia and the Regulation on the organization and conduct of civil defense in the Federal Medical and Biological Agency. We summarized information from more than 280 reports of medical organizations of the Federal Biomedical Agency and prepared a report on the implementation in 2021 of the Russian Federal Biomedical Agency Action Plan 2020-2024. (The report on implementation of the Federal Medical and Biological Agency's strategy in the field of civil defense, population and territories protection against emergencies, fire safety and safety of people at water objects in 2030 and the draft report on the state of the civil defense at the Federal Medical and Biological Agency were prepared. Plans of the main activities in the field of civil defense, prevention and elimination of emergencies, fire safety and anti-terrorist protection were agreed; Action Plans for emergencies of different nature submitted by medical organizations of the Federal Medical and Biological Agency of Russia.

On the basis of the study and analysis of the existing organizational and methodological basis in the system of

⁵ On the Strategies of Development of the Arctic Zone of the Russian Federation and National Security for the period up to 2035: Decree of the President of the Russian Federation of October 26, 2020 № 645

Таблица 1/ Table No. 1

Количество (абс.) телемедицинских консультаций, проведённых специалистами ВЦМК «Защита» в регионах Арктической зоны в 2019–2021 гг.

The number (abs.) of Telemedicine Consultations Conducted by Specialists of VTSMK Zashchita in the Regions of the Arctic Zone in 2019-2021

Регион АЗ РФ /Arctic zone of the Russian Federation	2019	2020	2021	Итого Total
Архангельская область / Arkhangelsk region	1153	1722	2025	4900
Красноярский край / Krasnoyarsk Territory	438	2038	2189	4665
Мурманская область / Murmansk region	970	1610	1948	4528
Ненецкий автономный округ / Nenets Autonomous Okrug	630	561	761	1952
Республика Карелия / Republic of Karelia	501	708	843	2052
Республика Коми / Komi Republic	547	868	870	2285
Республика Саха (Якутия) / Republic of Sakha (Yakutia)	853	1775	2452	5080
Чукотский автономный округ / Chukotka Autonomous Okrug	199	391	569	1159
Ямало-Ненецкий автономный округ / Yamalo-Nenets Autonomous Okrug	2138	3242	3472	8852
Всего / Total	7429	12915	15129	35473

emergency medical evacuation of patients and victims, including victims of polytrauma, patients with new coronavirus infection COVID-19 and other contingents, the basic principles determining the routing of medical evacuation were substantiated and developed, taking into account the distance of the zone/area of emergency from populated areas. The basic variants of the routing of the medical evacuation of the injured in emergencies have been revealed, which should be applied not only in the conditions of the emergency, but also in the everyday activity mode.

The activities of the Central Sanitary and Epidemiological Service and ambulance services were aimed at providing emergency medical care, including specialized emergency medical care and medical evacuation of patients and victims in an emergency. In 2021, over 600 patients were medically evacuated, including 168 patients with suspected COVID-19 (Table 2).

The decrease in the total number of medical evacuations performed is due to the transfer of "Zaschita" to the jurisdiction of FMBA of Russia and the change in the scope of medical evacuation tasks, as well as the closure of borders in conditions of the COVID-19 pandemic.

Much work has been done to license the activities of the Center for Emergency and Critical Care Medicine within the State Research Center of A.I. Burnazyan Federal Medical and Biological Center of the Federal Medical and Biological Agency of Russia for the provision of emergency medical care, including specialized ambulance services. An appropriate license has been obtained.

The specialists of the Center for Emergency Medicine took an active part in the development of "Proposals (practical recommendations) on the organization of internal quality control and safety of medical activity outside a medical organization" when providing emergency, including specialized, medical care outside a medical organization and the corresponding methodological recommendations [4]. In accordance with the created practical recommendations, specialists from the Roszdravnadzor's Quality Institute were the first in the country to audit the

internal quality control of emergency and ambulance specialized medical care and medical evacuations in "Zaschita", which resulted in a certificate of compliance.

In 2021 the specialists of "Zashchita" as a part of the Joint Medical Unit of FMBA of Russia performed a significant amount of work to ensure medical support events with mass participation of the population.

In order to provide medical support for the Forum of Cultures and Arts "Tavrida" (hereinafter — the Forum) in 2021 on the territory of the "Art Cluster" using pneumocage modules and container-type premises, the FMH was deployed. Its tasks were: to provide emergency and urgent medical care, if necessary — temporary isolation of patients with infectious diseases; if necessary — medical evacuation to the nearest medical organisations. The increase in the number of guests and participants of the Forum up to 10 thousand required additional medical forces and means from the medical treatment organizations of FMBA of Russia — emergency medical teams were on duty at the most important and numerous events, which took place simultaneously in different parts of the Forum territory. In addition, a multidisciplinary coordination and technical center was deployed to coordinate all medical services and equipment involved in providing medical care for the Forum. The medical organisations of the Republic of Crimea were identified in advance for the hospitalization of patients. Medical evacuation was carried out to the city hospital in Sudak and in cooperation with the teams of the Crimean Republican Center for Disaster and Emergency Medicine to other medical organisations of the Republic.

In total, during the Forum, about 12,000 people sought medical care at the FMH and emergency care stations, including 23 with laboratory-confirmed COVID-19. 53 people were hospitalized, including 23 with COVID-19; 4963 tests for COVID-19 were performed. There were no outbreaks of infectious diseases among Forum participants.

At the Forum venue, a training session entitled "Organizing the Elimination of Medical and Sanitary Consequences of the Fire on the Central Stage of the Forum Territory" was held twice, with training on the interaction

Таблица 2/ Table No.2

Объём проведения медицинской эвакуации больных и пострадавших в ЧС специалистами ВЦМК «Защита» в 2020–2021 гг.

Volume of Medical Evacuation of Patients and Victims by Specialists of "Zashchita" Disaster Medicine Center in 2020-2021

Объём выездной работы Volume of fieldwork	Число эвакуированных, чел. / Number of evacuees, people.					
	всеми видами транспорта by all means of transport	из них / of which				
		автотранспортом by motor transport	авиационным транспортом // by air transport			ж/д транспортом / by railroad transport
			всего total	из них / of which		
				по России in Russia	из-за рубежа from abroad	
2020						
Всего пациентов / Total patients	1651	142	210	170	40	12
в т.ч. с COVID-19/ including COVID-19	833	723	110	84	26	0
2021						
Всего пациентов / Total patients	608	555	47	39	8	6
в т.ч. с COVID-19/ including COVID-19	168	151	17	16	1	0

between Russian Federal Medical and Biological Agency forces and the executive authorities of the Republic of Crimea and other organizations participating in the elimination of the consequences of the fire.

In accordance with the Action Plan for the Russian stage of the annual international Silk Road Rally (hereinafter — the Rally) in 2021 the medical support of the whole route through the territory of Russia and Mongolia for the first time, without the involvement of international medical and insurance organizations, was entrusted to FMBA of Russia, which included more than 40 specialists from 11 FMBA medical organisations and specialists of the All-Russian Center for Disaster Medicine "Zaschita". During preparations for the Rally, areas of responsibility and ways to evacuate possible victims were identified along the entire route, and interaction was organized with regional representatives, health care authorities, ambulance stations and territorial Disaster Medicine Centers. Particular attention was paid to measures to ensure anti-COVID safety — PCR testing was organized before the start of the Rally and the day before the expected crossing of the border of the Russian Federation. All in all 144 people got medical help during the Rally; 141 out-patiently; 3 persons were sent to the hospital. During the Rally six participants were evacuated from the track by medical crews due to the malfunction of vehicles.

The results of the activity on medical and sanitary support of the event showed the necessity of the early solution of such organizational issues as accommodation, provision with the expendable drugs and medical products, diagnostic equipment, sanitary transport, engineering and technical equipment, etc.

In order to provide scientific and methodological support for "Zaschita" activities in 2021 were created: in the structure of "Zaschita" — Laboratory of problems of medical support in emergency situations (hereinafter — Laboratory); in the Medical and Biological University of Innovation and Continuing Education of A.I. Burnazyan

Federal Medical and Biological Center — Department of Disaster Medicine. The main direction of scientific-methodological and educational activity of "Zaschita" is development of the system of organization of medical aid rendering to victims of emergencies on objects and territories serviced by the Federal Medical and Biological Agency of Russia and training specialists in the field of "Disaster Medicine".

Specialists of the laboratory have developed terms of reference for the research work on the topic: "Development of the system of organization of medical care, medical evacuation in emergencies and emergency medical care in everyday activities on sites and territories served by the Federal Medical and Biological Agency of Russia" (code number: "Zaschita"), which received a positive review by the Department of Medical Sciences of the Russian Academy of Sciences with a recommendation to FMBA Russia to include this topic in the plan of research work. As part of the first phase of the research and development activities in 2021, medical and technical requirements for the FMH and JMD of the Federal Medical and Biological Agency of Russia were developed and received a positive review from leading experts in disaster medicine.

The medical and technical requirements define the procedure for the creation, location, deployment and operation of the Field Multidisciplinary Hospital and the Joint Medical Detachment when operating in the modes of daily operations, high readiness and emergency situations as surgical, toxic-therapeutic, radiological and infectious disease hospitals (Figure 1).

A draft concept for the creation of a field multidisciplinary hospital has been developed.

Decree of the Government of the Russian Federation on October 12, 2020 № 1671 on FMBA of Russia is tasked to create a functional subsystem of the RSChS. In pursuance of this Government Decree, specialists of "Zaschita" developed a draft Regulation on the functional subsystem of medical and sanitary aid to victims of emergencies in

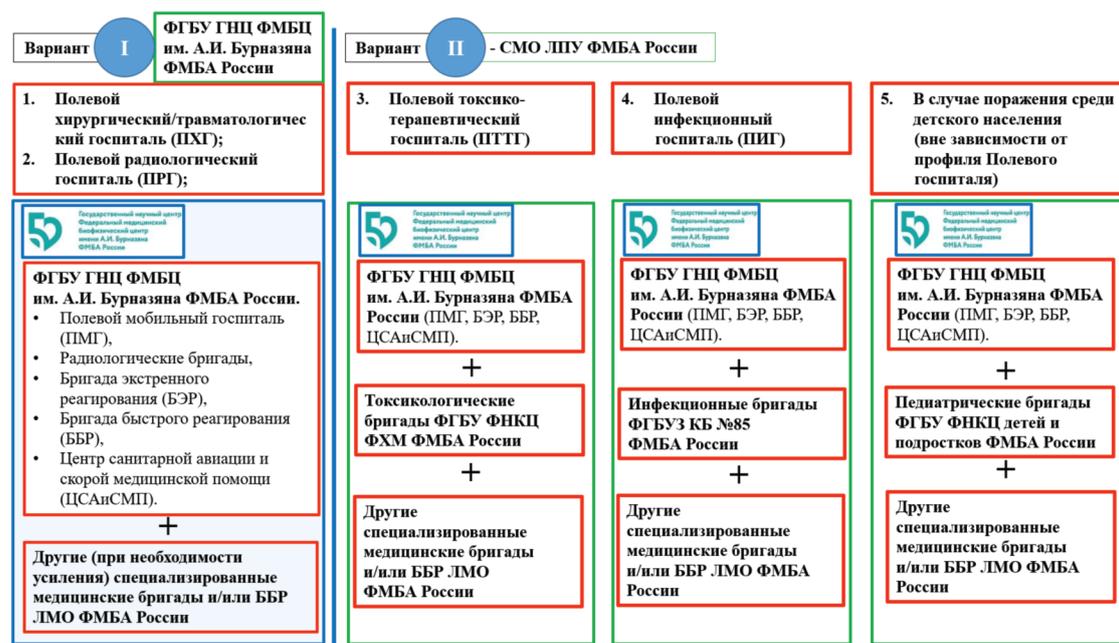


Рис 1. Варианты развертывания ПМГ и СМО
Fig. 1. Options for deployment of field multi and WSCs

organizations (at facilities) under the jurisdiction of FMBA of Russia — is currently under consideration in the Ministry of Emergency Situations of Russia.

The Department of Disaster Medicine has developed and approved additional professional development programs for specialists:

- "The Work of Medical Organizations of the Federal Medical and Biological Agency of Russia in Emergency Situations" (37 hours);

- "Organization of Internal Control over the Quality and Safety of Medical Activities in Emergency Medical Care, including Specialized Emergency Medical Care and Medical Evacuation of Patients and Victims" (37 hours).

Special attention at the Department of Disaster Medicine was paid to the training of specialists of aviation medical brigades and training in first aid techniques (Table 3).

The specialists of "Zaschita" together with the professors-scientists of the Military Medical Academy named after S.M. Kirov prepared the textbook "Medicine of extreme situations" in two volumes, designed for training of medical specialists of the power ministries — it was published in the first half of 2021.

The main results of scientific and practical work of "Zaschita" were presented at 16 All-Russian conferences and symposiums, including those with international participation. In the reports the following issues were presented: information support of the Federal Medical and Biological Agency of Russia; activities of the FMH and JMD, medical support activities with mass participation of the population, providing medical care to patients and medical evacuation of victims in emergencies, the medical response to emergencies of biosocial nature, management of emergency medical care. Final reports on all directions of "Zaschita" activities were made at the jubilee international scientific conference "Burnazyan Federal Medical and Biological Center: 75 years on guard of human health".

As part of the activities of the Russian Academy of Sciences at a meeting of the section of preventive medicine

and at the general meeting of the Department of Medical Sciences the reports "Routing in the system of medical and evacuation support in emergencies to improve the availability and quality of medical care provided to victims in the Arctic zone of the Russian Federation" and "Medical evacuation of COVID-19" were presented.

Dissertation works carried out by the staff of "Zaschita" are devoted to solving problems of medical evacuation of patients and victims in emergencies, including from abroad; organization of medical care during liquidation of medical and sanitary consequences of terrorist acts; normative regulation of the All-Russian Disaster Medicine Service; organization of first aid and medical care at Russian ski resorts; medical triage in radiation accidents; information technologies of FMBA of Russia.

"Zaschita" specialists paid attention to the development of the main aspects of the functioning and certification of International Emergency Medical Teams (EMTs); participated in the creation of organizational, clinical and technical principles of EMTs activities. The principles they developed were laid out in the WHO Blue Book and Red Book, published in 2021, which regulate the work of EMTs in response to natural disasters, epidemic outbreaks, military and armed conflicts.

A WHO working group on standardization of medical evacuations at the international level was established in 2019. As part of the group's work, 8 meetings were held in 2021, and a WHO medical evacuation manual is being developed to regulate the organizational, clinical and technical principles of medical evacuation teams at the national and international levels.

Conclusion

The presented results of the work of the All-Russian Center for Disaster Medicine "Zaschita" allow us to state that within the framework of their competence the specialists of "Zaschita" of the State Research Center for Medical and Biological Center named after A.I. Burnazyan of FMBA of Russia are able to determine and

Таблица 3/ Table No.3

Циклы подготовки и число обученных на кафедре медицины катастроф МБУ ИНО Training Cycles and the Number of Trainees at the Department of Disaster Medicine at Medical and Biological University of Innovation and Continuing Education

Наименование циклов и сроки их проведения Name of cycles and their timing	Кол-во циклов Number of cycles	Число обученных, чел. Number of people trained
Циклы дополнительного профессионального образования In cycles of additional professional education		
Санитарно-авиационная эвакуация / Air medical evacuation	4	66
Проведены занятия:/ Classes conducted		
Базовая сердечно-легочная реанимация с применением автоматического наружного дефибриллятора –тренинг с сотрудниками ФГБУ ГНЦ ФМБЦ России им. А.И.Бурназяна ФМБА России Basic cardiopulmonary resuscitation with an automatic external defibrillator (training with employees of the Federal State Budgetary Institution State Research Center named after A.I. Burnazyan of the Russian Federal Medical and Biological Agenc	5	55
Первая помощь в условиях огневого контакта – сотрудники Следственного комитета России First aid in the conditions of fire contact – employees of the Investigative Committee of Russia	3	44
Оказание первой помощи при несчастных случаях, травмах, отравлениях и других состояниях и заболеваниях, угрожающих жизни и здоровью First aid in case of accidents, injuries, poisoning and other conditions and diseases that threaten life and health	3	36
Всего / Total	15	201

to solve practical and scientific tasks on organization and scientific substantiation of problematic issues, organization of medical and sanitary support for victims in emergencies at the facilities and territories served by FMBA of Russia, on providing medical care and medical evacuation of patients and victims in emergencies in compliance with the routing principles.

The main tasks facing specialists of "Zaschita" in 2022 should be:

- achieving goals and priorities of medical-social and sanitary-epidemiological safety of the population of the Russian Federation, defined by the National Security Strategy of the Russian Federation, approved by Presidential Decree of 2 July 2021 № 400;
- ensuring readiness of mobile medical formations in the system of medical organizations of FMBA of Russia — FMH, JMD, rapid response brigades of specialized medical care to respond and act in emergency conditions;
- Establishment and operation of mobile medical formations, such as FMH and JMDs, in the system of medical support in emergencies;
- organizing the work of district medical centers and other medical organisations of the Federal Medical and Biological Agency of Russia in emergencies;
- improving the system of organization and provision of medical care, medical evacuation of victims in emergencies at facilities and territories served by FMBA of Russia;
- development and implementation of information technologies in the activities of the Federal Medical and Biological Agency as one of the components of the system of medical and sanitary support of the employees at the

facilities and the population of the territories serviced by the Federal Medical and Biological Agency of Russia;

- methodological support of activities to eliminate medical and sanitary consequences of possible emergencies at facilities and territories serviced by FMBA of Russia;
 - conducting special exercises and training sessions with the district medical centers of the Federal Medical and Biological Agency of Russia to organize medical aid to victims of emergencies at facilities and territories serviced by the Federal Medical and Biological Agency of Russia; improving the quality and efficiency of these exercises;
 - developing a system for providing emergency medical aid and medical evacuation by the Federal Medical and Biological Agency in emergency situations in the Arctic Zone of the Russian Federation;
 - developing requirements for specialists in medical units to provide emergency medical aid and medical evacuations as part of the Arctic Integrated Rescue Centers of the Russian Ministry of Emergency Situations;
 - improving the system for training medical specialists involved in the liquidation of medical and sanitary consequences of emergencies;
 - development of educational and methodological materials for the training of specialists involved in the elimination of medical and sanitary consequences of emergencies.
- Solution of the above tasks will increase the readiness of medical forces of FMBA of Russia to respond and act in emergencies, the availability and quality of medical care and medical evacuation of patients and victims in emergency situations.

REFERENCES

1. Goncharov S.F., Bobiy B.V., Akin'shin A.V. Service for Disaster Medicine of Ministry of Health of Russian Federation: Main Results of Activities in 2019 and Tasks for 2020. Message 1. *Meditsina Katastrof = Disaster Medicine*. 2020;1:15-27 (In Russ.). <https://doi.org/10.33266/2070-1004-2020-1-15-27>
2. Goncharov S.F., Titov I.G., Bobiy B.V., Akin'shin A.V. Main Results of Activities of All-Russian Centre for Disaster Medicine Zashchita of Federal Medical Biological Agency in 2020 and Tasks for 2021. *Meditsina Katastrof = Disaster Medicine*. 2021;1:10-17 (In Russ.). <https://doi.org/10.33266/2070-1004-2021-1-10-17>
3. Demenko V.V., Cheplyaev A.A., Savvin Yu.N., Prostakishin G.P. Medical Support of Mass Events During the COVID-19 Pandemic: Problems and Possible Ways of their Solution. *Meditsina Katastrof = Disaster Medicine*. 2021;2:35-45 (In Russ.). <https://doi.org/10.33266/2070-1004-2021-2-35-45>
4. URL: http://cmkee.ru/upload/doc/Predlozhenija_po_skoroj_v_tom_chisle_skoroj_spetsializirovannoj_meditzinskoj_pomoschi.pdf (Accessed date: 06.03.2021) (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. Гончаров С.Ф., Бобий Б.В., Акиншин А.В. Служба медицины катастроф Минздрава России: основные итоги деятельности в 2019 г. и задачи на 2020 г. // *Медицина катастроф*. 2020. №1. С. 15–27. <https://doi.org/10.33266/2070-1004-2020-1-15-27>.
2. Гончаров С.Ф., Титов И.Г., Бобий Б.В., Акиншин А.В. Основные итоги деятельности Всероссийского центра медицины катастроф «Защита» ФМБА России в 2020 г. и задачи на 2021 год // *Медицина катастроф*. 2021. №1. С. 10–17. <https://doi.org/10.33266/2070-1004-2021-1-10-17>.
3. Деменко В.В., Чепляев А.А., Саввин Ю.Н., Простакишин Г.П. Медицинское обеспечение массовых мероприятий в период пандемии COVID-19: проблемы и возможные пути их решения // *Медицина катастроф*. 2021. №2. С. 35–45. <https://doi.org/10.33266/2070-1004-2021-2-35-45>
4. http://cmkee.ru/upload/doc/Predlozhenija_po_skoroj_v_tom_chisle_skoroj_spetsializirovannoj_meditzinskoj_pomoschi.pdf. Дата обращения 06.03.2021 г.

KEY RESULTS OF ACTIVITIES OF THE FEDERAL CENTER FOR DISASTER MEDICINE OF THE FEDERAL STATE INSTITUTION "NATIONAL MEDICAL AND SURGICAL CENTER NAMED AFTER N.I. PIROGOV" AND OF THE DISASTER MEDICINE SERVICE OF THE MINISTRY OF HEALTH OF RUSSIA IN 2021

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Abstract. The preparedness of the Russian health care to react to emergency situations, issues of organization and provision of medical care and medical evacuation in emergencies are inextricably linked to the activities of the Disaster Medicine Service of the Russian Ministry of Health, the main component of the All-Russian Disaster Medicine Service. Since March 1, 2021 day-to-day administration of the All-Russian Disaster Medicine Service and of the Disaster Medicine Service of the Russian Ministry of Health is performed by the Federal Center for Disaster Medicine of National Medical and Surgical Center named after N.I. Pirogov.

The aim of the study is to define the priorities for the year 2022 for the Federal Disaster Medicine Center, for Disaster Medicine Service of the Russian Ministry of Health and for the All-Russian Disaster Medicine Service as well as for the whole system of population medical support in emergencies. The priorities will be defined based on the analysis of the 2021 year activities for the Federal Center for Disaster Medicine, for territorial centers of disaster medicine, for regional centers of emergency and disaster medicine and for regional centers of disaster and emergency medicine.

Materials and research methods. Regulatory and methodological documents governing the organization and functioning of the All-Russian Disaster Medicine Service and of the Disaster Medicine Service of the Ministry of Health of Russia, documents setting the procedure for medical care and medical evacuation of victims in emergencies; reports of territorial centers of disaster medicine, of regional centers of emergency and disaster medicine and of regional centers of disaster and of federal disaster medicine centres on the medical and sanitary emergency response activities in 2021 as well as other documents; scientific papers and publications on current issues of medical care in emergencies, on development of the Disaster Medicine Service information environment and on digitalization of healthcare. Research methods: analytical statistical, method of direct observation, logical and informational modeling.

Research results and their analysis. The main results of activities of Federal Disaster Medicine Center and of Disaster Medicine Service of the Russian Ministry of Health in 2021 were considered, including information interaction with the operational services in conference mode, monitoring of the medical and sanitary situation, emergency data, measures to combat the COVID-19 pandemic, etc. The structure of Disaster Medicine Service at the regional level was analyzed. The main directions of Federal Disaster Medicine Center and Disaster Medicine Service of the Russian Ministry of Health activities for 2022 are presented.

Key words: All-Russian Disaster Medicine Service, COVID-19 pandemic, emergencies, Federal Center for Disaster Medicine of N.I. Pirogov National Medical and Surgical Center of the Ministry of Health of Russia, patients, Russian Ministry of Health Disaster Medicine Service, victims,

Conflict of interest. The authors declare no conflict of interest

For citation: Zamyatin M.N., Bystrov M.V., Kolodkin A.A., Kilnik A.I., Belova A.B., Isaeva I.V., Bagaev G.A., Kataev A.S., Magazeishchikova N.G. Key Results of Activities of the Federal Center for Disaster Medicine of the Federal State Institution "National Medical and Surgical Center Named after N.I.Pirogov" and of the Disaster Medicine Service of the Ministry of Health of Russia in 2021. *Meditsina Katastrof* = Disaster Medicine. 2022; 1: 13-19 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-13-19>

ОСНОВНЫЕ ИТОГИ ДЕЯТЕЛЬНОСТИ ФЕДЕРАЛЬНОГО ЦЕНТРА МЕДИЦИНЫ КАТАСТРОФ ФГБУ «НАЦИОНАЛЬНЫЙ МЕДИКО-ХИРУРГИЧЕСКИЙ ЦЕНТР ИМ. Н.И.ПИРОГОВА» И СЛУЖБЫ МЕДИЦИНЫ КАТАСТРОФ МИНИСТЕРСТВА ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ в 2021 г.

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Резюме. Готовность российского здравоохранения к реагированию на чрезвычайные ситуации (ЧС), вопросы организации и оказания медицинской помощи и проведения медицинской эвакуации пострадавших в ЧС неразрывно связаны с деятельностью Службы медицины катастроф (СМК) Минздрава России – основной составляющей Всероссийской службы медицины катастроф (ВСМК). С 1 марта 2021 г. функции и полномочия органа повседневного управления ВСМК и СМК Минздрава России на федеральном уровне выполняет Федеральный центр медицины катастроф (ФЦМК) ФГБУ «Национальный медико-хирургический центр (НМХЦ) им. Н.И.Пирогова» Минздрава России.

Цель исследования – на основе анализа основных итогов деятельности в 2021 г. Федерального центра медицины катастроф, территориальных центров медицины катастроф (ТЦМК), региональных центров скорой медицинской помощи и медицины катастроф (РЦ СМП МК) и региональных центров медицины катастроф и скорой медицинской помощи (РЦ МК СМП) определить приоритетные направления деятельности в 2022 г. ФЦМК, СМК Минздрава России и ВСМК, всей системы медицинского обеспечения населения, пострадавшего в чрезвычайных ситуациях.

Материалы и методы исследования. Материалы исследования: нормативные и методические документы, определяющие порядок организации и функционирования ВСМК, СМК Минздрава России, порядок оказания медицинской помощи и проведения медицинской эвакуации пострадавших в ЧС; отчеты ТЦМК, РЦ СМП МК, РЦ МК СМП и ФЦМК о деятельности по ликвидации медико-санитарных последствий ЧС в 2021 г. и другие документы; научные работы и публикации, посвященные актуальным вопросам медицинского обеспечения населения в ЧС, развития информационной среды ВСМК и цифровизации здравоохранения. Методы исследования: аналитический статистический, метод непосредственного наблюдения, логическое и информационное моделирование.

Результаты исследования и их анализ. Рассмотрены основные результаты деятельности ФЦМК и СМК Минздрава России в 2021 г., в том числе по информационному взаимодействию с оперативными службами в режиме конференц-связи, мониторингу медико-санитарной обстановки, данные о ЧС, мерах по борьбе с пандемией COVID-19 и др. Проанализирована структура СМК на региональном уровне. Представлены основные направления деятельности ФЦМК и СМК Минздрава России в 2022 г.

Ключевые слова: *больные, Всероссийская служба медицины катастроф, пандемия COVID-19, пострадавшие, Служба медицины катастроф Минздрава России, Федеральный центр медицины катастроф ФГБУ «Национальный медико-хирургический центр им. Н.И.Пирогова» Минздрава России, чрезвычайные ситуации*

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: *Замятин М.Н., Быстров М.В., Колодкин А.А., Кильник А.И., Белова А.Б., Исаева И.В., Багаев Г.А., Катаев А.С., Магазейщикова Н.Г. Основные итоги деятельности Федерального центра медицины катастроф ФГБУ «Национального медико-хирургического центра им. Н.И.Пирогова» Минздрава России и Службы медицины катастроф Министерства здравоохранения Российской Федерации в 2021 г. // Медицина катастроф. 2022. №1. С. 13-19. org/10.33266/2070-1004-2022-1-13-19*

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The aim of the study is to analyze the main results of the activities of the Federal Center for Disaster Medicine of N.I. Pirogov National Medical and Surgical Center, Territorial Centers for Disaster Medicine, Regional Centers for Emergency and Disaster Medicine, Regional Centers for Disaster Medicine and Emergency Medical Care and to develop proposals for further development and identify priority activities in 2022 for the Federal Center for Disaster Medicine, Disaster Medicine Service of the Russian Ministry of Health and for the All-Russian Disaster Medicine Service, as well as for the whole system of medical care for the population affected in emergency situations.

Materials and research methods. The sources of information were as follows: normative and methodical documents determining the order of organization and functioning of the All-Russian Disaster Medicine Service, of the Disaster Medicine Service of the Ministry of Health of Russia, the procedure of medical care and medical evacuation of the emergency victims¹⁻³; reports of the Territorial Centers for Disaster Medicine, Regional Centers for Emergency and Disaster Medicine, Regional Centers for Disaster Medicine and Emergency Medical Care and of the Federal Center for Disaster Medicine on the work in the emergency medical care system in 2021; the reports on the state of readiness of the regional Disaster Medicine Service prepared by the specialists of the Federal Center for Disaster Medicine; the materials of the special tactical, command-staff trainings and command-

staff exercises; scientific papers and publications on current issues of medical care in emergencies, on the development of the information environment of the emergency medical response and digitalization of healthcare [1-4]. Research methods: analytical statistical, method of direct observation, logical and information modeling.

Results of the study and their analysis. Coordination of interaction between management bodies, as well as the use of forces and means of the All-Russian Service for Disaster Medicine is implemented within the framework of the Unified State System of Emergency Prevention and Response.

In accordance with the Decree of the Government of the Russian Federation from October 12, 2020 No. 1671⁴ since March 1, 2021 the functions and powers of the day-to-day management of the All-Russian Disaster Medicine Service at the federal level are entrusted to the Federal State Budgetary Institution "N.I. Pirogov National Medical and Surgical Center" of the Ministry of Health of the Russian Federation.

Based on the order of the Ministry of Health of Russia 1133⁵ from October 20, 2021 in the structure of the Federal State Budgetary Institution "N.I. Pirogov Scientific and Surgical Center" of the Ministry of Health of Russia the Federal Center for Disaster Medicine was established as a separate unit and is functioning since March 1, 2021.

At the first stage the key task of Federal Center was to provide continuity in solving all problems of the All-Russian Disaster Medicine Service and the Disaster medicine

¹ On the Protection of the Population and Territories from Natural and Man-Made Emergencies. Federal Law dated December 21, 1994, No. 68-FZ (In Russ.).

² On the Fundamental Principles of the Public Health Protection in the Russian Federation. Federal Law dated November 21, 2011, No. 323-FZ (In Russ.).

³ On the Approval of Regulations of the All-Russian Service for Disaster Medicine. Decree of the Government of the Russian Federation dated August 26, 2013, No. 734 (In Russ.).

⁴ On the Introduction of Amendments to Certain Acts of the Government of the Russian Federation and the Recognition of the Decree of the Government of the Russian Federation of May 3, 1994 No. 420 as Invalid. Decree of the Government of the Russian Federation dated October 12, 2020, No. 1671 (In Russ.).

⁵ On Approval of the Charter of the Federal State Budgetary Institution "N.I. Pirogov National Medical and Surgical Center" of the Ministry of Health of the Russian Federation: Order of the Ministry of Health of Russia of 20.10.2021 No. 1133

Service of Ministry of Health of Russia, to keep high professional potential and good traditions of the Service, established by "Zaschita" All-Russian Disaster Medicine Center, headed by S.F. Goncharov, RAS academician, main freelance specialist on disaster medicine of the Ministry of Health of Russia.

During the preparatory period, together with the profile department of the Russian Ministry of Health, a great work was carried out to solve personnel, legal, financial, informational, technological, property, medical and other issues. More than 70 experienced employees of "Zashchita" came to work to the Federal Center. In our opinion, the task of ensuring continuity in the transfer of authority has been successfully accomplished.

Starting from March 1, 2021 the Federal Center, as the day-to-day management body of the All-Russian Disaster Medicine Service and of Disaster Medicine Service of the Ministry of Health of the Russian Federation, in accordance with the Regulation, existing agreements and interaction regulations, coordinates actions and carries out interaction: with profile departments of the Russian Ministry of Health, the Main Directorate "National Center for Crisis Management" of the Russian Ministry of Emergency Situations, other units and working groups of the Russian Ministry of Emergency Situations, the National Defense Management Center of the Russian Federation and the Main Military Medical Directorate of the Russian Ministry of Defense, bodies and institutions of Rospotrebnadzor, FMBA of Russia, Russian Academy of Sciences, territorial and regional disaster medicine centres of the subjects of the Russian Federation (hereinafter referred to as subjects), with federal and regional medical organizations.

In 2021 information exchange with the operational services in the videoconferencing mode was conducted: with the Ministry of Emergency Situations of Russia — 960 sessions (in 2020 — 1,101); with the National Defense Management Center of the Russian Federation — 290 sessions (in 2020 — 333).

The Federal Center specialists, in cooperation with the specialists of the territorial and regional centers, monitor the medical and sanitary situation. In 2021, 2,389 emergencies with medical and sanitary consequences were registered (2,102 in 2020).

In 2021 the share of man-made emergencies in their total number was 91.1%. The share of other types of ES was much lower: biological and social ES — 8,0%; natural — 0,5%; social ES — 0,4%.

A special place among man-made ES was held by road accidents and fires: 60,3% and 28,5% respectively of all ES and 66,2% and 31,3% respectively of all man-made ES.

In 2021 the severity of the consequences (ratio of the number of deaths to the number of victims, %) of man-made emergencies was 45.7%. The most severe consequences of man-made emergencies are observed in accidents in life support systems (100%); accidents on railway transport (83.9%); sudden collapse of buildings, structures, rocks (73.1%); fires (68,1%); aviation accidents (66,2%); accidents with water transport (55,8%); accidents on the roads (37,3%), as well as natural (25,8%), biological and social (17,7%) and social emergencies (8,9%).

The rate of victims of man-made emergencies amounted to 81,4% of the total number of victims, biological and social emergencies — 15,5%, social — 2,0 %, natural emergencies — 1,1%.

The share of children in the total number of victims of emergencies was 22.4%.

The rate of death on the spot was: in man-made emergencies 92,4%, including: in accidents on the roads — 53,6%, in fires — 34,8%; in bio-social emergencies — 6,4% — mainly in cases of poisoning by non-medical toxins, carbon monoxide and household gas, alcohol surrogate and others; in natural emergencies — 0,7%; social emergencies — 0,5%.

The children accounted for 11.4% of all killed in emergencies and 19.2% of all injured in emergencies.

The structure of social ES was represented by social conflicts with the use of weapons. The proportion of victims of social emergencies who died and were treated in hospitals was 8.9% and 42.6% respectively.

The share of those hospitalized in the total number of victims in emergencies was 44.2%. The rate of hospitalized persons in man-made emergencies was 79.5% including accidents on highways — 66.6%; in bio-social emergencies — 18%; in social emergencies — 1.9%; the rate of hospitalized persons in natural emergencies was 0.6%.

Of the total number of victims of emergencies who received medical care in hospital, 6.6% were in extremely serious condition and 23.3% in serious condition.

In 2021 5,474 mobile medical teams were involved in elimination of the medical and sanitary consequences of emergencies, including 4,874 emergency medical teams; 336 rapid response teams of the territorial disaster medicine centers; 214 teams of specialized medical assistance; 50 aviation medical teams (AMTs).

On the territory of the Russian Federation 6099 emergency victims were evacuated, including 1644 children; 67 of them were evacuated by air, including 9 children.

On the instructions of the Ministry of Health of Russia in order to coordinate the use of resources and means of Disaster Medicine Service and interagency cooperation between health authorities to provide practical and methodological assistance and to conduct — if necessary — medical evacuations in response to medical and sanitary emergency situations the staff of the Federal Center visited: Stavropol Krai (accident, May 2021); Kazan (terrorist attack, May 2021); Kazan (fire in a hospital, May 2021); Republic of Crimea (emergency case connected with flooding: in 7 municipal districts — June, 2021); Bakhchisaray region (July, 4-5, 2021: for medical support of actions of Tavrida art Festival (September, 2021); Republic of North Ossetia-Alania (violation of medical oxygen supply in the Republican Clinical Hospital, August 2021); Noginsk, Moscow Oblast (gas explosion in an apartment house, September 2021).

In 2021, the staff of the Center for Sanitary Aviation and Emergency Medical Care organized and conducted medical evacuations of 893 people, including 519 children. A total of 147 persons, including 65 children, were evacuated by air. A total of 83 flights were performed, including 61 within Russia and 22 to foreign countries. The aviation medical teams evacuated 23 emergency victims in the Stavropol Territory, the Republic of Tatarstan and the Perm Territory.

Analyzing the work of the Russian Ministry of Health's Disaster Medicine Service in organizing and providing medical assistance to victims of emergencies and their medical evacuation to medical treatment organizations, it should be noted that in all cases the forces and means of the regional level were sufficient to eliminate the medical and sanitary consequences of the emergency. At the same time, monitoring of emergency victims in the hospital period was not established in all territorial and regional disaster medicine

centers. There were cases of medical evacuation of emergency victims in medical organisations with violation of the principles of optimal routing and delays in face-to-face and remote consultations, as well as inter-hospital evacuation of such patients to higher-level medical institutions. Telemedical consultations for victims of emergencies by specialists from federal medical organizations were insufficiently used. In 2021 only 58 telemedicine consultations on emergencies were carried out. In 2021, the Russian Ministry of Health and the Federal Medical Center held a number of meetings via videoconferencing with the heads of the executive authorities of the regional and territorial disaster medicine centers, at which the problematic issues were discussed and measures were outlined to resolve them. As a result of the meetings, provisional regulations for information interaction were developed; a monitoring system for children affected by emergencies was introduced; a draft Concept for Information Development was prepared and sent to the Russian Ministry of Health taking into account the current tasks, experience of digitalization of the Disaster Medicine Service.

In 2021, the staff of the Center for Crisis Management conducted daily monitoring and assessment of the medical and sanitary situation in the regions, with subsequent submission of consolidated information to the Ministry of Health of Russia, including

- during mass events on holidays;
- during the flood and fire hazard period in the Far Eastern, Siberian, Ural, Volga and Southern federal districts;
- on the number of people seeking medical assistance who suffered from hypothermia and frostbite.

In addition, the medical and sanitary situation was monitored of major and high-profile emergencies:

- explosion and shooting in Gymnasium No. 175 in Kazan;
- shooting in Perm State National Research University;
- explosion of a passenger bus in Voronezh;
- accident on a small vessel in Murmansk Oblast;
- domestic gas explosions in the Moscow and Lipetsk Regions;
- plane crash in the Irkutsk region;
- airplane crash in Khabarovsk region;
- helicopter crash in Kamchatka region;
- complex of unfavorable meteorological phenomena in the Republic of Crimea and Krasnodar Krai;
- complex of adverse meteorological phenomena and related waterlogging in the regions of the Far Eastern Federal District;
- natural fires in the Republic of Sakha-Yakutia, Irkutsk Region and a number of other regions;
- acute intestinal infection among Russian tourists in Egypt;
- emergency situation in the Listvyazhnaya mine in the Kemerovo Region.

In 2021, the Federal Center specialists continued the work on monitoring victims of emergencies who were in serious and extremely serious condition in regional medical treatment organisations, carried out by "Zaschita" Disaster Medicine Center together with territorial and regional disaster medicine centers since 2018. In 2021, compared to 2018, there was a 16.0% decrease in the number of medical evacuations of seriously injured persons in emergencies to Level 1 medical organisations. In the reporting year, the proportion of medical evacuations of emergency victims to Level 3 medical organisations was 31.9% of the total number of hospitalized victims. The analysis also revealed a 3.0% decrease in hospital

mortality among the seriously injured in 2021 compared to 2018.

In our opinion, these trends are the result of the work carried out in recent years in the Ministry of Health's Disaster medicine Service to organize the medical evacuation of emergency victims, taking into account the principles of optimal routing, including the monitoring of emergency victims who were in serious and extremely serious condition in regional medical institutions. Work on this important area of the Ministry of Health's Disaster Medicine Service will continue.

In 2021 in accordance with the regulatory requirements of the order of the Ministry of Health of Russia 1202n⁶ from 06.11.2020 the material base of the Field multidisciplinary hospital was formed.

Taking into account the urgent tasks of the Ministry of Health of Russia Disaster Medicine Service, in cooperation with the Department of organization of emergency medical care and health risk management of the Ministry of Health of Russia, and with the Ministry of Health of Russia chief freelance specialist on disaster medicine, S.F. Goncharov as well as with the chief freelance specialists on disaster medicine of the Ministry of Health of Russia in federal districts, the Federal Center staff worked out proposals on improvement of the regulatory legal base, which regulates activities of the disaster medicine service.

A draft Regulation on information interaction between the Ministry of Emergency Situations and the Ministry of Health of Russia was agreed upon.

In accordance with the request of the Ministry of Emergency Situations and the Russian Ministry of Health, the Federal Center specialists reviewed the draft federal law "On Civil Defense and Protection from Emergency Situations".

They analyzed the regulatory documents of the Russian Ministry of Emergency Situations regulating the issues of emergency response and operational information exchange.

The Federal Center specialists prepared and submitted to the Russian Ministry of Health for concurrence and approval:

- draft regulations on the Disaster Medicine Service of the Ministry of Health of the Russian Federation;
- draft regulations on the functional subsystem "Medical Resource Reserves";
- changes to the order of the Ministry of Health of Russia from 06.11.2020 N° 1202n, adopted by the Ministry of Health of Russia on August 6, 2021.

Specialists of the Federal Center together with specialists of "Federal Resource Center for Informatization and Technological Development" of the Ministry of Health of Russia (from 01.06.2021 — "Central Research Institute of Health Organization and Informatization" of the Ministry of Health of Russia), territorial and regional disaster medicine centers are working on the introduction of the incident management mechanism into the practice of the Ministry of Health of Russia Disaster Medicine Service, providing situational monitoring (control over the passage of milestones and deadlines in accordance with the algorithms of emergency response for each region).

In addition, the specialists of the Federal Center for Emergency Medicine and the Central Scientific Research

⁶. On the Approval of the Procedure for Organizing and Providing Medical Care in Emergency Situations, Including Medical Evacuation, by the All-Russian Service for Disaster Medicine. Order of the Ministry of Health of the Russian Federation dated November 06, 2020, No. 1202 (In Russ.).

Institute of Emergency Medicine of the Ministry of Health of the Russian Federation developed the information system "System for Monitoring Disaster Medicine Centers", which allows the collection and processing of the following information:

- on the medical equipment reserve;
- on the health care institution's irreducible stock;
- on stocks of medical equipment for emergencies;
- on conducted exercises, drills and trainings;
- on conducted exercises, drills and trainings with involvement of medical organizations;
- grouping of forces;
- grouping of equipment;
- grouping of aircraft;
- grouping of watercrafts;
- activity of medical organizations, providing emergency medical assistance and medical evacuation in case of field forms of work;
- demand for medical assistance during the flood period;
- demand for medical care during the fire hazardous period;
- demand for medical care of the citizens who suffered from hypothermia and frostbite;
- indicators of the work of the outreach;
- information systems of emergency medical care and the Regional Medical Information System.

The information system generates summary statistical forms for any period of time and allows to analyze the activities of the Russian Ministry of Health Disaster medicine Service.

Standard algorithms were developed for the response of the Russian Ministry of Health Disaster Medicine Service to man-made emergencies (transport accidents (disasters) on roads and social emergencies (terrorism, banditry, the actions of organized criminal groups, mass riots, etc.), providing methodological support to eliminate the medical and sanitary consequences of these emergencies, which constitute a large proportion of all emergencies that occurred in 2021.

These documents were discussed, finalized and approved in the framework of the Russian Ministry of Health Working Group on the development of standard algorithms of response to emergencies, to monitor their actualization and introduction into practice in the subjects of the Russian Federation.

In order to ensure the readiness of the subjects' disaster medicine service to respond to the medical and sanitary consequences of emergencies, taking into account the current tasks, the specialists of the Federal Center worked out and adjusted the list of basic questions to assess the state and readiness of the subject disaster medicine service to respond to emergencies, which became the basis for to conduct verification activities to assess the state and readiness of the subjects' disaster medicine service.

Based on the results of the on-site inspections, an assessment was made of the state and readiness of the regional disaster medicine service forces and facilities, the reports were prepared with recommendations based on the assessment results — the reports were agreed with the heads of the subject state authorities in the field of public health protection: in Voronezh (March), Tula (April), Kursk (May), Vologda (September), Tver (October) and Ryazan (December) regions.

In the course of inspections the following was assessed: readiness of the disaster medicine service management bodies and medical organizations to act in emergencies;

plans for medical support of population in emergencies; organization of interaction of disaster medicine service with subdivisions and formations of other ministries and organizations, participating in emergency response; possibility of application of sanitary aviation for medical aviation evacuation of seriously injured to higher level medical organisations; efficiency of existing system of passing information about emergency and dispatchers interaction; accumulation, storage and usage of medical resources.

The analysis of the structure of disaster medicine service at the regional level, including the field trips made by the specialists of the Federal Center proves the existence of different organizational models of disaster medicine service functioning at the regional level: territorial disaster medicine center as an independent medical organization; territorial disaster medicine center within the leading regional hospital; united emergency medical center. In large subjects — Moscow, Moscow region, Sverdlovsk region, Khabarovsk krai, Khanty-Mansi Autonomous okrug — Yugra, Kemerovo region — "territorial disaster medicine center as an independent medical organization" model prevails. During the year 2021 the tendency for the organizational unification of territorial disaster medicine centers and the ambulance stations remained; the number of the united regional centers of emergency and disaster medicine (regional centers of disaster and emergency medicine) increased to 34; the territorial disaster medicine center functioning as an independent medical organization — to 35; the number of the territorial disaster medicine center as a part of the leading regional hospital — to 16. In 2021 there were processes of consolidation of emergency medical care stations and territorial disaster medicine centers in the Stavropol Krai, Tver and Smolensk regions, and the Republic of Mordovia. Chuvash Republic, Tula region, Republic of Crimea, etc. register positive impact on the activities of the united centers. At the same time, in some subjects during the process of reorganization and unification of the stations, the "disaster medicine" functionality was not properly provided in terms of staffing. The relevant units responsible for performing the tasks of the day-to-day management body of the disaster medicine service at the regional level were not formed. This is unacceptable and requires measures from the management of the executive authorities of these subjects and the united regional centers to rectify the situation. The principle position of the Federal Center on this issue is that regardless of the organizational model of functioning of the disaster medicine service at the regional level, the functions and powers of the daily management body of the disaster medicine service and the whole disaster medicine service of the subject must be carried out in full. It should be noted that the recommended organizational structure is presented in Appendix No. 9 to the Procedure of organization and rendering of medical aid by the All-Russian Disaster Medicine Service in emergencies, including medical evacuation, approved by the order of the Ministry of Health of Russia from 06.11.2020 No. 1202n.

In 2021, the efforts of regional-level specialists were largely focused on the fight against the new coronavirus infection COVID-19. Territorial and Regional Disaster Medicine Centers were involved in solving various organizational, methodological and therapeutic-diagnostic issues, organizing and conducting medical evacuation of patients with COVID-19. The specialists of the Federal

Center took an active part in this work and provided the formation and coordination of 43 mobile multidisciplinary teams from the staff of federal medical organizations. These teams worked in the republics of Buryatia, Dagestan, Kalmykia, Karelia, Crimea, Sakha (Yakutia), North Ossetia-Alania, Tyva, Khakassia, in the Chechen Republic, in Zabaikalsky, Krasnoyarsky, Perm and Khabarovsk territories, Arkhangelsk, Astrakhan, Vladimir, Volgograd, Irkutsk, Kurgan, Magadan, Novgorod, Orenburg, Pskov, Rostov, Sakhalin, Tambov, Tula, Tyumen, and Chelyabinsk regions.

The teams were staffed with 259 medical specialists, including 226 specialist physicians and 33 mid-level medical staff.

In 2021, the Federal Center specialists were actively involved in the work of the reserve Federal remote consulting center of anesthesiology and intensive care on the diagnosis and treatment of the new coronavirus infection COVID-19 and pneumonias. Employees of the center received 1,537 telephone calls from citizens and organizations providing medical care to patients with the new COVID-19 coronavirus infection.

Every day, the Department of Digital Development and Information Technology of the Russian Ministry of Health submitted a report on the work of federal remote advisory centers for anesthesiology and intensive care on the diagnosis and treatment of the new COVID-19 coronavirus infection and pneumonia in adults, children and pregnant women.

In 2021, in order to train specialists of the Russian Ministry of Health's Disaster Medicine Service, the Federal Center staff conducted tactical-special and command-staff exercises and staff trainings with management bodies, formations and institutions of the federal and regional levels, as well as international command-staff exercises with participation of representatives of the CIS member states and the People's Republic of China.

On April 13-15, 2021 within the framework of the All-Russian staff-command exercises the Center specialists worked through the issues of providing accident-free floods passage, as well as protection of settlements, economic objects and social infrastructure from natural fires. All received signals were processed in the prescribed manner, the notification scheme of the executive staff was checked, 191 operative reports of 39 entities with decisions on drill induction were received and processed.

Specialists of the Crisis Management Center of the Federal Disaster Medicine Center, together with specialists of the Moscow region territorial disaster medicine center worked on the solution of operational tasks for the three introductory scenarios relating to the passage of the complex adverse weather phenomena and disconnection of water and electricity supply in socially important facilities, including medical care organizations, in the Moscow region with subsequent hearing in a video conferencing mode and broadcast for visitors and participants of the XIII International Salon "Integrated Safety and Security".

Employees of the Federal Center participated in the preparation and provision of methodological assistance to the participants in the Interagency Experimental and Research Exercise in the Arctic Zone of the Russian Federation, held by the Ministry of Emergency Situations of Russia in September 2021.

On September 26, 2021, an interregional interdepartmental exercise on improving medical care to victims of road accidents on the administrative border of the Tula and Orel Regions and their border areas was held.

On December 15, 2021 within the framework of the field evaluation of the condition and readiness of the Ryazan region forces and means to respond in emergencies, an emergency drill "Organization of liquidation of medical and sanitary consequences of man-made emergencies (accident with a bus) with a large number of victims" was held. During the exercise, the algorithm of response of the regional and federal level disaster medicine service to an emergency caused by a road traffic accident was practiced.

In 2021 with the participation of the Federal center specialists all-Russian conferences were organized and conducted: in March — the online conference "Teaching First Aid in Life Safety Course: New Textbooks and Contemporary Recommendations", which was attended by more than 800 registered users from many regions; in October — the All-Russian scientific and practical conference with international participation "First Aid — 2021" and a master class at the VIII All-Russian interdisciplinary scientific and practical conference "Socially significant and extremely dangerous infectious diseases"; in December, within the framework of the scientific and practical forum "Russian Health Care Week - 2021", together with the Moscow Territorial Center for Disaster Medicine — "First Aid and Disaster Medicine" section.

Since March, 1, 2021 the specialists of the Federal Center worked on cooperation with WHO, CIS countries and People's Republic of China, making the following: interaction with profile departments of the Ministry of Health of Russia; informing — through the Ministry of Health of Russia — WHO, profile State Committee of the People's Republic of China, Executive Committee of CIS.

To execute the point 7 of the protocol of XXXIV session of the Council for Cooperation in the field of Public Health of the CIS countries the Federal Center with the support of the Ministry of Health of Russia and the CIS Executive committee held 2 international events — a web conference and a command-staff exercise on November 25-26, 2021.

On November 25, 2021, the Federal Center staff organized an international web conference "Medical Response to Biosocial Emergencies (outbreaks of infectious diseases)". The conference was attended by specialists from the Central Office of the Russian Ministry of Health, Federal Center, chief freelance specialists of the Russian Ministry of Health for Disaster Medicine and Infectious Diseases, representatives of Rospotrebnadzor, FMBA of Russia, CIS Executive Committee, CIS member states (Republics of Armenia, Belarus, Uzbekistan, Moldova, Kyrgyz Republic), China, Russian Red Cross, territorial and regional disaster medicine centers of the subjects of the Russian Federation.

"Organization of medical assistance and medical evacuation of victims in case of emergency of biosocial nature (outbreak of infectious disease)" event was organized and conducted on November 26, 2021. At this event, reports were presented by specialists from the Federal Center and regional disaster medicine center of Tula region, Shanghai Eastern Hospital and specialized agencies from the Republic of Armenia and the Republic of Belarus.

It should be noted that the specialists of the Federal Center together with staff from other departments of N.I. Pirogov Institute of the Russian Ministry of Health did a lot of work to prepare for the move of the federal disaster medicine service to a new base, to equip its departments with modern equipment and transport, which will signifi-

cantly increase its technological capabilities to solve current and future problems.

Conclusion

The analysis of the results of the activities of the Disaster Medicine Service of the Russian Ministry of Health at federal and regional levels allows us to state that the tasks set for it in 2021 have generally been accomplished. In the reporting period, the Russian Ministry of Health Disaster Medicine Service carried out its activities under difficult conditions associated with the spread of the new coronavirus infection COVID-19, as well as with organizational and functional changes in the management bodies at the federal level and in a number of subjects of the Russian Federation.

In 2022, the Federal Center and Disaster Medicine Service of the Russian Ministry of Health will work in the following main areas:

- Improvement of the regulatory legal and methodological framework at the federal and regional levels;
- organization and rendering of medical aid, medical evacuation of victims in emergencies, taking into account the three-level system of medical aid at the regional level, involving, if necessary, federal medical organizations;
- organization and monitoring of emergency medical care in pre-hospital and hospital periods to patients and victims of emergencies, including usage of telemedicine technologies, in various modes of operation;
- information and technological development of the Disaster Medicine Service of the Russian Ministry of Health, introduction of a system of emergency response based on incident management;

- formation and implementation of algorithms for response of the Disaster Medicine Service of the Russian Ministry of Health and medical organizations to various emergencies;

- updating the system of forecasting and monitoring medical and sanitary consequences of emergencies;
- development of outreach forms of medical care, including the system of emergency consultative medical care and medical evacuation (air ambulance);
- improvement of the structure and activities of Disaster Medicine Service at regional and federal levels; control of the performance by the territorial and regional disaster medicine centers;
- conducting operational training activities with the management bodies, organizations and formations of the Ministry of Health of the Russian Federation and medical organizations involved in the provision of medical care to victims of emergencies, on the issues of emergency response preparedness;
- training of managers and specialists of the management bodies, organizations and formations of the Ministry of Health of the Russian Federation Disaster Medicine Service and medical organizations on the issues of disaster medicine;
- development and implementation of measures aimed at improving the first aid system;
- organization of work on the effective functioning of the reserve of medical resources of the health management body of the subject of the Russian Federation in the event of an emergency.

REFERENCES

1. Goncharov S.F., Bobiy B.V., Akin'shin A.V. Service for Disaster Medicine of Ministry of Health of Russian Federation: Main Results of Activities in 2019 and Tasks for 2020. Message 1. *Meditsina Katastrof* = Disaster Medicine. 2020; 1: 15-27 (In Russ.). <https://doi.org/10.33266/2070-1004-2020-1-15-27>
2. Goncharov S.F., Bystrov M.V. The Ministry of Health's Disaster Medicine Service in the System of Organizing and Providing Emergency Medical Care to the Population, Taking into Account the Development of the Country's Health. *Prioritetnye Napravleniya Razvitiya Vserossiyskoy Sluzhby Meditsiny Katastrof v Sovremennykh Usloviyakh* = Priorities for the Development of the All-Russian Disaster Medicine Service in Modern Conditions: Materials of the All-Russian Scientific and Practical Conference. Moscow, VTSMK Zashchita Publ., 2019. Pp. 42–46 (In Russ.).
3. Popov V.P., Rogozhina L.P., Medvedeva E.V. Evaluation of the Preparedness of Territorial Centers of Disaster Medicine for the Elimination of Medical and Sanitary Effects of Emergency Situations. *Meditsina Katastrof* = Disaster Medicine. 2018; 3: 14-17 (In Russ.).
4. Baranova N.N. Information Technology in the Monitoring System Translocator - Medical Evacuation of Victims in Emergency Situations. *Prioritetnye Napravleniya Razvitiya Vserossiyskoy Sluzhby Meditsiny Katastrof v Sovremennykh Usloviyakh* = Priorities for the Development of the All-Russian Disaster Medicine Service in Modern Conditions: Materials of the All-Russian Scientific and Practical Conference. Moscow, VTSMK Zashchita Publ., 2019. Pp. 14–15 (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. Гончаров С.Ф., Бобий Б.В., Акиншин А.В. Служба медицины катастроф Минздрава России: основные итоги деятельности в 2019 г. и задачи на 2020 г. // *Медицина катастроф*. 2020. № 1. С. 15–27. <https://doi.org/10.33266/2070-1004-2020-1-15-27>
2. Гончаров С.Ф., Быстров М.В. Служба медицины катастроф Минздрава России в системе организации и оказания экстренной медицинской помощи населению с учетом развития здравоохранения страны // *Приоритетные направления развития Всероссийской службы медицины катастроф в современных условиях: Материалы Всероссийской научно-практической конференции*. М.: ФГБУ ВЦМК «Защита», 2019. С. 42–46.
3. Попов В.П., Рогожина Л.П., Медведева Е.В. Оценка готовности территориальных центров медицины катастроф к ликвидации медико-санитарных последствий чрезвычайных ситуаций // *Медицина катастроф*. 2018. №3. С. 14–17.
4. Баранова Н.Н. Информационные технологии в системе мониторинга медицинской эвакуации пострадавших при чрезвычайных ситуациях // *Приоритетные направления развития Всероссийской службы медицины катастроф в современных условиях: Материалы Всероссийской научно-практической конференции*. М.: ФГБУ ВЦМК «Защита», 2019. С. 14–15.

Материал поступил в редакцию 28.02.22; статья принята после рецензирования 11.03.22; статья принята к публикации 21.03.22
The material was received 28.02.22; the article after peer review procedure 11.03.22; the Editorial Board accepted the article for publication 21.03.22

STANDARD OPTIONS FOR CREATING A GROUPING OF MEDICAL FORCES AND MEANS IN THE ORGANIZATION OF MEDICAL AND EVACUATION SUPPORT FOR THE VICTIMS OF A TERRORIST ATTACK

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Abstract. *The objectives of the study are:* to analyze the experience of organizing medical assistance and medical evacuation of victims during terrorist acts committed with the use of conventional means of destruction; to determine standard options for creating a group of medical forces and means, their possible composition and the main tasks to be solved in the implementation of medical and evacuation support.

Materials and research methods. Materials of the research: normative and methodical documents regulating the order of medical aid rendering and carrying out medical evacuation of wounded at acts of terrorism; reports of territorial disaster medicine centers on liquidation of medical and sanitary consequences of acts of terrorism classified as emergencies; data of expert evaluation maps on the research theme; scientific works and publications devoted to the organization of medical aid rendering and of carrying out medical evacuation.

The following scientific methods were applied: content-analysis, expert estimation, logic and information modeling, analytical method.

Research results and their analysis. The results of the study of the basic principles of creating a grouping of medical forces and means intended to provide medical assistance and evacuation of victims of terrorist acts with the use of conventional means of destruction are presented.

Substantiated propositions on creation of standard variants of echelon grouping of medical forces and means at liquidation of medical and sanitary consequences of terrorist acts were made; composition of medical forces and means, included in each echelon of the grouping, and their main tasks were defined.

The results of the research have shown that medical organizers and specialists of the Disaster Medicine Service of the Russian Ministry of Health experience difficulties when creating and determining the order of functioning of a group of medical forces and means involved in medical and evacuation support of injured, especially during large-scale terrorist attacks. It is conditioned by: insufficient knowledge of peculiarities of modern terrorist acts and of factors, influencing the organization of medical aid and medical evacuation; insufficient practical experience of medical specialists; shortcomings in generalization of experience of public health management bodies, medical organizations and formations, participating in liquidation of consequences of such emergency situations; imperfection of normative and methodical base.

Key words: *echelon of medical forces and means, emergencies, grouping of medical forces and facilities, medical and evacuation support, medical formations, medical organizations, public health authorities, regional centers of emergency and disaster medicine, system of organization of medical aid and medical evacuation, territorial disaster medicine centers, terrorist acts, victims*

Conflict of interest. The authors declare no conflict of interest

For citation: Titov I.G., Goncharov S.F., Bobiy B.V., Akinshin A.V. Standard Options for Creating a Grouping of Medical Forces and Means in the Organization of Medical and Evacuation Support for the Victims of a Terrorist Attack. *Meditsina Katastrof = Disaster Medicine.* 2022;1:20-30 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-20-30>

ТИПОВЫЕ ВАРИАНТЫ СОЗДАНИЯ ГРУППИРОВКИ МЕДИЦИНСКИХ СИЛ И СРЕДСТВ ПРИ ОРГАНИЗАЦИИ ЛЕЧЕБНО-ЭВАКУАЦИОННОГО ОБЕСПЕЧЕНИЯ ПОРАЖЁННЫХ В РЕЗУЛЬТАТЕ ТЕРРОРИСТИЧЕСКОГО АКТА

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Резюме. *Цели исследования –* изучить и проанализировать опыт организации оказания медицинской помощи и проведения медицинской эвакуации пораженных при террористических актах (терактах), совершенных с применением обычных средств поражения; определить типовые варианты создаваемой группировки медицинских сил и средств, их возможный состав и основные задачи, решаемые при осуществлении лечебно-эвакуационного обеспечения пораженных. *Материалы и методы исследования.* Материалы исследования: нормативные и методические документы, регламентирующие порядок оказания медицинской помощи и проведения медицинской эвакуации пораженных при террористических актах; донесения и отчеты территориальных центров медицины катастроф (ТЦМК) о ликвидации медико-санитарных последствий терактов, классифицируемых как чрезвычайные ситуации (ЧС); данные карт экспертной оценки по теме исследования; научные работы и публикации, посвященные организационным технологиям оказания медицинской помощи и проведения медицинской эвакуации пораженных при терактах.

При выполнении исследования применялись следующие научные методы: метод контент-анализа, метод экспертной оценки, логическое и информационное моделирование, аналитический метод.

Результаты исследования и их анализ. Представлены результаты исследования основных принципов создания группировки медицинских сил и средств, предназначенной для оказания медицинской помощи и проведения медицинской эвакуации пораженных при террористических актах с применением обычных средств поражения.

Внесены обоснованные предложения по созданию типовых вариантов эшелонированной группировки медицинских сил и средств при ликвидации медико-санитарных последствий терактов; определены состав медицинских сил и средств, входящих в каждый эшелон группировки, и возлагаемые на них основные задачи.

Результаты исследования показали, что врачи-организаторы и специалисты Службы медицины катастроф (СМК) Минздрава России часто испытывают затруднения при создании и определении порядка функционирования группировки медицинских сил и средств, привлекаемой для лечебно-эвакуационного обеспечения пораженных, особенно – при крупномасштабных терактах. Это обусловлено: недостаточным знанием особенностей совершения современных терактов и действующих при этом факторов, влияющих на организацию оказания медицинской помощи и проведения медицинской эвакуации; отсутствием достаточного практического опыта у соответствующих медицинских специалистов; недостатками в обобщении опыта работы органов управления здравоохранением, медицинских организаций и формирований, участвовавших в ликвидации последствий таких ЧС; несовершенством нормативной и методической базы по исследуемому вопросу.

Ключевые слова: группировка медицинских сил и средств, лечебно-эвакуационное обеспечение, лечебные медицинские организации, медицинские формирования, органы управления здравоохранением, пораженные, региональные центры скорой медицинской помощи и медицины катастроф, система организации оказания медицинской помощи и проведения медицинской эвакуации, территориальные центры медицины катастроф, террористические акты, чрезвычайные ситуации, эшелон медицинских сил и средств

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Титов И.Г., Гончаров С.Ф., Бобий Б.В., Акиншин А.В. Типовые варианты создания группировки медицинских сил и средств при организации лечебно-эвакуационного обеспечения пораженных в результате террористического акта // Медицина катастроф. 2022. №1. С. 20-30. <https://doi.org/10.33266/2070-1004-2022-1-20-30>

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The experience of liquidation of medical and sanitary consequences of acts of terrorism, especially of those accompanied by a great number of wounded, by capture and detention of hostages with the threat to their lives; the contents of the scientific works and publications devoted to the organization of medical aid and medical evacuation of the wounded during the attacks show that one of the first-rate organization measures is the determination or specification (if it was done beforehand based on the forecasted data) of the medical care and evacuation of the wounded.

The following must be taken into account: the number and structure of the wounded; the location of medical treatment facilities, especially hospitals, and their ability to provide medical aid to the wounded, to deal with traumas and diseases; number and location of: mobile medical formations, ambulance teams and the Disaster Medicine Service; number and condition of medical evacuation routes from the emergency area (a list of means of transportation, medical evacuation, and location of the medical evacuation routes).

In connection with the stated above attention should be paid to the fact that the officials, making decisions on the liquidation of medical and sanitary consequences of terrorist acts, and the specialists of Disaster Medicine Service developing proposals to support such decisions, must be competent and trained professionally and methodologically in the issues of creating an appropriate group of medical forces and means. Compliance with this requirement is also due to the fact that as a rule, terrorist acts result in rapid emergencies, rate of spread of which often does not allow to give an adequate assessment of the situation and in which a high-preparedness mode is not introduced. It is known that within the time frame of this mode of operation

there should be opportunities for some kind of preparatory activities.

The study and analysis of normative and methodological documents of the Ministry of Health of Russia, scientific works and other literature sources have shown that so far that there is practically no scientifically described and systematized technology of creating a group of medical forces and means and definition of tasks assigned to it during the implementation of complex medical and evacuation measures to liquidate medical and sanitary consequences of terrorist attacks^{1,2}.

These circumstances required a scientific study, using the method of retrospective analysis, of topical issues of the technology of creation and functioning of a group of medical forces and facilities designed to save lives and preserve health of victims of terrorist attacks.

The above emphasizes the relevance of the results of the study presented in this article and their relevance to practical health care.

At first glance it may seem that the article is overloaded with information. However, from the methodological point of view, it is done intentionally in order to give a more complete description of the system of possible options for grouping medical forces and facilities, to define their typical tasks and composition, which, in the authors' opinion, will eventually contribute to a more objective understanding of the

¹ Procedure for the organization and provision of medical aid in emergency situations, including medical evacuation by the All-Russian Disaster Medicine Service of: Approved by Order of the Ministry of Health of the Russian Federation of November 6, 2020, No. 1202n

² Procedure for the provision of emergency, including specialized emergency medical care: Approved by Order of the Ministry of Health of Russia from June 20, 2013 No. 388n

organization of medical and evacuation support of the victims of terrorist attacks.

The authors understand that the presented typical variants of the grouping of medical forces and means will not always fully correspond to such groupings created in practice, because the grouping elements and tasks of its echelons will largely depend on the number and structure of the contingent of the injured, on specific conditions affecting the organization of their medical and evacuation support.

We consider it necessary to draw attention of specialists in disaster medicine to the fact that the concept of "creation of group of medical forces and means" should not be understood literally — as the creation of new medical organizations and formations. It concerns mainly the existing and functioning in the real situation specific formations and subdivisions, public health authorities and other medical organizations involved in the liquidation of medical and sanitary consequences of the terrorist attacks.

The aim of the study is to determine the typical variants of the created group of medical forces and means, their possible structure and the main tasks to be solved by the medical and evacuation support of the wounded by terrorist acts with the use of the conventional means of destruction on the basis of the study and analysis of the experience of medical aid organization and carrying out medical evacuation of the wounded.

Materials and research methods. Materials: normative and methodical documents regulating the organization of medical aid and medical evacuation of the wounded at acts of terrorism; reports and accounts of territorial centers of disaster medicine on liquidation of medical and sanitary consequences of acts of terrorism classified as emergencies; data of expert evaluation maps on the topic of research; scientific works and publications devoted to the organizational technologies of medical aid and medical evacuation of the wounded.

Research methods: content analysis method, method of expert estimation, logical and informational modeling and analytical method.

Research results and their analysis. The research of state of the problem question, concerning the order of creation and functioning of the grouping of medical forces of means, intended for rendering medical aid and carrying out medical evacuation of victims at acts of terrorism, first of all of large scale ones, has shown that quite often there are difficulties at its practical solution. In this regard, it became necessary to identify the causes of this situation. It turned out that this is connected mainly not only with the peculiarities of terrorist acts, with the conditions in which they were committed, and the factors influencing the organization of medical aid and the medical evacuation of the wounded, but also — to a large extent — with the lack of sufficient practical experience of specialists of health care administration, medical organizations and formations involved in the liquidation of medical and sanitary consequences of various terrorist acts, and shortcomings in its generalization.

To a certain extent, this situation is confirmed by the results of the examination of the regulatory and methodological documents on the organization of medical and evacuation support of the population affected by terrorist acts, which are in effect in healthcare as part of this study. The following results were obtained in the analysis of expert evaluations: 6.1% of experts believed that the cur-

rent official documents allow "fully" to organize medical and evacuation support; 72.3 — only "partially"; 15.9 — "do not allow"; 5.7% of experts found it difficult to give a specific assessment of the state of the regulatory and methodological base, which regulates such an important direction in healthcare activity.

The results of the assessment of the state of the regulatory and methodological framework on this issue indicate the need to take measures for its development and improvement, coordinated with the general set of activities carried out within the framework of counter-terrorism. In addition, such a provision obliges the heads of authorities and medical organizations to bring the provisions of these documents to the relevant medical specialists in a timely manner and monitor their knowledge.

Some scientific works and other sources have already discussed the issues of grouping medical forces and facilities in response to the medical and sanitary consequences of emergencies to a certain extent [5-8]. At the same time, there is reason to believe that some of the provisions set out in them do not sufficiently generalize the experience of the organization of medical care and the medical evacuation of the injured specifically in terrorist attacks, which does not create a holistic view of these issues and thereby does not allow more substantiated practical recommendations to be developed³⁻⁵.

It should be noted that in the normative, methodological and other documents of the Russian Ministry of Health the term "grouping of forces and means" is practically never used. At the same time, in other subsystems of the Unified State System of Emergency Prevention and Response, including the Ministry of Emergency Situations and the Ministry of Defense of Russia, this concept is used quite widely^{6,7}.

In view of this, we consider it necessary to give a definition of this concept in relation to medical forces and means. According to the authors, it is the most successful and complete and reflects its essence.

A group of medical forces and facilities should be understood as organizationally, functionally and territorially united in a particular system of various health care management bodies, medical units and formations, medical organizations involved to perform specific tasks of medical and evacuation support of the affected during a terrorist attack.

In the course of the study it was found that the creation of a group of medical forces and means should be initiated in advance based on the forecast of medical and sanitary consequences for stationary objects — railway stations, airports, shopping and cultural and entertainment centers, stadiums and other facilities where activities involving a large number of people, objects with a high risk of danger

³ Documents from the emergency situation with hostage-taking in the Palace of Culture "Nord-Ost" / Case No 11-04/20 VTSMC "Protection" of the Ministry of Health of the Russian Federation, 2002. 258 p.

⁴ Documents from the emergency situation, the terrorist act in Beslan / Case #11-04/21 "Zashchita" Disaster Medicine Center of the Ministry of Health of Russia, 2004. 522 p.

⁵ Documents on the emergency situation — the terrorist act in the Moscow metro / Case #11-04/53 VSMC "Protection" of the Ministry of Health of Russia, 2010. 155 p.

⁶ Grazhdanskaya Zashchita = Civil Protection. Encyclopedia in 4 volumes. Ed. Puchkov V.A. Vol. 1 (A-I). Moscow, FGBU VNII GO CHS(FTS) Publ. P. 391 (In Russ.).

⁷ Melnichenko P.I., Popov V.I. Entsiklopedicheskiy Slovar Voenno-Profilakticheskikh Terminov = Encyclopedic Dictionary of Military-Prophylactic Terms. Voronezh, Izdatel'stvo-Poligraficheskiy Tsentr "Nauchnaya Kniga" Publ., 2016. P. 140-141 (In Russ.).

to the population, etc., and then finally — in the decision to eliminate medical and sanitary consequences of the attack. Consequently, the grouping of medical forces and means should be created in relation to the specific emergency conditioned by an act of terrorism. This methodical approach should probably be seen as a necessary condition for creating a potentially and functionally stable system of medical and evacuation support for the victims of terrorist attacks.

The main conditions that affect the formation of such a grouping of medical forces and means are presented in the authors' article [9].

It should be emphasized that the determination of possible variants of creating a grouping of medical forces and means to eliminate the medical and sanitary consequences of terrorist acts will take place in the conditions of formation and functioning on the territory of subjects of the Russian Federation (hereinafter - subjects) of a three-tier system of organization of medical aid to population, medical districts, interregional medical centers and regional centers of emergency and disaster medicine — [10].

In the course of the study, the question naturally arose — what medical forces and facilities can be part of such a grouping? While studying and analyzing, using the method of expert evaluation, the experience of liquidation of medical and sanitary consequences of terrorist acts, especially large-scale ones, it was established that, except for medical treatment organizations, the created group of medical forces and means, a variant of the system of organization of medical aid and medical evacuation of victims of terrorist acts, should include first of all: EMTs; emergency response teams of the Regional Center of Emergency and Disaster Medicine.

From the results of the research and the content of the concept of "grouping of medical forces and facilities" it is clear that its elements may have unequal, even intradepartmental (Ministry of Health of Russia) affiliation — include forces and facilities not only of the regional and federal level health care, but also subordinate to other fed-

eral bodies of executive power (Table). For example, during the terrorist attack in the St. Petersburg metro (2017) almost 20.0% of the injured, who needed medical care in hospital conditions, were sent to the clinic of the S.M. Kirov Military Medical Academy of the Ministry of Health of the Russian Federation [11].

Such cases of liquidation of the consequences of terrorist attacks require a clear organization of dispatching the wounded, interagency cooperation (military-civilian cooperation) and coordination of medical forces and means involved in providing medical assistance and conducting the medical evacuation of the wounded.

Apparently, we can agree that in order to study, to analyze the results of the study and to clearly distinguish the location and deployment of medical forces and means involved in the elimination of the medical and sanitary consequences of terrorist acts; for their purpose and procedure of application, it is appropriate to use the term "echeloned grouping of medical forces and means".

Obviously, in this case, the concepts of "echelon" and "grouping" of medical forces and means, located on a separate territory (area) and designed to solve the specific tasks, coincide in essence. At the same time, it does not exclude the expediency of introducing the concept of "echelon", which implies the presence of a unified holistic (multilevel) health care system, carrying out the liquidation of medical and sanitary consequences of a single terrorist attack.

The study of the experience of liquidation of medical and sanitary consequences of the terrorist attacks showed that during the organization of the medical care for the affected people the medical care was provided by the specialists of the EMT and Disaster Medicine teams, including the Field Multidisciplinary Hospital of the "Zaschita" All-Russian Disaster Medicine Center, teams of the regional and federal level. Consequently, the creation of the system should be based on the availability of various options for the use of medical forces and facilities included in the medical constellation.

Таблица / Table

Распределение пораженных при теракте в метро по лечебным медицинским организациям Санкт-Петербурга (2017) – [18]

Distribution of injured in the subway terrorist attack among medical treatment organizations in St. Petersburg (2017) – [18]

Травмоцентр / Trauma center	Расстояние от места теракта до ЛМО, км / Distance from the place of the terrorist attack to the medical treatment organisation, km	Число пораженных, поступивших в ЛМО, чел. / Number of affected admitted to the medical treatment organisation, people.	в том числе пораженных в тяжелом состоянии / including those in severe condition
Городская Мариинская больница / Mariinskaya City Hospital	3,0	11	3
Детский городской многопрофильный клинический центр высоких медицинских технологий им. К.А.Раухфуса / Children's City Multidisciplinary Clinical Center of High Medical Technologies named after K.A. Rauchfuss	3,7	1	–
Военно-медицинская академия им. С.М.Кирова Минобороны России / Military Medical Academy named after S.M.Kirov of the Ministry of Defense of Russia	5,8	7	3
НИИ скорой помощи им. И.И.Джанелидзе / I.I.Dzhanelidze Research Institute of Emergency Medicine	7,0	14	4
Городская больница №26 / City Hospital No. 26	8,6	3	–
Всего / Total		36	10

On the basis of the results of the research of the issues of the methodology of the creation of the grouping of medical forces and means, 3 main variants of the grouping were developed in relation to the organization of the liquidation of medical and sanitary consequences of terrorist acts, which are to a great extent typical. The main criteria determining the creation of this or that typical variant of grouping are: the place of the terrorist attack — within a large city; in a suburban area — at a distance of 100 km from the city; at a considerable distance from medical organisations of the 2nd and 3rd levels or in rural areas; the number of casualties requiring, first of all, medical care in hospital conditions; the structure of the casualty contingent, the capability of medical organisations of the region where the attack has occurred, to provide medical care, treatment and medical evacuation of the casualties.

In studying the procedure for liquidating the medical and sanitary consequences of terrorist attacks it was found that if as a result of such emergencies there is a significant number of victims (as a rule — more than 150), in need of specialized, including high-tech, medical care in hospital, medical organisations often not able to provide all the victims the necessary medical care in full in optimal time and to provide complete treatment. Therefore, in order to eliminate the medical and sanitary consequences of such a terrorist attack, it is necessary to create an appropriate version of the group with the involvement of medical forces and means not only of the regional, but also of the federal level of healthcare with a certain number of elements and echelons included in its composition.

In the course of this study such a variant of grouping of medical forces and means was developed in relation to a large-scale terrorist act (explosion of a house, hotel, administrative building, cultural or shopping center, stadium, transport vehicle — passenger train, plane, bus — located at a considerable distance from the medical organisation of the 1st — 3rd level, etc.) or terrorist act with a great number of hostages and a threat to their lives and possibility of operation of mobile medical forces in the focus (on the border of the focus) of emergency (Fig. 1). The terrorist act of capturing and keeping hostages in Beslan is a convincing evidence of the possibility of committing such terrorist acts and creating a group of medical forces and means for liquidating their medical and sanitary consequences (Fig. 2). As a rule, to eliminate the medical and sanitary consequences of such terrorist acts requires quite a long time, which will be spent on searching for and releasing injured people from under rubble, collapsed buildings, damaged vehicles, and negotiating with terrorists who have taken hostages.

The first echelon of this grouping of medical forces and means is located within the area/area of the terrorist attack. Its typical composition is advisable to include: ambulance and emergency medical teams; a task force of specialists from the regional health authority, regional or territorial centers of disaster medicine; ambulances (reanimobiles) and other vehicles; medical stations, including a point (office or equipped room) for medical and psychological assistance. In addition, in some cases the first echelon of the group may include a mobile medical unit, an aviation mobile medical complex; a task force of the Ministry of Health of Russia.

Attention should be paid to the following requirement, which must be met in the first echelon of medical forces and

means — in the area of a large-scale terrorist attack it is necessary to have an additional fund of medical stretchers and — depending on the air temperature — means for warming the injured (blankets, sleeping bags, etc.), which are acquired and stored in advance in the property reserve at the emergency rescue organizations of the Ministry of Emergency of Russia, designed for emergency response, and are delivered to the emergency zone.

The analysis of real work of medical specialists during liquidation of consequences of terrorist acts, scientific works and publications on the problem under study, as well as the results of modeling of organization of medical aid rendering and carrying out of medical evacuation of the injured during solution of thematic situation tasks and trainings with virtual usage of forces and means of health-care, included into the first echelon of the group, allowed to formulate the following main tasks, which are advisable to entrust the forces and means of this echelon

- organizing and conducting medical triage of the wounded in order to identify those in need of emergency medical assistance provided in the area of the terrorist attack;

- determining the procedure for medical evacuation (the order of evacuation, destination medical organisation, type of transport and method of evacuation);

- providing emergency medical assistance to the wounded — mainly in an emergency form — and preparing them for medical evacuation to the medical organisation;

- medical evacuation of casualties from the terrorist attack zone to the medical organisation, in accordance with the principles of routing and taking into account the medical and tactical situation and the functioning system for organizing the medical evacuation of casualties requiring hospital care;

- providing medical assistance to members of emergency teams involved in the response to the terrorist attack;

- medical and psychological assistance to the wounded, participants in rescue operations and others;

- coordinate the activities of medical teams and mobile medical formations working in the terrorist attack zone/area;

- control over the arrival and activities of mobile medical formations, medical teams working in the terrorist attack zone, carried out by the operational management team;

- presenting information on the health situation in the terrorist attack zone/area to the appropriate medical institutions by the command and control unit;

- interaction with management bodies, subdivisions and formations of other ministries, services and organizations acting as part of the first echelon of the overall group of forces and means involved in the response to the terrorist attack, to agree on joint activities to ensure timely medical assistance and the medical evacuation of the injured from the terrorist attack zone/area to medical treatment organizations (trauma centers).

As the results of the study have shown, the second echelon of the grouping should mainly include: regional medical organisations of the 1st — 3rd level, including trauma centers involved in the elimination of medical and sanitary consequences of a terrorist attack, as well as federal medical treatment organizations, stationed on the territory of the region; teams of specialized medical care of regional and federal level medical organisations; clinics; regional emergency and disaster medicine centers; sanitary transport,

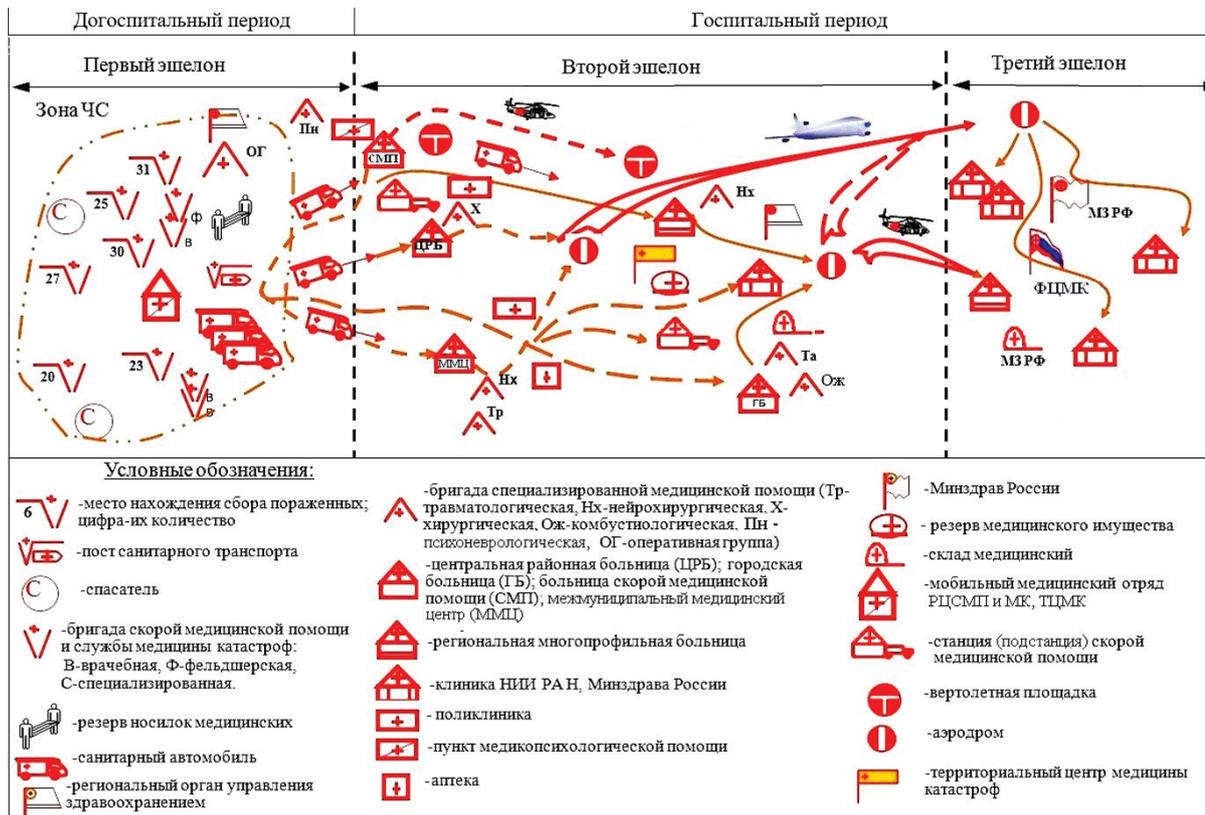


Рис. 1. Принципиальная схема организации лечебно-эвакуационного обеспечения пораженных в результате крупномасштабного теракта с применением обычных средств поражения
Fig. 1. Principle scheme of organization of medical evacuation support of the wounded in a large-scale terrorist attack with the use of conventional means of destruction

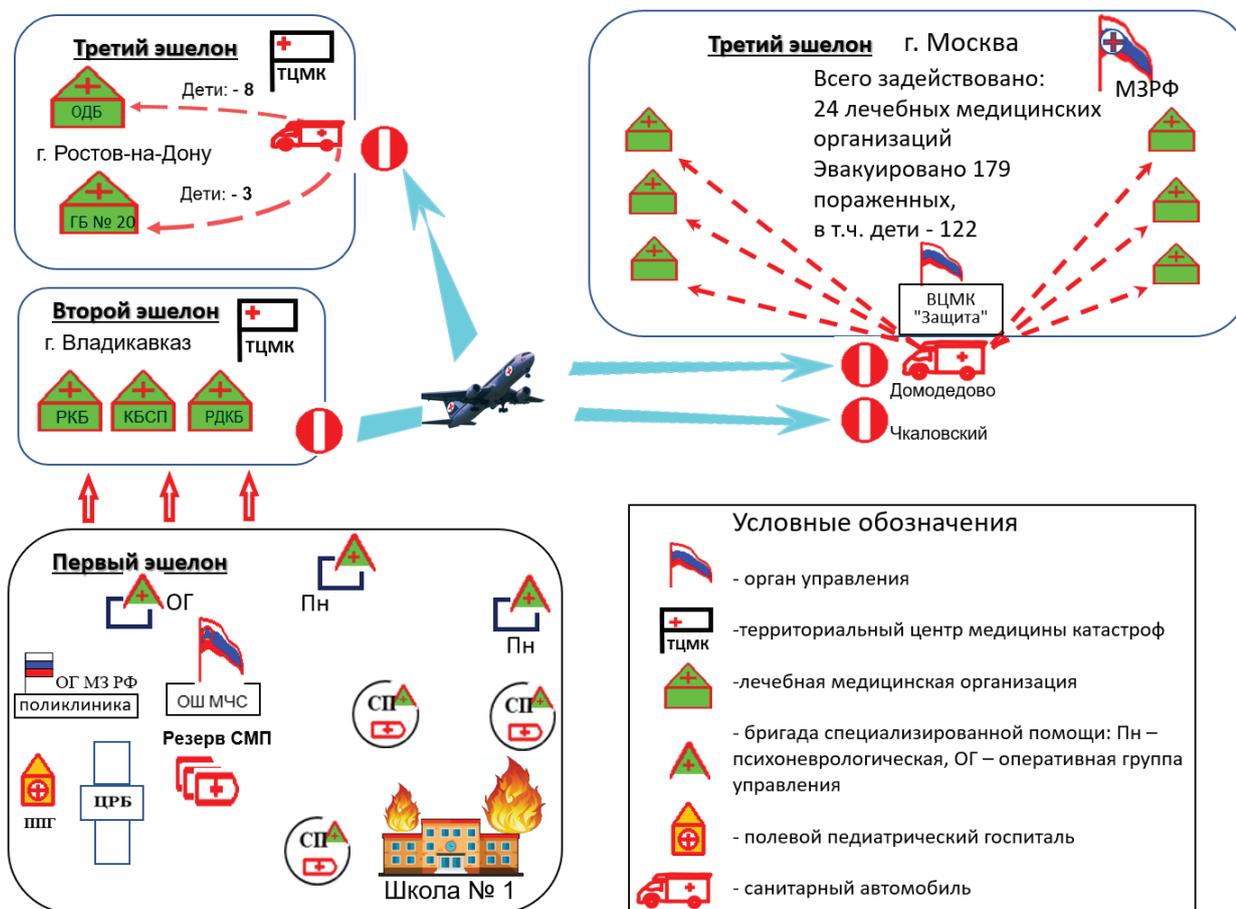


Рис. 2. Схема лечебно-эвакуационного обеспечения пораженных в результате террористического акта в г. Беслане (на 11 сентября 2004 г.)
Fig. 2. Scheme of medical evacuation support of the wounded in the act of terrorism in Beslan (as of September 11, 2004).

including sanitary and aviation, means, reserve of medicines.

It is reasonable to assign the following most important tasks for elimination of medical and sanitary consequences of terrorist attacks to the specialists of medical organizations of the second echelon, as evidenced by the results of the study:

- clarification (development) of the plan of medical and evacuation support of the victims of the terrorist attack;
- provision of specialized, including high-tech, medical care, as well as, in some cases, emergency medical care, including specialized emergency medical care, during the admission of the wounded and primary medical care for those in need of outpatient treatment;
- selection and referral to federal medical treatment centers (organizations) and medical organisations in other regions for treatment of patients with the most complex pathologies;
- coordination of issues concerning the order of referral and medical evacuation of the wounded to regional and federal medical treatment organizations;
- organization of inter-hospital transfers of the injured; preparation of the injured for medical evacuation and its implementation;
- selection and deployment of medical specialists to work in medical organisations involved in the elimination of the medical and sanitary consequences of the terrorist attack;
- organization and implementation of uninterrupted supply of medicines and necessary medical equipment to medical formations, units and organizations of the first and second echelons, providing medical assistance and carrying out medical evacuation of the wounded;
- management of medical organizations, subdivisions and formations called in to provide medical assistance and the medical evacuation of the wounded, and also the coordination of the activities of specialized medical assistance teams from federal medical treatment organizations arriving and working on the basis of hospital facilities;
- interaction with the relevant regional and territorial administrations of the Federal Security Service, the Ministry of Internal Affairs, the Ministry of Emergency Situations and the Ministry of Defense and with other services and organizations involved in the response to the terrorist act in order to provide timely medical assistance and medical evacuation of the wounded.

A specific feature of the grouping of medical forces and means of the first and second echelons is that they are territorially located within the borders of the subject where the terrorist attack took place. Thus, medical organizations and health care of the region as a whole bear the main load and responsibility for elimination of medical and sanitary consequences of the terrorist attack. Consequently, such an organizational decision to implement medical support of the victims of the terrorist attack fully complies with the provisions specifying responsibility and order of liquidation of the emergency consequences, which were regulated by the Government Decree of the Russian Federation dated December 30, 2003 No. 794⁸.

⁸ On the Unified State System of Prevention and Liquidation of Emergency Situations. The Decree of the Government of the Russian Federation dated December 30, 2003, No. 794 (as amended on 26.01.2017) (In Russ.).

An analysis of the experience of organizing medical and evacuation support for the victims of large-scale emergencies caused by terrorist attacks suggests that the group of medical forces and facilities often has to create a third echelon, which is represented mainly by medical organisations of the federal level [8]. This echelon, as a rule, includes: multidisciplinary and specialized medical organisations, medical centers and research organizations with clinics subordinated to the Ministry of Health of Russia and the RAS; reserve of specialized beds, located in the above medical organisations; reserve of medical equipment of the Ministry of Health of Russia for emergency response; Federal Medical Center of the Federal State Budgetary Institution N.I. Pirogov Medical and Surgical Center; Federal Medical Center for Emergency Medicine; Russian Ministry of Health (Commission for Emergency Prevention and Response and Fire Safety) and, if necessary, other federal medical organizations. In addition, in some cases the third echelon may include multidisciplinary or specialized medical organisations located on the territory of neighboring subjects [8]. Thus, during the elimination of the medical and sanitary consequences of the terrorist attack in Beslan (2004), 11 victims (all children) were evacuated by air to Rostov-on-Don.

The study analyzed and summarized the experience of federal medical treatment organizations and public health authorities in organizing and providing medical care and medical evacuation of the wounded during the liquidation of, first of all, large-scale terrorist attacks. The results obtained made it possible to formulate the main tasks to be performed by the third echelon of medical forces and means:

- provision of specialized, including high-tech, medical care to the injured with the most complex pathology (wounds, combined trauma and polytrauma);
- selection and dispatching of the operative management group, mobile medical formations and individual specialists from federal health care authorities, from N.I. Pirogov Federal Medical and Surgical Center and medical treatment organizations subordinate to the Russian Ministry of Health and the RAS to work in the medical and evacuation support for the injured, functioning within the territory of the region where the terrorist attack took place;
- participation in the selection of patients in need of specialized, including high-tech, medical care from among the wounded who are hospitalized in the region, for their transfer to federal medical organisations for treatment;
- organizing and conducting medical evacuation of the wounded — mainly by air transport — from medical organisations of the region to the federal medical treatment facilities (sometimes — to the regional medical organisations of other subjects);
- organizing the dispatch of the necessary medical equipment to ensure the uninterrupted operation of medical treatment organizations, medical formations, participating in the liquidation of the medical and sanitary consequences of the terrorist attack;
- Ministry of Health and N.I. Pirogov Federal Medical and Surgical Center as authorized to manage and coordinate the activities of mobile medical teams, medical treatment teams, and other medical organizations involved in the medical care and medical evacuation of the victims of the terrorist attack;

- organization of interaction with federal executive bodies, management bodies of the subsystems taking part in the response to the terrorist attack, in order to effectively implement measures of medical treatment of the wounded.

As can be seen, a significant part of the tasks performed by this echelon of the group does not belong to the category of managerial tasks alone.

The results of the study showed that almost all (98.7%) experts were in full agreement with the proposals on the composition and tasks assigned to the corresponding echelons of the standard versions of the grouping of medical forces and means created to provide medical aid and conduct medical evacuation of the injured in acts of terrorism. Only 1.3% of the experts had difficulty formulating a specific conclusion on these problematic issues. It turned out that these experts included medical specialists who were either not involved in, or had little experience in, organizing the medical and sanitary consequences of emergencies, including terrorist attacks. At the same time, as a rule, they had little experience in the health care management bodies, in the service of the emergency medical services. This situation, naturally, requires appropriate measures to improve the professional training of these persons in disaster medicine.

During the study it was found that the above described variant of the system (scheme) of organization of medical care in large-scale terrorist attacks as applied to such cities as Moscow and St. Petersburg, where there are head and large medical organisations, centers subordinated to city health care, as well as federal medical treatment facilities (clinics, centers, research institutes, including RAS), in which specialized, including high-tech, medical care is provided, can hardly be considered typical. This provision has been repeatedly confirmed by the practice of eliminating the medical and sanitary consequences of such terrorist attacks as Nord-Ost (Moscow, 2002), in the St. Petersburg metro (2017), and at other sites in these cities - Fig. 3 [11].

In such cases, the system of medical care for victims of a terrorist attack may include a grouping of medical forces and means, consisting, as a rule, of two echelons (Fig. 4). The first echelon of such a grouping fully corresponds to the first echelon of the above-described version of the standard scheme of organization of the medical care. The situation with the second echelon of the grouping is quite different. It is represented by medical organisations, which, depending on their distance from the terrorist attack zone and their ability to provide the necessary medical care to the wounded in view of the available pathology, may be segregated and thus form separate echelons in the city. This solution for establishing and operating a grouping of medical forces and resources makes it possible, as a rule, to send the casualties in an extremely grave or serious condition to the nearest terrorist attack zone, and those in a moderately grave condition to more distant medical organisations. An important role is played by the organization and implementation of clear and continuous monitoring of: the number of casualties in the terrorist attack zone; the structure of the contingent of casualties and their need for medical care; the availability of free hospital beds of the required profile; the readiness of the medical organisations to receive and to provide medical care to the casualties; the routing of the casualties.

It should be noted that in the case of terrorist attacks in the above and some other cities (Nizhny Novgorod, Kazan, Yekaterinburg, Novosibirsk, etc.), where there is a developed network of medical organisations, which have great opportunities for providing specialized, including high-tech, medical care, the emergency medical services will have a high level of readiness and equipped with medical transport, including air ambulances, which creates more favorable conditions for the implementation of the routing principles of the affected. The affected people can be immediately sent to medical organisations, where, as a rule, they will be provided with comprehensive medical care and full treatment before the onset of the outcome. Consequently, the transfer of casualties from one medical treatment organization to another is unlikely, and inter-hospital medical evacuation is practically unnecessary due to the effective application of the above-mentioned monitoring and rapid preparation of hospital beds in the respective medical organisations.

At the given variant of organization of medical support, except medical treatment organizations, composition of the second echelon of group, as a rule, will include: center of disaster medicine, ambulance station; polyclinics; sanitary transport, including sanitary helicopter; reserve of medicines and medical equipment for liquidation of medical and sanitary consequences of emergency, contained at center of disaster medicine and in organizations of medical equipment supply; management body of city health care.

Depending on the situation, the second echelon of the grouping may also include other medical organizations.

It should be noted that in the event of terrorist attacks in these cities the system of medical and evacuation support for the wounded and, consequently, the grouping of medical forces and facilities will be located within one city (Moscow, St. Petersburg, etc.). Naturally, such a situation makes it possible to solve problems on forming a group of medical forces and means, on managing the involved medical organisations and medical formations, including more effective implementation of the necessary interaction, to achieve better results in saving lives and preserving the health of the affected people.

The study has shown that in terrorist acts accompanied by a small number of casualties in need of medical care in hospital, and if there is a regional health care system that is able to provide the necessary medical care to the casualties in full within the optimal time frame and their treatment based on the existing pathology, the basic scheme of the organization of the medical aid will be somewhat different than in large-scale acts of terrorism. In this regard, the composition of the created group of medical forces and means involved in the liquidation of medical and sanitary consequences of terrorist attacks will be mainly focused on the regional level of healthcare (Fig. 5).

It is necessary to pay attention to two principal provisions. The first is that the system of medical and evacuation support for the victims of such terrorist attacks is territorially located within the borders of a particular subject. The second is that the period of liquidation of medical and sanitary consequences of these terrorist attacks, as a rule, is not long [9]. Except for those cases, when as a result of terrorist act there is considerable destruction of buildings and at that time is required for removal of rubble in order to find and release the affected people.

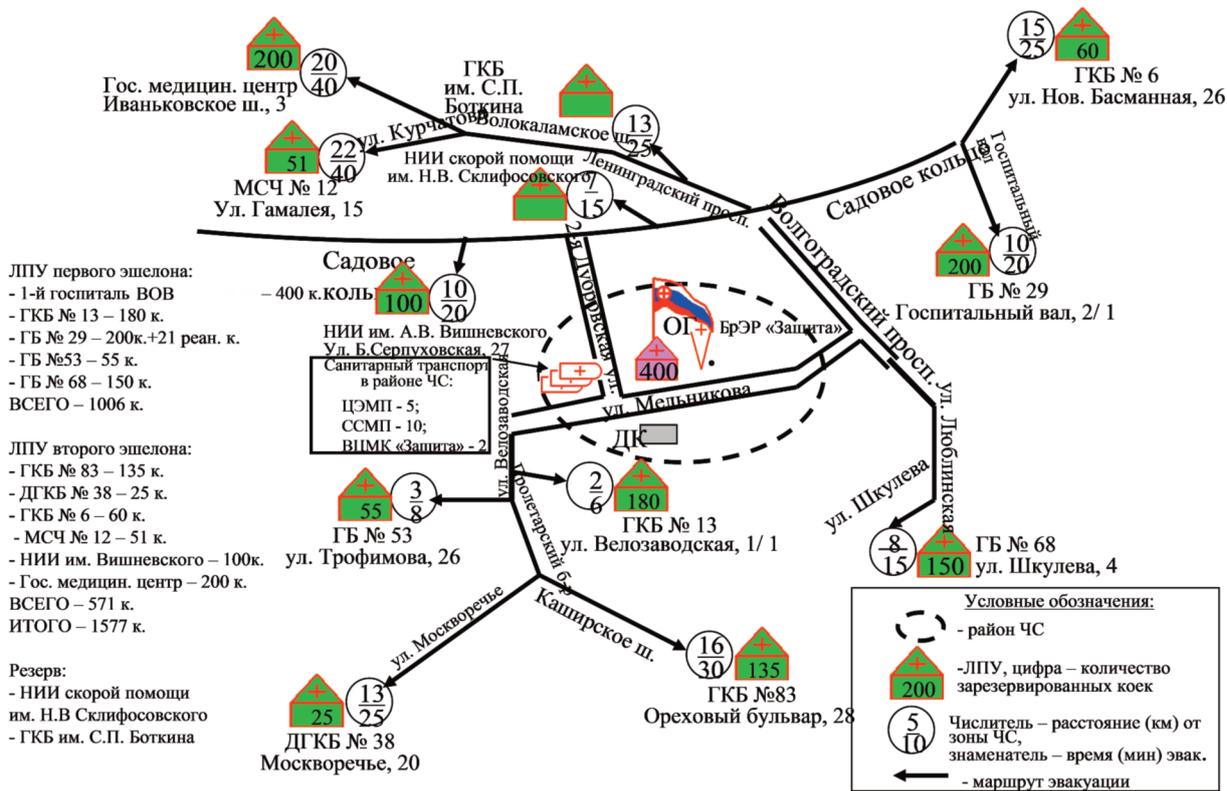


Рис. 3. Схема организации лечебно-эвакуационного обеспечения пораженных при теракте в культурно-развлекательном центре шарико-подшипникового завода (Москва, октябрь 2002 г.)
Fig. 3. Scheme of the organization of medical evacuation support of the wounded in the act of terrorism in the cultural-entertaining center of the ball bearing factory (Moscow, October, 2002)



Рис. 4. Принципиальная схема организации лечебно-эвакуационного обеспечения пораженных при теракте, совершенном в мегаполисе с применением обычных средств поражения
Fig. 4. Schematic diagram of the organization of medical evacuation support of the wounded in a terrorist attack committed in a megapolis with the use of conventional means of destruction

In such terrorist attacks the first echelon of the group of medical forces and facilities performs the same tasks as a similar echelon of the group created to eliminate the medical and sanitary consequences of large-scale terrorist attacks.

In this case the composition of the first echelon is advisable to include: ambulance teams; reanimobiles, if available — ambulance helicopter; operational group of the health management body, consisting mainly of specialists from regional and territorial disaster medicine centers (according to the situation). In addition, at the beginning of the liquidation of medical and sanitary consequences of the terrorist attack it is reasonable to entrust the tasks solved by the operative management group to one of the best prepared teams which first arrived at the site of the event.

Since the terms of elimination of medical and sanitary consequences of these terrorist attacks are not so long, this situation virtually eliminates the need to deploy a medical and psychological aid station near the emergency area.

All of the above makes it possible to formulate the following conclusion, which has an important practical value. The created grouping of medical forces and facilities for liquidation of medico-sanitary consequences of terrorist acts of municipal and regional scale with use of conventional means of destruction includes, as a rule, two echelons which solve practically the same tasks as similar echelons of grouping of medical forces and facilities created during large scale terrorist acts. Their main difference is that the echelons will not include medical forces and means of the federal level stationed outside the region.

Conclusions

1. The study has shown that one of the basic requirements to be met in establishing an echelon group of medical forces

and facilities is to ensure the provision of all kinds of medical aid to the wounded in a terrorist attack, an uninterrupted supply of medical equipment to the medical formations and organizations involved in the liquidation of the medical and sanitary consequences of the terrorist attack and the management of these medical forces and facilities.

2. In view of the above, attention should be paid to several very important organizational provisions concerning the echelons of the grouping of medical forces and means, created when eliminating the medical and sanitary consequences of terrorist attacks:

2.1 The location of stationary medical organisations and placement of mobile medical formations, sanitary transport, management bodies and other medical organizations on the relevant territory, the order of their use determines the need for an organizational system of medical assistance and medical evacuation of victims of terrorist attacks on the relevant territory. In addition, the specified organizational system must be comprehensive in nature and be in its composition an optimal grouping of health care forces and means.

2.2 Depending on the specific conditions, the system of medical and evacuation support for the wounded as a result of a terrorist attack (grouping of medical forces and means) may consist of several echelons, which mainly solve problems peculiar to them alone.

2.3 The echelons of the grouping of medical forces and facilities may be located not only in one, but also in several subjects of the Russian Federation, which necessitates the participation of relevant specialists and structural subdivisions of the Russian Ministry of Health in the response to the medical and sanitary consequences of such a terrorist attack.

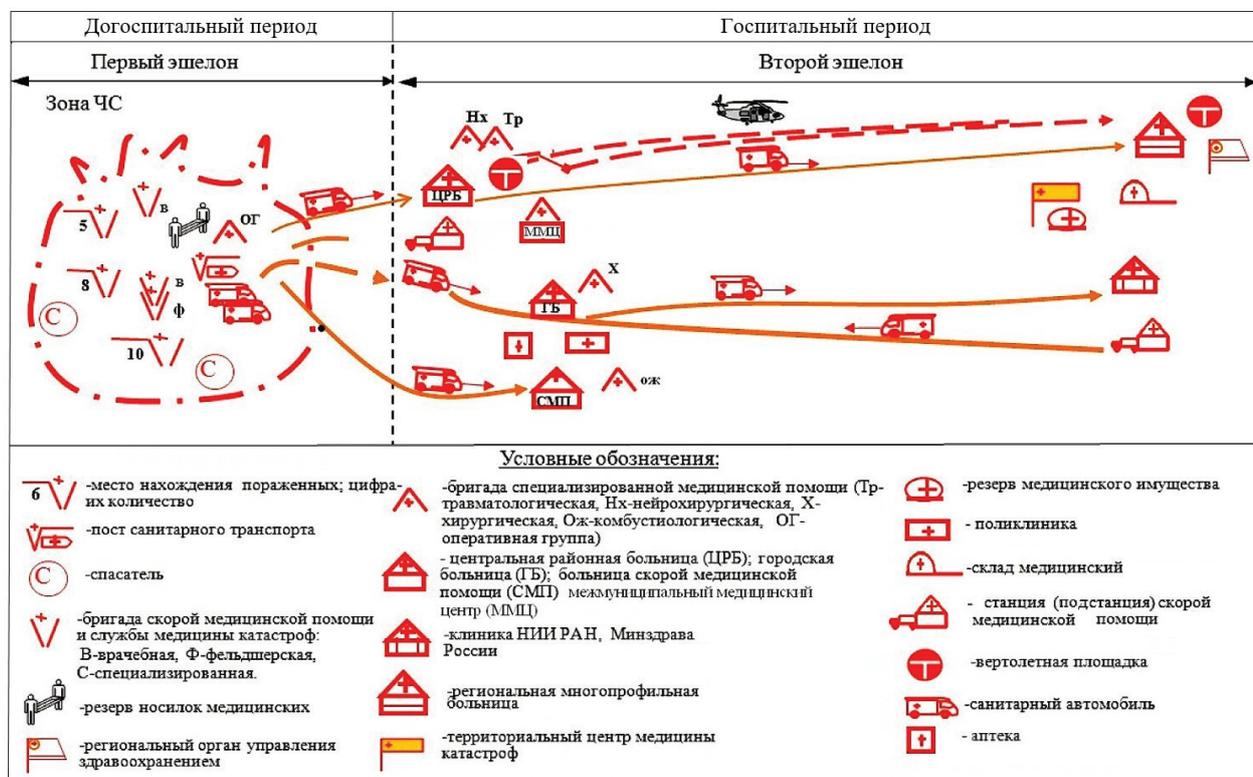


Рис. 5. Принципиальная схема организации лечебно-эвакуационного обеспечения пораженных при теракте муниципального или регионального масштаба, совершенном с применением обычных средств поражения (вариант)
 Fig. 5. Principle scheme of organization of medical evacuation support of the wounded in an act of terrorism of municipal or regional scale, committed with the use of conventional means of destruction (variant)

2.4 The medical forces and means included in the echelon of the grouping may be subordinate to different levels of health care (the Ministry of Health of Russia), sometimes to other ministries and organizations, which requires the organization of clear interaction and coordination of their actions.

2.5 The echelon of medical forces and means involved in the elimination of the medical and sanitary consequences of a terrorist attack should be considered a forced measure in the general system of organization and provision of medical care and the medical evacuation of the wounded.

REFERENCES

1. *Obshchestvennoye Zdorovye i Zdravookhraneniye. Natsionalnoye Rukovodstvo* = Public Health and Healthcare. National Leadership. Ed. Starodubov V.I., Shchepin O.P., et al. Moscow, GEOTAR-Media Publ., 2013. P. 390-407 (In Russ.).
2. *Osnovy organizatsii okazaniya meditsinskoy pomoshchi postradavshim pri chrezvychaynykh situatsiyakh* = Fundamentals of Organizing the Provision of Medical Care to Victims of Emergency Situations. A Manual for Doctors. Moscow, VTSMK Zashchita Publ., 2017. 98 p. (In Russ.).
3. *Meditsina Chrezvychaynykh Situatsiy* = Emergency Medicine. Ed. Goncharov S.F., Fisun A.Ya. Textbook in 2 volumes. Moscow, GEOTAR-Media Publ., 2021. V.2. P. 246-281 (In Russ.).
4. Goncharov S.F., Bobiy B.V., Titov I.G., Akin'shin A.V., Samoylova M.S. Some Issues of Optimizing Management Activities in Organizing Provision of Medical Care to Victims of Terrorist Acts. *Meditsina Katastrof* = Disaster Medicine. 2021;2:29-34. <https://doi.org/10.33266/2070-1004-2021-2-29-34> (In Russ.).
5. *Meditsinskoye Obespecheniye Naseleniya pri Terroristicheskikh Akтах* = Medical Support of the Population during Terrorist Acts. A manual for doctors. Moscow, VTSMK Zashchita Publ., 2016. 79 p. (In Russ.).
6. Onishchenko G.G., Goncharov S.F., Bobiy B.V. *Opyt Organizatsii Mediko-Sanitarnogo Obespecheniya Naseleniya i Vosstanovleniya Zdravookhraneniya Chechenskoy Respubliki Formirovaniyami i Uchrezhdeniyami Minzdrava Rossii (1999-2000 gg.)* = Experience in Organizing Medical and Sanitary Provision of the Population and Restoring Healthcare in the Chechen Republic by Formations and Institutions of the Ministry of Health of Russia (1999-2000). Moscow, VTSMK Zashchita Publ., 2002. 552 p. (In Russ.).
7. Bobiy B.V. Groupings of Forces and Means of Health Care for Medical and Sanitary Support of the Population of the Chechen Republic. *Meditsina Katastrof* = Disaster Medicine. 2001;1:9-13 (In Russ.).
8. Goncharov S.F., Kryukov A.P., Kryukov V.I., et al. Organization of Medical Support for the Victims of the Terrorist Act in Beslan on September 3, 2004. *Meditsina Katastrof* = Disaster Medicine. 2004;3-4:1-3 (In Russ.).
9. Bobiy B.V., Goncharov S.F., Titov I.G. Main Conditions and Factors Affecting the Organization of Medical Care Delivery and Medical Evacuation in Terrorist Acts Involving Explosive Devices and Conventional Weapons. *Meditsina Katastrof* = Disaster Medicine. 2020;4:16-27. <https://doi.org/10.33266/2070-1004-2020-4-16-27> (In Russ.).
10. Bystrov M.V. Analysis of Organizational Models of Disaster Medicine Service of the Ministry of Health of the Russian Federation at Regional Level. *Meditsina Katastrof* = Disaster Medicine. 2021;4:5-10. <https://doi.org/10.33266/2070-1004-2021-4-5-10>. (In Russ.).
11. Fisun A.Ya., Samokhvalov I.M., Boykov A.A., Parfenov V.Ye., Badalov V.I., Kipor G.V. Liquidation of Medical and Sanitary Consequences of Terrorist Act: Event's Chronology and Clinic of Injuries. *Meditsina Katastrof* = Disaster Medicine. 2018;2:22-24 (In Russ.).

3. The implementation of the proposed approaches to the order of creation and functioning of the echeloned grouping of medical forces and means, designed for medical and evacuation support of the victims of terrorist acts, may create conditions for a more reasonable, rational and effective use of medical organizations and formations, sanitary transport, public health authorities in order to achieve better results in saving lives and health of victims and minimize medical and sanitary evacuations.

СПИСОК ИСТОЧНИКОВ

1. Общественное здоровье и здравоохранение. Национальное руководство / Под ред. Стародубова В.И., Щепина О.П. и др. М.: ГЭОТАР-Медиа, 2013. С. 390-407.
2. Основы организации оказания медицинской помощи пострадавшим при чрезвычайных ситуациях: Учебное пособие для врачей. М.: ФГБУ ВЦМК «Защита», 2017. 98 с. (Библиотека Всероссийской службы медицины катастроф).
3. Медицина чрезвычайных ситуаций: Учебник: в 2 т. / Под ред. Гончарова С.Ф., Фисун А.Я. М.: ГЭОТАР-Медиа, 2021. Т.2. С. 246-281.
4. Гончаров С.Ф., Бобий Б.В., Титов И.Г., Акиншин А.В., Самойлова М.С. Некоторые вопросы оптимизации управленческой деятельности при организации оказания медицинской помощи пострадавшим в результате террористических актов // Медицина катастроф. 2021. №2. С. 29-34. <https://doi.org/10.33266/2070-1004-2021-2-29-34>.
5. Медицинское обеспечение населения при террористических актах: Учебное пособие для врачей. М.: ФГБУ ВЦМК «Защита», 2016. 79 с. (Библиотека Всероссийской службы медицины катастроф).
6. Онищенко Г.Г., Гончаров С.Ф., Бобий Б.В. Опыт организации медико-санитарного обеспечения населения и восстановления здравоохранения Чеченской Республики формированиями и учреждениями Минздрава России (1999-2000 гг.). М.: ВЦМК «Защита», 2002. 552с.
7. Бобий Б.В. Группировки сил и средств здравоохранения для медико-санитарного обеспечения населения Чеченской Республики // Медицина катастроф. 2001. №1. С.9-13.
8. Гончаров С.Ф., Крюков А.П., Крюков В.И. и др. Организация медицинского обеспечения пораженных при террористическом акте в г.Беслан 3 сентября 2004 г. // Медицина катастроф. 2004. №3-4. С. 1-3.
9. Бобий Б.В., Гончаров С.Ф., Титов И.Г. Основные условия и факторы, влияющие на организацию оказания медицинской помощи и проведения медицинской эвакуации при террористических актах с применением взрывных устройств и обычных средств поражения // Медицина катастроф. 2020. №4. С. 16-27. <https://doi.org/10.33266/2070-1004-2020-4-16-27>.
10. Быстров М.В. Анализ организационных моделей функционирования Службы медицины катастроф Министерства здравоохранения Российской Федерации на региональном уровне // Медицина катастроф. 2021. №4. С. 5-10. <https://doi.org/10.33266/2070-1004-2021-4-5-10>.
11. Фисун А.Я., Самохвалов И.М., Бойков А.А., Парфенов В.Е., Бадалов В.И., Кипор Г.В. Ликвидация медико-санитарных последствий террористического акта: хронология события и клиника пораженных // Медицина катастроф. 2018. №2. С. 22-24.

SCIENTIFIC AND METHODOLOGICAL APPROACHES TO THE ASSESSMENT OF FMBA OF RUSSIA INSTITUTIONS EMERGENCY PREPAREDNESS IN CASE OF RADIATION ACCIDENTS AND INCIDENTS

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Abstract. The purpose of the study is to develop approaches to the substantiation of criteria and methods for quantitative assessment of the preparedness of medical organizations of FMBA of Russia to work in case of radiation emergency situations.

Materials and research methods. Expert (analytical) and computer-based methods were used to estimate preparedness indices for medical organizations of FMBA of Russia on the basis of consensus ideas about possible medical and sanitary consequences of radiation accidents.

Research results and their analysis. A general approach to the quantitative evaluation of emergency preparedness of medical organizations of FMBA of Russia in case of radiation accidents at the enterprises and territories they serve is formulated. The peculiarity of the approach under consideration in determining the proper (baseline) level of readiness for emergency response is the identification of the scale (magnitude) of medical and sanitary consequences based on the gradation of exposure doses and the number of victims. Approaches to substantiation of federal, regional and territorial (local) levels of emergency response of medical organizations of FMBA of Russia are proposed.

Key words: emergency response, emergency preparedness, health consequences, institutions of FMBA of Russia, radiation accident, radiation damages

Conflict of interest. The authors declare no conflict of interest

For citation: Salenko Y.A., Frolov G.P., Grachev M.I., Bogdanova L.S., Tesnov I.K. Scientific and Methodical Approaches to the Assessment of the Emergency Preparedness of Medical Organizations of Fmba of Russia in the Event of a Radiation Accident. *Meditsina Katastrof* = Disaster Medicine. 2022;1:31-39 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-31-39>

НАУЧНО-МЕТОДИЧЕСКИЕ ПОДХОДЫ К ОЦЕНКЕ ПРОТИВОАВАРИЙНОЙ ГОТОВНОСТИ МЕДИЦИНСКИХ ОРГАНИЗАЦИЙ ФМБА РОССИИ В СЛУЧАЕ ВОЗНИКНОВЕНИЯ РАДИАЦИОННОЙ АВАРИИ

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Резюме. Цель исследования – разработка подходов к обоснованию критериев и способов количественной оценки готовности медицинских организаций ФМБА России к работе в случае возникновения чрезвычайных ситуаций (ЧС) радиационного характера.

Материалы и методы исследования. Использованы экспертный (аналитический) и компьютерный методы оценки показателей готовности медицинских организаций ФМБА России на основе консенсусных представлений о возможных медико-санитарных последствиях радиационных аварий (РА).

Результаты исследования и их анализ. Сформулированы общие подходы к количественной оценке противоаварийной готовности медицинских организаций ФМБА России в случае радиационной аварии на обслуживаемых предприятиях и территориях. Особенностью рассматриваемого подхода при определении должного (базового) уровня готовности к аварийному реагированию является выявление масштаба (величины) медико-санитарных последствий на основе градации доз облучения и числа пораженных. Предложены подходы к обоснованию федерального, регионального и территориального (местного) уровней аварийного реагирования медицинских организаций ФМБА России.

Ключевые слова: аварийное реагирование, медико-санитарные последствия, медицинские организации ФМБА России, научно-методические подходы, оценка противоаварийной готовности, радиационные аварии, радиационные поражения

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Саленко Ю.А., Фролов Г.П., Грачев М.И., Богданова Л.С., Теснов И.К. Научно-методические подходы к оценке противоаварийной готовности медицинских организаций ФМБА России в случае возникновения радиационной аварии // *Медицина катастроф*. 2022. №1. С. 31–39. <https://doi.org/10.33266/2070-1004-2022-1-31-39>

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Introduction

The establishment of nuclear industry and energetics in our country, as well as in other developed countries, was accompanied by radiation accidents of different types and scales [1]. During its 75-year history the State Research Center — A.I. Burnazyan Federal Medical Biophysical Center (hereinafter referred to as the Center) has accumulated unique scientific and practical experience of eliminating medical and sanitary consequences of such accidents. The specialists of the Center directly participated in organization and implementation of large-scale radiation-hygienic activities. The treatment of the injured with severe forms of acute radiation syndrome (ARS), local radiation, lesions was organized and performed.

The basic elements of readiness of specialized organizations of FMBA of Russia to carry out a set of treatment, radiation-hygienic and physical-dosimetric measures are the availability of competent specialists and the possibility to transfer the accumulated "live" experience to the modern generation of doctors and hygienists. Conducting emergency drills and exercises on a regular basis is crucial for emergency preparedness. The importance of motivation and conscious understanding of risks for own health among the medical personnel working in conditions of complicated radiation should not be underestimated.

The aim of the study is to substantiate the necessity of improvement of quantitative methods for evaluation of readiness of medical organizations of FMBA of Russia to liquidate medical and sanitary consequences of radiation accidents and expert evaluation by the criterion "dose — number of exposed (involved) persons" to establish minimum (mandatory) and maximum (conservative) readiness levels which can be provided with available resources.

Materials and research methods. Expert (analytical) and computer methods of quantitative assessment of readiness indicators of medical organizations of FMBA of Russia — REDIAS program — were used. The algorithm of readiness level evaluation is based on the analysis of conformity of the available resources of the medical organization intended for the effective performance of the necessary volume of medical and radiation-hygienic measures with the formal requirements (indices) calculated in an experimental way with reference to the probable scale of medical and sanitary consequences in case of RA at the served enterprise. The program takes into account: the characteristics of the medical base of the organization — capacity of the hospital, polyclinics, laboratories; availability of formations for emergency response, their provision with medical equipment; training and motivation of medical personnel and other critical indicators, as well as the demographic parameters of the territory served. Calculations of the predicted health consequences are limited to the number of casualties and persons requiring medical support. REDIAS also takes into account the probability of occurrence of combined lesions.

The methodology is recommended for testing and used in the current activities of the regional emergency medical dosimetry centers of FMBA of Russia for assessing and improving the preparedness of medical organizations with the development of substantive recommendations, as well as for calculating the probable medical and sanitary consequences of RA during the exercises.

Results of the study and their analysis. Domestic and foreign authors for defining the concept of "preparedness in case of emergency" use the term "capability", i.e. preparedness is considered as a certain capacity to perform (implement) certain functions, such as a rescuer, a doctor, an institution as a whole or a management body [2].

Preparedness is closely related to the existence of a system of emergency planning. It is important to emphasize the importance of realistic planning and implementation of medical and radiation-hygienic measures in the required volume and within the established timeframes. This means, firstly, compliance of the capabilities of medical organizations of FMBA of Russia to receive and treat the victims or to carry out a set of sanitary and hygienic measures with those medical and sanitary consequences, which can be estimated for a given enterprise or territory in case of a radiation accident, and, secondly, the possibility of prompt allocation of additional forces and means and their delivery both within the departmental system of emergency response, and at the national level.

Excessively conservative assessments of the degree of potential radiological threat and, as a consequence, establishment of big planning zones of protective measures can lead to unjustified economic costs and to difficulties in the management of emergency response. To a certain extent this may also apply to the estimation of possible medical and sanitary consequences and, consequently, to the emergency preparedness of the medical organizations of the territorial and federal level.

Table 1 presents a list of indicators used to analyze the preparedness of the centers for hygiene and epidemiology of FMBA of Russia in case of emergency of radiation character [3]. The above indicators, in a sense, are administrative in nature and must be formulated for a specific medical organization of FMBA of Russia, taking into account the specifics of the enterprise served. At the same time, the official approval of such indicators and their introduction into the reporting forms will make it possible to create an electronic database for continuous dynamic monitoring and formulation of promising tasks for preparedness management and improvement.

The purpose of response is not only to ensure the implementation of emergency measures, but also to perform them in accordance with the established time parameters. One of the main elements of evaluation of preparedness of the response system as a whole as well as its separate elements are time parameters: time of deployment of emergency re-

Перечень показателей готовности центров гигиены и эпидемиологии ФМБА России

List of Preparedness Indicators of Centers for Hygiene and Epidemiology of FMBA of Russia

Показатель / Indicator	
1.	Нормативная база / Regulatory framework
1.1.	Наличие нормативно-методической документации в соответствии с установленным перечнем / Availability of regulatory and methodological documentation in accordance with the established list
1.2.	Результаты и выводы из ранее выполненных оценок готовности / Results and conclusions from previous readiness assessments
1.3.	Проведение мероприятий по результатам проверок / Activities based on the results of inspections
2.	Подготовка персонала / Staff training
2.1.	Подготовка врачебного персонала – квалификация, стаж работы, курсы повышения квалификации / Training of medical staff – qualifications, work experience, advanced training courses
2.2.	Подготовка инженерного персонала / Training for engineering staff
2.3.	Подготовка среднего медицинского и технического персонала / Training of nursing and technical staff
3.	Мощность базы ЦГиЭ / Capacity of the Center for Hygiene and Epidemiology
3.1.	Виды и объем проводимых измерений и анализов / Types and volume of measurements and tests performed
3.2.	Количество проводимых обследований, подготавливаемых отчетов и заключений / Number of examinations conducted, reports and opinions prepared
3.3.	Наличие и площадь оборудованных лабораторных помещений / Availability and area of equipped laboratory facilities
3.4.	Возможности наращивания мощности при радиационной аварии / Levelling-up possibilities in the event of a radiation accident
3.5.	Численность и укомплектованность аварийных бригад (групп) / Number and staffing of emergency teams (groups)
4.	Материально-техническое обеспечение / Material and technical facilities
4.1.	Наличие приборов и оборудования в соответствии с утвержденными перечнями / Availability of devices and equipment in accordance with approved lists
4.2.	Наличие аттестованных методик измерений, в том числе выполнения экспрессных анализов содержания радионуклидов в пробах внешней среды, в продуктах питания и питьевой воде / Availability of certified measurement techniques, including express analyses of radionuclide content in environmental samples, in food and drinking water
4.3.	Наличие передвижных лабораторий радиационного контроля и их оснащение / Availability of mobile radiation control laboratories and their equipment
4.4.	Обновляемость лабораторной и измерительной базы / Updateability of laboratory and measurement facilities
4.5.	Наличие вычислительной техники и расчетных программ / Availability of computer equipment and calculation programs
4.6.	Наличие современных систем связи, в том числе для обмена информацией с обслуживаемым предприятием / Availability of modern communication systems, including for the exchange of information with the enterprise served
4.7.	Наличие комплектов аварийных упаковок и их соответствие утвержденному перечню / Availability of emergency kits and their compliance with the approved list
4.8.	Вопросы финансирования обеспечения потребностей в технике, приборном оснащении, оснащении аварийными упаковками и др. / Funding of equipment, instrumentation, emergency kits, etc.
5.	Отработка действий персонала на учениях и тренировках / Personnel training in exercises and drills
5.1.	Знание персоналом должностных инструкций по действиям в случае радиационной аварии / Personnel knowledge of job instructions for actions in the event of a radiation accident
5.2.	Результаты и выводы из проведенных тренировок и учений / Results and conclusions from training and exercises
5.3.	Планы проведения тренировок, учений и учебных занятий / Plans for drills, exercises and training sessions

sponse facility; time of notification of the managerial and personnel personnel; time of gathering of the formations; time of performance by emergency formations of separate operations and tasks, including medical and sanitary orientation, etc. Taking into account the IAEA recommended time parameters for emergency response activities at radiation hazardous facilities, during exercises and drills the optimal time is determined, which is formalized in time parameters of emergency preparedness [4, 5].

Table 2 presents the possibilities of a differentiated approach to preparedness management and planning of medical and sanitary support in accordance with the level of anticipated radiological threats or the scale of RA in case of its occurrence. The unique features of the Russian Federal Medical and Biological Agency system are the maximum approximation of the medical base to the serviced radiation hazardous facility, knowledge of the medical and hygienic specificity of harmful industrial factors, including the characteristic factors of possible RA. All previous experience of FMBA of Russia emergency response organization is based on the staged system of medical care and close combination of therapeutic and radiation-hygienic measures depending on specific conditions and consequences of radiation accident — see Table 3 [3, 6]. Scientific and methodological sup-

port from leading scientific centers and regional emergency medical and dosimetry centers created on their basis, including specialized emergency brigades, occupies an important place. At the same time in case of a major RA a large number of interaction issues are supposed to be solved, including those with territorial health care authorities and medical organizations.

One of the important features of the differentiated approach, established, in particular, in the Decree of the Government of the Russian Federation "On the classification of emergencies of natural and man-made character" from May 21, 2007 No.304, as well as formulated in the IAEA publications — the desire to avoid excessive planning and complex decisions when putting into operation the system of emergency response [4, 5, 7, 8]. Without considering the fundamental differences between the classification of emergencies of natural and man-made nature and the classification of the RA, we should emphasize the failure of direct comparisons, for example, by the number of deaths, direct economic damage, etc. Thus, in practice, often even in the case of overexposure of a single person, the issues of diagnosis and subsequent treatment are addressed at the federal level in a specialized clinical center. Of course, an important role is also played by the territorial (local) link:

Участие медицинских организаций ФМБА России в ликвидации медико-санитарных последствий радиационных аварий на обслуживаемых объектах и территориях

Participation of medical organizations of FMBA of Russia in elimination of medical and sanitary consequences of radiation accidents at serviced facilities and territories

Уровень Level	Медицинские последствия Medical consequences	Санитарно-эпидемиологические последствия Sanitary and epidemiological consequences
Федеральный Federal	Участие нескольких специализированных клинических центров ФМБА России в обследовании и лечении пораженных с различными формами и степенью тяжести лучевых поражений. Проведение широкомасштабных клинико-диагностических мероприятий по обследованию пораженных и вовлеченных лиц Participation of several specialized clinical centers of FMBA of Russia for examination and treatment of patients with various forms and severity of radiation injuries. Large-scale clinical-diagnostic activities to examine the affected and involved persons	Проведение масштабных мероприятий по дозиметрическому обследованию населения с целью оценки обоснованности принятых защитных мер. Контроль и проведение мероприятий по ограничению потребления населением местной сельскохозяйственной продукции и водопользования могут охватывать территории нескольких административно-территориальных образований Large-scale activities on dosimetric survey of the population in order to assess the validity of the protective measures taken. Control and implementation of measures to limit the consumption of local agricultural products and water use by the population — may cover the territory of several administrative territorial formations
Региональный Regional	Участие специализированного клинического центра ФМБА России, в том числе отделения с асептическим режимом ведения больных, в лечении ОЛБ и местных лучевых поражений. Использование спектрометров излучений человека (СИЧ), биофизических и цитогенетических лабораторий Involvement of a specialized clinical center of FMBA of Russia, including a department with an aseptic patient management regime, for the treatment of acute radiation sickness and local radiation lesions. Use of human radiation spectrometers (HRS), biophysical and cytogenetic laboratories	Проведение мероприятий по дозиметрическому обследованию населения с целью оценки эффективности принятых защитных мер. Контроль и проведение мероприятий по ограничению потребления населением местной сельскохозяйственной продукции и водопользования могут охватывать ареалы расположения нескольких сельских населенных пунктов Activities on the dosimetric survey of the population in order to assess the effectiveness of the protective measures taken. Control and implementation of measures to limit the consumption of local agricultural products and water use by the population may cover the areas of several rural settlements
Местный Local	Амбулаторное медицинское и дозиметрическое обследование, включая СИЧ, использование биофизических и цитогенетических исследований, пораженных и вовлеченных лиц Outpatient medical and dosimetry examinations, including HRS, use of biophysical and cytogenetic studies of affected and involved persons	Участие в организации мониторинга пораженных и вовлеченных лиц. Контроль и проведение мероприятий по ограничению потребления населением местной сельскохозяйственной продукции и водопользования Participation in the organization of monitoring of affected and involved persons. Control and implementation of measures to limit the consumption of local agricultural products and water use by the population

a health unit, a medical-sanitary unit, a professional pathology center, a regional department, an interregional department and the Federal Medical and Biological Agency of Russia.

The peculiarity of the approach under consideration in determining the proper (baseline) level of preparedness of the medical organization of FMBA of Russia for an emergency of radiation character is the identification of the scale of medical and sanitary consequences based on the gradation of exposure doses and the number of affected persons. Besides, this approach is based on the analysis of the historical experience of liquidation of radiological consequences of radiation accidents and the established ideas about the capability of FMBA organizations to carry out the necessary diagnostic procedures and treatment of patients with various forms of radiation injuries. In the initial period of the accident, the assessment of doses to the personnel and population may imply significant errors associated with the shortcomings of the used calculation methods and incompleteness of the obtained information. Therefore, clinical manifestations of radiation exposure and operational dosimetric values are used in medical triage, medical care of the injured and assessment of the severity of their condition [9, 10]. Nevertheless, exposure dose is a universal integral indicator, which allows assessing the level of participation of FMBA organizations in the emergency response taking into account the number of exposed persons (Table 4).

Thus, for example, in the case of availability of more than 5 people with radiation doses higher than the threshold values for deterministic effects it is necessary to ensure the readiness of all specialized clinics of FMBA of Russia, and in the case of a considerable number (several dozens) of pa-

tients with severe forms of acute radiation sickness it may be necessary to cooperate with medical institutions of other ministries and departments. According to the above-mentioned expert evaluation, the use of the resources of medical organizations of the Federal Medical and Biological Agency of Russia at the federal level should also be envisaged in case of a need for an in-depth medical and dosimetric examination of over 50 people with radiation doses exceeding 200 mSv. In this case it may be necessary to involve several laboratories for human radiation spectrometry and biophysical laboratories, to use cytogenetic techniques for examination and verification of dose burdens. The mentioned situations will most likely concern the personnel of the emergency facility and the emergency rescue teams who took part in the liquidation of the RA consequences.

Exposure in the dose range of 50-200 mSv, including those within the limits of doses used as criteria for making urgent decisions in accordance with the Radiation Safety Standards, can affect a larger number of people. The exposed contingents can be both the personnel of the enterprise and emergency rescue teams and separate groups of population, applying protective measures to which have been insufficiently effective. In any case, the proposed mandatory level of preparedness, which requires participation in the emergency response of the Federal Medical and Biological Agency of Russia organizations of the federal level, is the availability of 500 people with dose loads in the specified range. The peculiarity of organizing and, therefore, ensuring preparedness for mass clinical dosimetry examination of the population is the need to plan not only for specialized medical centers, but also for several mobile specialized emergency response teams. At the same time, the tasks to be

Этапы и оптимальные сроки оказания первой и медицинской помощи
Stages and optimal timing of first aid and medical care

Этап медицинской эвакуации Medical evacuation stage	Медицинские формирования и организации Medical formations and organizations	Первая помощь, виды медицинской помощи First aid, types of medical care	Оптимальное время начала оказания первой и медицинской помощи Optimal time to start of first aid and medical care
Место аварии Accident site	Персонал предприятия, спасательные службы Personnel of the enterprise, rescue services	Первая помощь в виде само- и взаимопомощи, расширенная первая помощь First aid in the form of self- and mutual aid, extended first aid	Сразу после установления факта радиационного воздействия Immediately after establishing the fact of radiation exposure
Санитарный пост, санитарный пропускник Sanitary post, sanitary passageway	Формирования гражданской обороны – санитарный пост, санитарная дружина Civil defense formations – sanitary post, sanitary squadron	Первичная доврачебная медико-санитарная помощь, санитарная обработка Primary pre-hospital medical care, sanitation	Первые 10–20 мин First 10-20 min
Здравпункт Health Station	Фельдшер здравпункта, радиологическая бригада МСЧ* Medical assistant of the health center, radiological team of the medical unit	Первичная доврачебная, первичная врачебная медико-санитарная помощь Primary pre-hospital, primary medical and sanitary care	Первые 20–30 мин First 20-30 min
Сортировочная площадка, автомобиль СМП** Sorting area, ambulance	Бригада СМП Ambulance team	Медицинская сортировка, первичная врачебная медико-санитарная помощь Medical triage, primary medical care	Первые 20–60 мин First 20-60 min
Специализированное приемное отделение МСЧ Specialized admission department of the medical unit	Радиологическая бригада МСЧ Radiological team of the medical unit	Первичная врачебная медико-санитарная помощь, санитарная обработка Primary medical and sanitary care, sanitation	Первые 1–2 ч First 1-2 h
Профильные отделения МСЧ Specialized departments of the medical unit	Стационар МСЧ: - отделение профпатологии; - отделение травматологии; - отделение интенсивной терапии и реанимационное отделение Inpatient unit of the medical unit: - occupational pathology department; - traumatology department; - intensive care unit	Первичная медико-санитарная помощь с элементами специализированной медицинской помощи Primary medical care with elements of specialized medical care	Начиная с первых одного-двух часов Starting with the first one or two hours
Специализированный стационар Specialized hospital	Профильные отделения Specialized departments	Первичная специализированная, в том числе высокотехнологичная, медицинская помощь Primary specialized, including high-tech, medical care	Не позднее 24 ч No later than 24 h

* МСЧ – медико-санитарная часть / medical unit

** СМП – скорая медицинская помощь / ambulance

solved by them should include: conducting selective dosimetric examination of the population using mobile complexes; blood sampling for cytogenetic studies; radiation and hygienic examination of the territory of settlements and their agricultural areas.

The above examples, to a certain extent, will also be characteristic of preparedness at the regional level. With the above scale of medical and sanitary consequences, there is reason to believe that the FMBA organizations of Russia can provide a sufficient level of preparedness and to carry out medical-diagnostic and radiation-hygienic activities in full scope.

At any scale of a radiation accident, participation in the medical and sanitary support and emergency response of the units of FMBA of Russia is certainly a priority and will be mandatory. In the medical-sanitary unit, when it is necessary to treat the injured with high radiation doses, the main attention should be paid to stabilizing their condition and to preparing them for evacuation to the specialized hospital of

the federal level. Important measures are to conduct a simplified dosimetric examination (preliminary assessment of surface radioactive contamination of the injured, as well as the intake of radioactive substances into the body), selection, preparation and transfer of biological samples of the required volume for subsequent research in specialized laboratories.

In the case of RA, the development of spatial and temporal models of the formation of dose loads on personnel under uncontrolled exposure is associated with even greater uncertainties than the results of forecasting of radiological consequences for the population in the event of an accidental release. For this reason, expert approaches, based on the historical experience of liquidation of the consequences of past radiation events, are used to assess the possible medical and sanitary consequences.

The data of the Burnazyan Federal Medical and Biological Center and the information published by the IAEA on the RA consequences in 1945-2010 suggest that as a result of

a single emergency event (with the exception of the accident at the Chernobyl NPP in 1986) the number of victims of acute radiation injury of varying severity ranges from several people to several dozens of them [11]. To illustrate a conservative estimation of possible medical and sanitary consequences of different scales of RA, quantitative characteristics and structure of affected persons from among the personnel of the NPP at the operating power unit with RBMK-1000 reactor are presented in Table 5. These calculations were performed using the computer program REDIAS on the basis of the data on the number of the affected persons and the structure of the radiation injuries of the personnel and the liquidators of the Chernobyl accident as well as on the available data on the medical and sanitary consequences of the RA in our country and abroad (Fig. 1). Such modifying factors as the number of personnel on maximum shift, combined lesions as a result of thermal and mechanical injuries and other factors were taken into account by expert judgment.

On Fig. 2 there is a principal scheme of algorithm of medical organization preparedness in case of RA on the object of I category of potential radiation danger - according to sanitary rules 2.6.1.2612-10 (OSPORB 99/2010).

The presented assessments are indicative, but at the same time the use of the calculation program allows to quickly assess the structure of radiation injuries, depending on the initial data and the scenario under consideration. The resulting tables can be analyzed by experts to determine whether the estimates are realistic.

In general, in determining the level of preparedness of medical institutions of FMBA of Russia in case of large-scale RA (level 6-7 according to the INES scale) it should be oriented (according to maximum estimates) on the need to provide medical care to about 100 patients with various forms of radiation injuries, including 10 patients with life-threatening indications (see Table 5). These values correspond to a two-threefold reserve in planning the medical and sanitary provision of the injured in full and in an optimum time. We should also take into account the possibility of a large number of the wounded as a result of overdiagnosis and their self-referral for medical help.

Таблица 4/Table No. 4

Уровни участия медицинских организаций ФМБА России в аварийном реагировании в зависимости от доз облучения и числа пораженных и/или вовлеченных лиц
Levels of involvement of medical organizations of FMBA of Russia in emergency response depending on exposure doses and the number of victims and/or persons involved

Уровень Level	>1Гр на все тело >1 Gy for the whole body	0,2–1,0 Зв / Sv	0,05–0,2 Зв / Sv	0,005–0,05 Зв / Sv
Число пораженных и/или вовлеченных лиц, чел. Number of victims and/or persons involved, pers.				
Федеральный Federal	>5	>50	>500	>5000
Региональный Regional	1–5	10–50	100–500	1000–5000
Местный Local	Нет / No	<10	<100	<1000

It is assumed that the severely injured will be mainly with combined lesions, and almost always there will be a need to carry out their sanitary treatment in the organization of the sanitary-access regime in the medical institution[12].

Currently, the developed indicators and methodology for assessing the preparedness of medical organizations of FMBA of Russia are used as a research and analysis tool. On this basis, consultations are conducted and targeted recommendations are prepared to improve certain readiness indicators. In our opinion, taking into account the accumulated experience and existing comments, the pilot version of the methodology and the REDIAS program can be officially used in the practice of FMBA organizations of the medical and sanitary-hygienic profile. The main arguments in favor of adopting this proposal are the possibility of identifying the "weak link", independent control and management of readiness to eliminate emergencies of radiation nature.

Conclusion

The article formulates general approaches to the quantitative assessment of emergency preparedness of Russian Federal Medical and Biological Agency organizations in case of emergency situations at the enterprises and territo-

Таблица 5/Table No. 5

Прогноз медико-санитарных последствий в случае возникновения крупной радиационной аварии на АЭС – программа REDIAS

Forecast of health consequences in case of a major radiation accident at a nuclear power plant – REDIAS program

Факторы аварии / Accident factors	Структура контингента пораженных, чел. Contingent structure of victims, pers.
Внешнее облучение / External exposure	Тяжелопораженные – до 5 / Severely injured – up to 5 Средней степени тяжести – до 35 / Moderate severity – up to 35 Легкой степени тяжести – до 50 / Mild degree of severity, up to 50 Без прогноза клинических эффектов – до 150 / No prognosis of clinical effects – up to 150
Внутреннее облучение / Internal exposure	Тяжелопораженные – 0–1 / Severely injured – 0-1 Средней степени тяжести – до 5 / Moderate severity – up to 5 Без прогноза клинических эффектов – до 15 / No prognosis of clinical effects – up to 15
Общее число лиц, нуждающихся в оказании специализированной медицинской помощи / Total number of persons in need of specialized medical care	До 100 / Up to 100 Доля лиц с сочетанным поражением – 60% Percentage of persons with co-morbidities – 60% Доля лиц, нуждающихся в полной санобработке – 60% Percentage of persons in need of complete sanitation – 60%
Общее число лиц, нуждающихся в проведении медицинского обследования и профилактических мероприятий / Total number of persons in need of medical examination and preventive measures	Более 1 тыс. / More than 1 thousand pers.

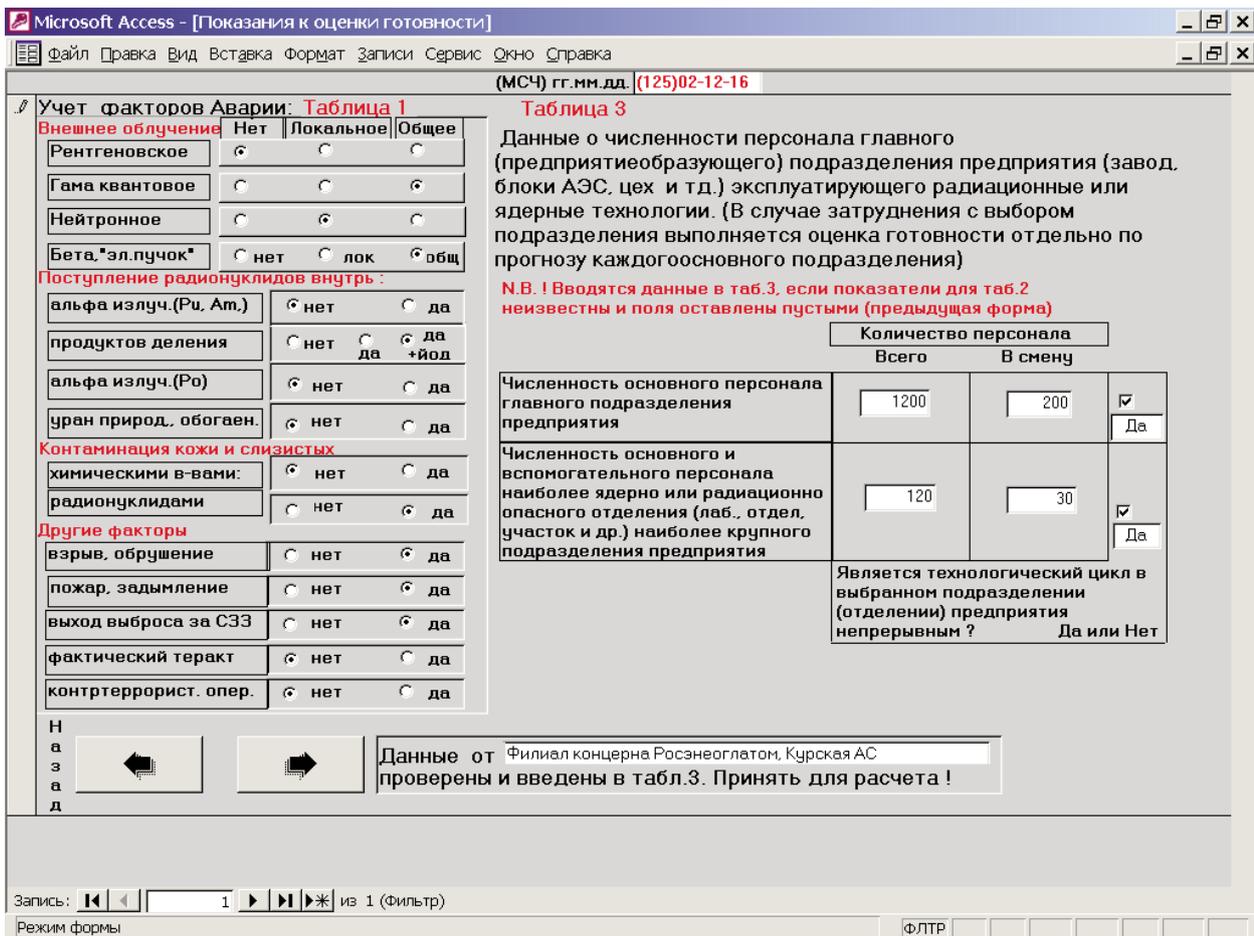


Рис. 1. Интерфейс программы REDIAS
Fig. 1. REDIAS Program Interface

ries they serve. The maintained level of preparedness must correspond to the potential or situational threat of RA and be based on the results of assessments of radiation consequences. As a rule, these results contain significant uncertainties associated with the complexity of modeling the factors and conditions of emergency development. Therefore, quantitative assessments of medical and sanitary consequences contained in site plans for personnel protection measures should be treated with a fair degree of caution. For example, the experience of participation in comprehensive emergency drills at NPPs shows that the maximum medical and sanitary consequences, included by the operating organization in the exercise scenario, are, as a rule, 1-3 people from among the NPP personnel. In this case the radiation consequences are also minimal. The practical conclusion from this experience is the necessity of developing medical scenarios for exercises and drills in order to work out the thematic issues of preparedness of the organizations of FMBA of Russia [13]. An important element of maintaining the preparedness of the stages of medical care in the pre-hospital period is the close interaction between the emergency services and the medical organization of the Federal Medical and Biological Agency of Russia. In 2016, for effective implementation of measures to provide first and subsequent

medical aid to the injured in emergencies at NPPs, the "Model Agreement on Cooperation between the Branch of Rosenergoatom JSC — Operating Nuclear Power Plant and Medical Organization of FMBA of Russia during establishment and operation of the NPP rescue medical service" was put into effect.

The Burnazyan Federal Medical and Biological Center has developed a standard program of exercises and drills aimed, among other things, at studying such issues as medical triage of the injured; assessment of the capacity of medical and sanitary departments; time parameters for a set of dosimetry and laboratory tests.

At present, it is necessary to introduce into the practice of FMBA organizations of the medical and sanitary-hygienic profile a pilot version of the methodology and computer program REDIAS to assess the readiness for emergency response. One of the mechanisms for assessing and managing preparedness is the creation of an information-management system (database), which greatly simplifies the collection and storage of necessary information and maintenance of documentation, allowing to assess the dynamics of development of the emergency response system, to draw conclusions and justifications for its further development.

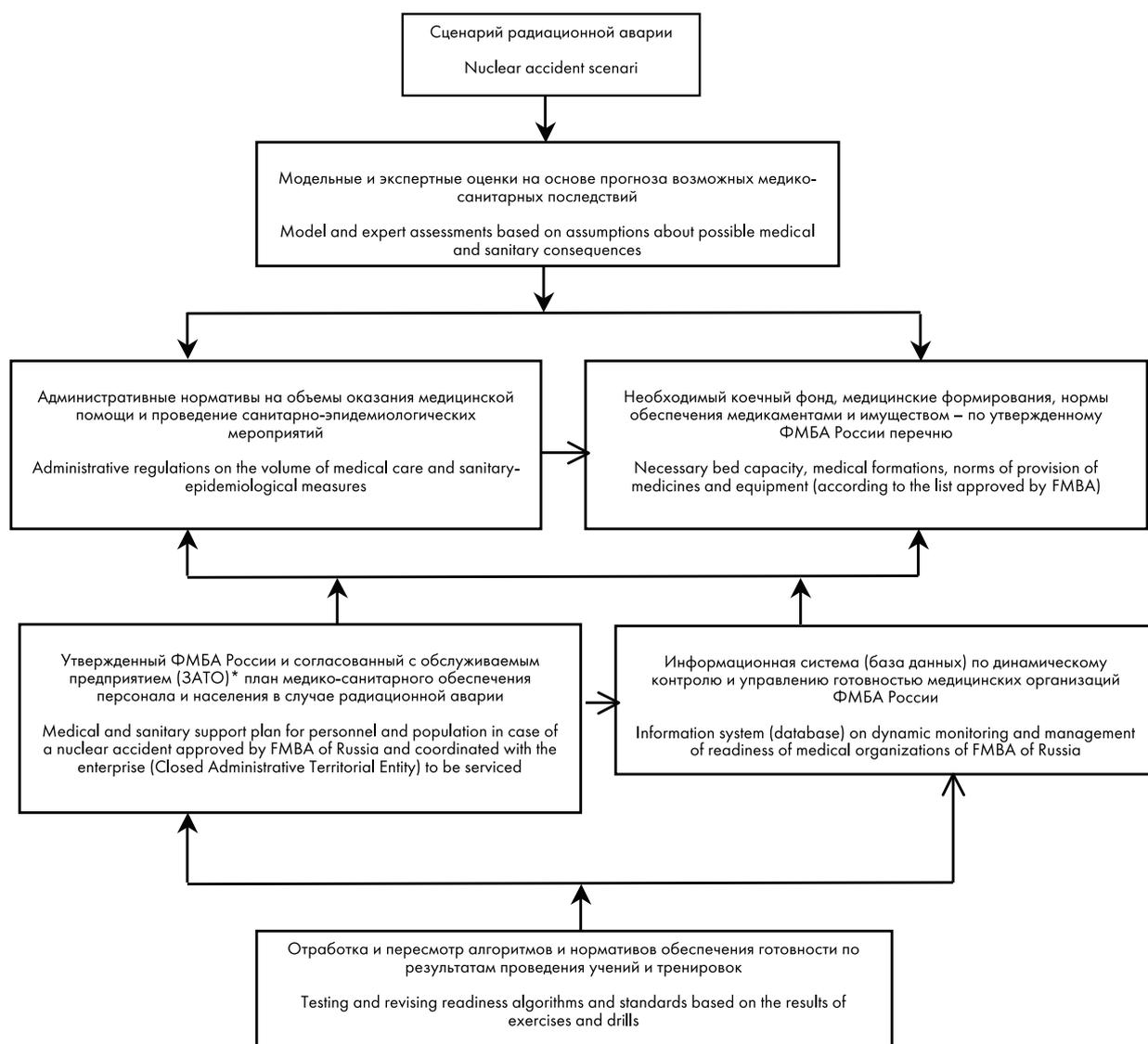


Рис. 2. Принципиальная схема оценки показателей и алгоритма обеспечения готовности медицинской организации ФМБА России
* ЗАТО – закрытое административно-территориальное образование

Fig. 2. Schematic Diagram of the Assessment of Indicators and the Algorithm for Ensuring the Preparedness of the FMBA of Russia Medical Organization

REFERENCES

1. Aleksakhin R.M., Buldakov L.A., Gubanov V.A., Drozhko E.G., Ilyin L.A., Kryshch I.I., et al. Major Radiation Accidents: Consequences and Protective Measures. Eds Ilyin L.A., Gubanov V.A. Moscow, Izdat Publ., 2001. 752 p. (In Russ.).
2. IAEA Safety Glossary: 2018 Edition. Vienna: IAEA, 2019. 278 p.
3. Organization of Sanitary-Hygienic and Treatment-and-Prophylactic Measures in Radiation Accidents: Manual. Ed. Ilyin L.A., Moscow, VTsMK Zashchita Publ., 2005. 524 p. (In Russ.).
4. Arrangements for Preparedness for a Nuclear or Radiological Emergency. Safety Guide. IAEA Safety Standards Series No. GS-G-2.1. Vienna, IAEA, 2007. 159 p.
5. Preparedness and Response for a Nuclear or Radiological Emergency. General Safety Requirements No. GSR. Part 7. Vienna, IAEA, 2015. 136 p.
6. Grachev M.I., Kotenko K.V., Frolov G.P., Salenko Yu.A. Health-Care Provision to the Rescue and Other Emergency Operations in Case of Radiation Accidents at Facilities under FMBA of Russia Service. *Meditsina Truda i Promyshlennaya Ekologiya* = Russian Journal of Occupational Health and Industrial Ecology. 2012;10:28-32 (In Russ.).
7. Generic Procedures for Assessment and Response During a Radiological Emergency. IAEA-TECDOC-1162. Vienna, IAEA, 2000. 193 p.

СПИСОК ИСТОЧНИКОВ

1. Алексахин Р.М., Булдаков Л.А., Губанов В.А., Дрожко Е.Г., Ильин Л.А., Крышев И.И. и др. Крупные радиационные аварии: последствия и защитные меры / Под ред. Ильина Л.А., Губанова В.А. М.: Издат, 2001. 752 с.
2. IAEA Safety Glossary: 2018 Edition. Vienna: IAEA, 2019. 278 p.
3. Организация санитарно-гигиенических и лечебно-профилактических мероприятий при радиационных авариях: Руководство / Под ред. Ильина Л.А. М.: ВЦМК «Защита», 2005. 524 с.
4. Arrangements for Preparedness for a Nuclear or Radiological Emergency. Safety Guide. IAEA Safety Standards Series No. GS-G-2.1. Vienna: IAEA, 2007. 159 p.
5. Preparedness and Response for a Nuclear or Radiological Emergency. General Safety Requirements No. GSR. Part 7. Vienna: IAEA, 2015. 136 p.
6. Грачев М.И., Котенко К.В., Фролов Г.П., Саленко Ю.А. Медико-санитарное обеспечение аварийно-спасательных и других неотложных работ при радиационных авариях на предприятиях, обслуживаемых ФМБА России // *Медицина труда и промышленная экология*. 2012. № 10. С. 28-32.
7. Generic Procedures for Assessment and Response During a Radiological Emergency. IAEA-TECDOC-1162. Vienna: IAEA, 2000. 193 p.

8. Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency (Updating IAEA-TECDOC-953). Vienna, IAEA, 2003. 273p.

9. Radiation Medicine. A Guide for Medical Researchers and Healthcare Organizers. V.2. Radiation Damages. Ed. Ilyin L.A. Moscow, Izdat Publ., 2001. 432 p. (In Russ.).

10. Grachev M.I., Salenko Yu.A., Abramov Yu.V., Frolov G.P., Klochkov V.N., Kukhta B.A., et al. Operational Values of Radioactive Skin Contamination in the Case of Radiological Accident. *Meditsinskaya Radiologiya i Radiatsionnaya Bezopasnost* = Medical Radiology and Radiation Safety. 2020;65;3:20-26. DOI: 10.12737/1024-6177-2020-65-3-20-26 (In Russ.).

11. Lessons Learned from the Response to Radiation Emergencies (1945-2010). EPR-Lessons learned. Vienna, IAEA. 2012. 154 p.

12. Frolov G.P., Kazakevich E.V., Semenov A.E., Parabin P.V., Klimenko E.I. Organization Features of Reception and Sorting Department of Multi-Specialty Hospital in Situation of Admission of Patients from Radiation Emergency Zone. *Meditsina Katastrof* = Disaster Medicine. 2020;3:28-37. DOI: 10.33266/2070-1004-2020-3-28-37 (In Russ.).

13. Salenko Yu.A., Grachev M.I., Frolov G.P., Bogdanova L.S., Tesnov I.K. Experience of Anti-Accident Trials and Training with Participation of Medical Emergency Radiation Dosimetry Center. *Meditsina Truda i Promyshlennaya Ekologiya* = Russian Journal of Occupational Health and Industrial Ecology. 2017;4:28-33 (In Russ.).

8. Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency (Updating IAEA-TECDOC-953). Vienna: IAEA, 2003. 273 p.

9. Радиационная медицина: Руководство для врачей-исследователей и организаторов здравоохранения. Т.2. Радиационные поражения человека / Под ред. Ильина Л.А. М.: ИздАТ, 2001. 432 с.

10. Грачев М.И., Саленко Ю.А., Абрамов Ю.В., Фролов Г.П., Клочков В.Н., Кухта Б.А. и др. Операционные величины радиоактивного загрязнения кожи в случае радиационной аварии // Медицинская радиология и радиационная безопасность. 2020. Т.65, № 3. С. 20-26.

11. Lessons Learned from the Response to Radiation Emergencies (1945-2010). EPR-Lessons learned. Vienna: IAEA. 2012. 154 p.

12. Фролов Г.П., Казакевич Е.В., Семенов А.Е., Парабин П.В., Клименко Е.И. Особенности организации работы приемно-сортировочного отделения многопрофильной больницы в условиях поступления пациентов из зоны чрезвычайной ситуации радиационного характера // Медицина катастроф. 2020. № 3. С. 28-37.

13. Саленко Ю.А., Грачев М.И., Фролов Г.П., Богданова Л.С., Теснов И.К. Опыт проведения противоаварийных учений и тренировок с участием Аварийного медицинского радиационно-дозиметрического центра // Медицина труда и промышленная экология. 2017. № 4. С. 28-33.

Материал поступил в редакцию 11.10.21; статья принята после рецензирования 14.02.22; статья принята к публикации 21.03.22
The material was received 11.10.21; the article after peer review procedure 14.02.22; the Editorial Board accepted the article for publication 21.03.22

MONITORING OF PATIENTS IN SEVERE CONDITION IN LEVEL 1 AND LEVEL 2 MEDICAL TREATMENT ORGANIZATIONS – A TOOL FOR ORGANIZING MEDICAL CARE FOR PATIENTS AND VICTIMS IN EMERGENCY SITUATIONS

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Abstract. *The objective of the study* was to analyze the effectiveness of the "Monitoring" program for patients with new coronavirus infection and to evaluate its preparedness to work in emergency situations, as well as to substantiate the effectiveness of the program as a monitoring tool for patient care management in level 1 and level 2 medical treatment organizations when there is a shortage of intensive care beds at level 3 medical institutions.

Materials and research methods. Materials of the research: normative legal documents regulating the order of application of telemedicine technologies in Russia and Kuzbass, including in the field of the Disaster Medicine Service, scientific publications, personal work experience in the organization of remote consultations.

The research was based on the data on the provision of consultative medical care to the patients with the diagnoses "new coronavirus infection" and "community-acquired pneumonia", who were hospitalized in the intensive care departments of level 1 and level 2 medical treatment organizations.

Research results and their analysis. The retrospective analysis of the calls to the monitoring center from the patients in severe condition, being treated in level 1 and level 2 medical treatment organizations for the diagnoses of new coronavirus infection and pneumonia, who needed monitoring by the specialists of the consulting center (mainly by intensive care specialists), was performed.

Inclusion criteria in the study: adult patients with new coronavirus infection and pneumonia; receipt of call to the monitoring center during the study period – 01.11.2020-31.01.2022; availability of patient counseling using "Monitoring" program.

Conclusion was made, that the system, linking major hospitals with local hospitals, which have the maximum load in periods of peak morbidity, through conducting emergency and urgent telemedicine consultations was created in Kuzbass. The analysis of the obtained data testifies to the effective work of the monitoring center for severe patients as a type of telemedicine tool when working in high alert mode.

Key words: *emergency situations, Kuzbass Disaster Medicine Center, level 1 and level 2 medical treatment organizations, "Monitoring" patients with new coronavirus infection, pneumonia patients, program, severe patient monitoring center, telemedicine consultations, victims*

Conflict of interest. The authors declare no conflict of interest

For citation: K.S. Radivilko, P.V. Ploskonosov, D.A. Maslakova. Monitoring of Patients in Severe Condition in Level 1 and Level 2 Medical Treatment Organizations – a Tool for Organizing Medical Care for Patients and Victims in Emergency Situations. *Meditsina Katastrof = Disaster Medicine.* 2022;1:40-43 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-40-43>

МОНИТОРИНГ ПАЦИЕНТОВ В ТЯЖЕЛОМ СОСТОЯНИИ, ПОСТУПИВШИХ В СТАЦИОНАРЫ 1-го И 2-го УРОВНЯ – ИНСТРУМЕНТ ОРГАНИЗАЦИИ ОКАЗАНИЯ МЕДИЦИНСКОЙ ПОМОЩИ БОЛЬНЫМ И ПОСТРАДАВШИМ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ

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Резюме. *Цели исследования* – проанализировать эффективность работы программы «Мониторинг» с пациентами с новой коронавирусной инфекцией в условиях режима повышенной готовности; оценить готовность данной системы к работе в режиме чрезвычайной ситуации (ЧС).

Материалы и методы исследования. Материалы исследования: нормативные правовые документы, регламентирующие порядок применения телемедицинских технологий (ТМК), в том числе в сфере деятельности Службы медицины катастроф (СМК) Минздрава России, в Российской Федерации в целом и в Кузбассе, в частности, научные изыскания коллег в данной области исследования; личный опыт работы по организации проведения дистанционного консультирования. В основе исследования – данные об оказании консультативной медицинской помощи пациентам с диагнозами «новая коронавирусная инфекция» и «внебольничная пневмония», находившимся на стационарном лечении в отделениях реанимации лечебных медицинских организаций (ЛМО) 1-го и 2-го уровня Кемеровской области.

Критерии включения в исследование: взрослые пациенты с пневмонией и новой коронавирусной инфекцией; поступление заявки в центр мониторинга в период с 01.11.2020 г. по 31.01.2022 г.; выполнение консультации пациента через программу «Мониторинг».

Результаты исследования и их анализ. Проведен ретроспективный анализ заявок, поступивших в центр мониторинга пациентов в тяжелом состоянии, находившихся в ЛМО 1-го и 2-го уровня с диагнозом «пневмония» и «новая коронавирусная инфекция», нуждавшихся в контроле специалистов консультативного центра по различным профилям – в основном, по профилю «реаниматология».

Анализ результатов исследования позволяет говорить об эффективной работе центра мониторинга тяжёлых пациентов как разновидности телемедицинской системы при работе в режиме повышенной готовности.

Крупные стационары в лице врачей-консультантов могут оказывать значимую организационно-методическую поддержку при лечении большого числа пациентов ЛМО 1-го и 2-го уровня.

Оценку работы профильных консультативных центров в режиме повышенной готовности в системе мониторинга тяжелых пациентов можно считать подтверждением возможности использования данного инструмента в чрезвычайных ситуациях.

Ключевые слова: больные, Кузбасский центр медицины катастроф, лечебные медицинские организации 1-го и 2-го уровня, медицинская помощь, новая коронавирусная инфекция, пациенты в тяжелом состоянии, пневмония, пострадавшие, программа «Мониторинг», режим повышенной готовности, режим чрезвычайной ситуации, телемедицинские консультации

Конфликт интересов. Авторы сообщения подтверждают отсутствие конфликта интересов

Для цитирования: Радивилко К.С., Плосконосов П.В., Маслакова Д.А. Центр мониторинга пациентов в тяжелом состоянии, поступивших в стационары 1-го и 2-го уровня в Кузбассе – инструмент организации медицинской помощи, в том числе при чрезвычайных ситуациях // Медицина катастроф. 2022. №1. С. 40-43. <https://doi.org/10.33266/2070-1004-2022-1-40-43>

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The relevance of the problem of "complex" patients, especially when they are admitted to a hospital with an insufficient level of equipment or staffing capacity is of no doubt. Timely medical evacuation to the appropriate medical treatment organization certainly plays a significant role in the outcome of the disease [1-3].

Health care in Kuzbass (Kemerovo region) has a number of peculiarities. In the densely populated region there are only two major cities with a population of more than 600 thousand people — Novokuznetsk and Kemerovo. Patients from small towns are routed according to the agglomeration principle — patients in severe condition need to be transferred for treatment to medical treatment organisations of these cities. At the same time, neither in Kemerovo, nor in Novokuznetsk there are multidisciplinary hospitals, which would take a patient with a complex diagnosis without prior approval. The organizer of the transfer of such patients is the Emergency Consultative Medical Care (ECMC) department of the Kuzbass Center for Disaster Medicine, whose staff often encounter situations in which the patient's diagnosis or condition does not comply with existing regulations on routing. Often such a patient remains in the district hospital and his condition requires special monitoring by Level 3 medical organisation specialists until the patient is transferred or his condition improves.

In the conditions of health care reform and against the background of staff shortages in small hospitals, this period of patient care requires the solution of a strategically important task. That is the remote provision of highly qualified medical care using modern information technologies and the intellectual potential of specialists of large multidisciplinary hospitals [4, 5].

In order to solve this problem and to monitor patients requiring special attention, in 2018 on the basis of the Kuzbass Disaster Medicine Center the project "Monitoring center for patients in serious condition" (hereinafter — "Monitoring", Program) was created and put into practice as a type of telemedicine [6]. When developing the Program, the following requirements were taken into account: 24/7 accessibility, ease of use for all participants of the process,

including the ordinary medical staff of Level 1 — Level 2 hospitals. The program was installed in all inpatient units of Kuzbass, accepting patients for emergency indications ^{1,2}.

With the beginning of the pandemic of a new coronavirus infection COVID-19 "Monitoring" has become even more relevant, especially during the periods of peak waves of morbidity and organization of treatment of patients in re-assigned hospitals with a small number of transfers to large ones. With the development of the epidemiological process, approaches to the treatment of new coronavirus infection have changed and continue to change, placing new demands on specialists [7, 8]. The software product is also capable of change. For example, the latest change in the Program was a simplified form of telemedicine consultation protocol with the possibility of uploading and attaching it to the patient history.

Thus, in order to monitor the condition of critically ill patients in the intensive care unit of a Level 1 to Level 2 hospital, a system was created in Kuzbass, which ensures the collection of information in a short time according to specified parameters with the ability to assess the condition of patients by Level 3 medical organisation specialists, to conduct telemedicine consultations with protocol execution and determination of subsequent tactics.

During the COVID-19 pandemic about 70 patients with a new coronavirus infection who were in a serious condition were monitored through "Monitoring" at one time, which proved the effectiveness of its work in the emergency preparedness mode that was in effect in Kuzbass. The authors believe that in the emergency situation mode, this

¹ On the Approval of the Development Concepts of the Telemedicine Technologies in the Russian Federation and its Implementation Plan. Decree of the Ministry of Health of the Russian Federation, Russian Academy of Medical Sciences dated August 27, 2001, No. 344/76 (In Russ.) URL: <https://base.garant.ru/4177911/> (Date of access 17.03.2022).

² On the Approval of the Procedure for the Organization And Providing of Medical Care Using Telemedicine Technologies. Decree of the Ministry of Health of the Russian Federation, Russian Academy of Medical Sciences dated November 30, 2017, No. 965n (In Russ.). URL: <https://www.garant.ru/products/ipo/prime/doc/71751294/> (Date of access 17.03.2022).

product will be able to adjust to the specific features of the event and to provide comprehensive organizational and methodological support in solving complex clinical issues during the elimination of medical and sanitary consequences of emergency situation.

The aim of the study was to analyze the effectiveness of the "Monitoring" program with patients with new coronavirus infection COVID-19 in conditions of high readiness and to assess the readiness of this system to work in emergency situations.

Study Objectives:

1. To analyze the effectiveness of profile advisory centers in the conditions of high readiness mode — under the threat of emergency.

2. To substantiate the effectiveness of "Monitoring" as a tool to control the organization of treatment of patients in medical organisations of level 1 and 2 in conditions of shortage of intensive care beds in medical organisation of level 3.

Materials and methods. Materials of the study are the normative legal documents regulating the order of application of telemedicine technologies, including in the field of the Disaster Medicine Service of the Russian Ministry of Health — in the Russian Federation as a whole and in Kuzbass, in particular; scientific researches in this field; personal experience in organization of consultations. The study was based on the data on the provision of consultative medical care to patients with diagnoses of "new coronavirus infection" and "community-acquired pneumonia" who were hospitalized in the intensive care units of medical organisations of Level 1 and Level 2 of Kemerovo region. Inclusion criteria for the study: adult patients with pneumonia and new coronavirus infection; submission to the monitoring center in the period from 01.11.2020 to 31.01.2022; patient consultation through the monitoring program.

Results of the study and their analysis. A retrospective analysis of the monitoring center applications received from patients in a serious condition, who were in medical organisations of Level 1 and Level 2 with diagnoses "pneumonia" and "new coronavirus infection", who needed monitoring by specialists of the consulting center in different profiles — mainly in the profile "resuscitation" was carried out.

A total of 32 patients were enrolled in "Monitoring", of which 17 were Level 1 medical organisation patients and 15 — Level 2.

Patients were monitored according to the following scheme: when a patient meeting the criteria regulated by the order of the Ministry of Health of the Kemerovo region was admitted to the hospital, a Level 1 or Level 2 medical organisation physician entered his data into a special program (developed by the Kuzbass Medical and Analytical Center). A monitoring center paramedic (a disaster medicine center employee) determined the patient's profile and sent the patient's chart to the appropriate profile center. According to the current bicenter agglomeration model of Kuzbass health care, to help patients with new coronavirus infection, 5 profile advisory centers were organized on the basis of large re-profiled hospitals in the cities of Kemerovo and Novokuznetsk. The responsible consulting physician determined the tactics of patient management, the frequency of data entry, the advisability of a face-to-face consultation and transfer to a higher level hospital. In addition to leading intensive care specialists, consultations were conducted by "narrow" specialists — infectious disease specialists, pulmonologists, cardiologists and neurologists. A mechanism for paying consultants was developed and implemented. If necessary, a telephone conference call with recording of the conversation was conducted. In addition, a full-time employee of the monitoring center, an anesthesiologist and resuscitator, competently and timely resolved issues related to the patient's clinical condition and routing. In particularly complicated or controversial cases, the chief out-of-staff specialist, a departmental employee, or other competent persons could be involved in consultations.

All 3,159 patients diagnosed with pneumonia and/or new coronavirus infection who underwent "Monitoring" during the study period received full remote consultative assistance from specialists at consultative centers (Figure 1). The dynamics of severe patients' need for counseling had a wave-like character and coincided with the growth of the number of patients in the region. The number of monitored patients peaked in November 2020, July, and November 2021.

During the entire period of monitoring, as a result of the effective work of the specialists from the profile counseling centers: 1081 patients with persistent positive dynamics (34%) were transferred to somatic departments; 541 patients (17%) were transferred to a higher level organisation.

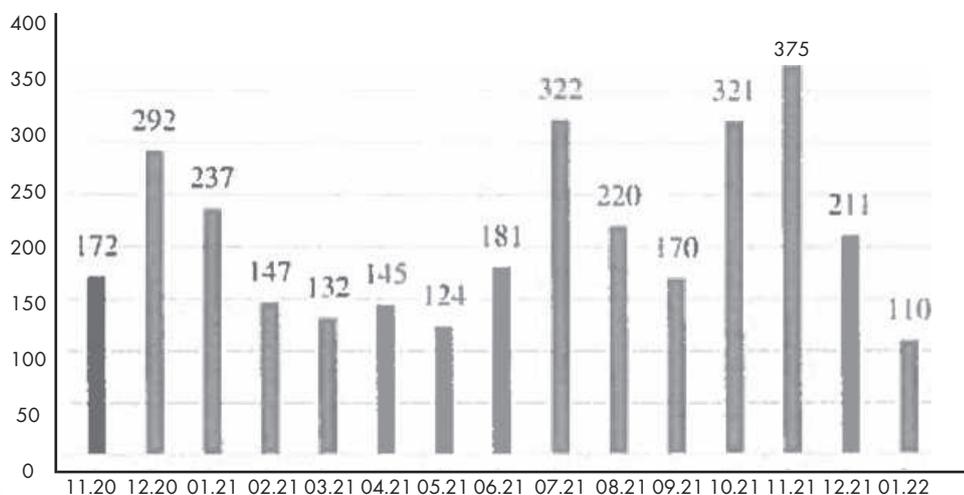


Рис. 1 Динамика числа тяжёлых пациентов (чел.), поступивших в ноябре 2020 – январе 2022 гг. в Единый центр мониторинга (ЕЦМ) для проведения дистанционного консультирования
Fig. 1. Dynamics of the number of patients with severe severity admitted to the UMC for remote consultation for November 2020 - January 2022

The proportion of patients removed from the monitoring due to death was 48% — 1,537 people. The high proportion of lethal outcomes was due to the fact that the following patients were monitored: initially in a serious condition; with polymorbid background; on high-flow ventilation; resistant



Рис.2 Результаты работы единого центра мониторинга за ноябрь 2020 - январь 2022 гг, %
Fig. 2. Results of the work of the unified monitoring center for November 2020 - January 2022

to treatment and conditionally untransportable. Expert work with chief out-of-staff specialists showed that only 5% of cases were "conditionally preventable" of lethal outcomes (Fig. 2).

Conclusion

1. The analysis of the results of the study allows us to speak about the effective work of the center for monitoring severe patients as a kind of telemedical system when working in high readiness mode.

2. In the Kemerovo region there is a system that links large hospitals with small hospitals, which have the maximum load in the periods of peak morbidity, by carrying out urgent and emergency telemedicine consultations.

3. Large hospitals, represented by consulting physicians, can provide meaningful organizational and methodological support in treating a large number of patients in medical organisations of Level 1 and Level 2.

4. Evaluation of the work in high availability mode of profile advisory centers in the system of monitoring of severe patients allows to judge about its effectiveness and readiness to work in conditions of emergency.

REFERENCES

1. Baranova N.N., Akinshin A.V., Goncharov S.F., Meshkov M.A., Zelenцов K.M., Pismenny V.P. Medical Evacuation of the COVID-19 Patients. *Emergency Medicine*. 2020;3:83-89 (In Russ.). <https://doi.org/10.47183/mes.2020.007>.
2. Piven D.V. Scientific Justification of the Implementation Model of the Telemedicine in the Regions of Siberia. Doctor's thesis in Medicine. 14.00.33. Central Research Institute of Healthcare Organization and Informatization. Moscow Publ., 2004. 300 p. (In Russ.).
3. Levanov V.M. Organizational and Medico-Social Aspects of the Telemedicine Technologies Application in the System of the Population Medical Support. Candidate's thesis in Medicine. 14.00.33. Ryazan State Medical University. Ryazan Publ., 2003. 192 p. (In Russ.).
4. Malinnikova E.Yu. New Coronavirus Infection. Today's View of the Pandemic of the XXI Century. *Infectious Diseases: News. Opinions. Training*. 2020;2:18-32 (In Russ.). URL: <https://base.garant.ru/4177911/> (Date of access 17.03.2022).
5. Radivilko K.S., Malinovsky S.V., Sychev I.A., Chikrina A.S. Monitoring Center of the Patients in the Severe State in the Structure of the Kemerovo Regional Center of Disaster Medicine: Problems, Development Perspectives. *Prioritetnyye Napravleniya Razvitiya Vserossiyskoy Sluzhby Meditsiny Katastrof v Sovremennykh Usloviyakh = Priority Directions of Development of the All-Russian Disaster Medicine Service in the Current Conditions*. Materials of the All-Russian Scientific and Practical Conference. Moscow, VTSMK Zashchita Publ., 2019. 58 p. (In Russ.).
6. Shakhobov I.V., Melnikov Yu.Yu., Smyshlyayev A.V. Features of the Development of Digital Technologies in Healthcare in the Context of the COVID-19 Pandemic. *Scientific Review. Medical Sciences*. 2020;6:66-71 (In Russ.).
7. Baranova N.N., Goncharov S.F. Medical Evacuation: Monitoring Problems, Routing and Quality Criteria. *Skoraya Meditsinskaya Pomoshch – 2019 = Emergency Medical Care-2019*. Materials of the 18th All-Russian Congress – All-Russian Scientific and Practical Conference with the International Participation. Ed. S.F.Bagnenko. St. Petersburg, May 30-31, 2019. St. Petersburg State Medical University named after I.P. Pavlov Publ., 2019. P. 14-15 [CD-ROM]. (In Russ.).
8. Minin A.S., Shen N.P., Tretyakov D.S., Panov I.D. Prognosis of Medical Evacuation in Patients with Cardiovascular Dysfunction. A Retrospective Study. *Bulletin of the Intensive Care* named after A.I.Saltanov. 2021;2:136-142 (In Russ.). DOI: 10.21320/1818-474X-2021-2-136-142.

СПИСОК ИСТОЧНИКОВ

1. Баранова Н.Н., Акиншин А.В., Гончаров С.Ф., Мешков М.А., Зеленцов К.М., Письменный В.П. Медицинская эвакуация больных COVID-19 // *Медицина экстремальных ситуаций*. 2020. № 3. С. 83-89. <https://doi.org/10.47183/mes.2020.007>.
2. Пивень Д.В. Научное обоснование модели внедрения телемедицины в регионах Сибири: Дис. ... докт. мед. наук: 14.00.33 / Центральный НИИ организации и информатизации здравоохранения. М., 2004. 300 с.
3. Леванов В.М. Организационные и медико-социальные аспекты применения телемедицинских технологий в системе медицинского обеспечения населения: Дис. ... канд. мед. наук: 14.00.33 / Рязанский государственный медицинский университет. Рязань, 2003. 192 с.
4. Малинникова Е.Ю. Новая коронавирусная инфекция. Сегодняшний взгляд на пандемию XXI века // *Инфекционные болезни: Новости. Мнения. Обучение*. 2020. №2. С. 18-32. URL: <https://base.garant.ru/4177911/> (дата обращения: 17.03.2022).
5. Радивилко К.С., Малиновский С.В., Сычѳв И.А., Чикрина А.С. Центр мониторинга пациентов в тяжелом состоянии в структуре Кемеровского областного центра медицины катастроф: проблемы, перспективы развития // *Приоритетные направления развития Всероссийской службы медицины катастроф в современных условиях: Матер. Всероссийской научно-практической конференции*. М.: ФГБУ «ВЦМК «Защита», 2019. С. 58.
6. Шахобов И.В., Мельников Ю.Ю., Смышляев А.В. Особенности развития цифровых технологий в здравоохранении в условиях пандемии COVID-19 // *Научное обозрение. Медицинские науки*. 2020. №6. С. 66-71.
7. Баранова Н.Н., Гончаров С.Ф. Медицинская эвакуация: проблемы мониторинга, маршрутизации и критериев качества // *Скорая мед. помощь-2019: Матер. 18-го Всерос. конгр. (Всерос. науч.-практ. конф. с междунар. участием), посвящ. 120-летию скорой мед. помощи в России, Санкт-Петербург, 30–31 мая 2019 г.* СПб.: ПСПбГМУ им. И.П.Павлова, 2019. С. 14-15.
8. Минин А.С., Шень Н.П., Третьяков Д.С., Панов И.Д. Прогноз медицинской эвакуации у пациентов с сердечно-сосудистой дисфункцией. Ретроспективное исследование // *Вестник интенсивной терапии им. А.И.Салтанова*. 2021. №2. С.136–142. DOI: 10.21320/1818-474X-2021-2-136-142.

Материал поступил в редакцию 28.02.22; статья принята после рецензирования 18.03.22; статья принята к публикации 14.03.22
The material was received 28.02.22; the article after peer review procedure 04.03.22; the Editorial Board accepted the article for publication 21.03.22

<https://doi.org/10.33266/2070-1004-2022-1-44-48>
UDK 159.944.2:614.23:578.834.1

Original article
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ASSESSMENT OF THE INFLUENCE OF STRESS ON THE PROFESSIONAL READINESS OF A DOCTOR

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Abstract. The aim of the study is to determine approaches to investigate the impact of COVID-19 pandemic stress on the professional preparedness of a physician.

Materials and research methods. Working hypothesis of the research is based on K. Maslach's model of three-dimensional structure of professional burnout. The physicians of Volgograd medical organizations took part in the study — N=112, mean age — (40,2±1,4) years, mean length of service — (6,2±1,7) years. As psychodiagnostic testing methods "Diagnosis of psychological rigidity" and "Determination of neuropsychological resistance and risk of maladaptation to stress" ("Prognoz") were used. The express interview, in which physicians of Volgograd city and Volgograd region, whose professional activity is connected with rendering of medical aid to patients with COVID-19 took part, was conducted on the basis of Google electronic platform using Google Forms (N=236). An additional questionnaire was developed for the model group of doctors, the purpose of which was to subjectively assess the respondents' opinion on the necessity of determining the preparedness of physicians for professional activity in extreme conditions.

Research results and their analysis. The results of the research showed the relevance of socio-psychological support of physicians working under extreme conditions in order to improve the quality of medical care.

Key words: COVID-19 pandemic, physicians, professional preparedness, professional stress, psychological preparedness

Conflict of interest. The authors declare no conflict of interest

For citation: Poroisky S.V., Donika A.D., Eremina M.V. Assessment of the Stress Impact on Physicians' Professional Preparedness. *Meditsina Katastrof = Disaster Medicine*. 2022;1:44-48 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-44-48>

<https://doi.org/10.33266/2070-1004-2022-1-44-48>
УДК 159.944.2:614.23:578.834.1

Оригинальная статья
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ОЦЕНКА ВЛИЯНИЯ СТРЕССА НА ПРОФЕССИОНАЛЬНУЮ ГОТОВНОСТЬ ВРАЧА

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Резюме. Цель исследования – определение подходов к исследованию влияния стресса, вызванного пандемией COVID-19, на профессиональную готовность врача.

Материалы и методы исследования. Рабочая гипотеза исследования базируется на модели трехмерной структуры профессионального выгорания К.Маслак. В исследовании приняли участие врачи медицинских организаций г.Волгограда – N=112, средний возраст – (40,2±1,4) лет, средний стаж работы – (6,2±1,7) лет. В целях психодиагностического тестирования применялись методики «Диагностика психологической ригидности» и «Определение нервно-психической устойчивости и риска дезадаптации в стрессе» («Прогноз»). Экспресс-опрос, в котором приняли участие медики г.Волгограда и Волгоградской области, чья профессиональная деятельность связана с оказанием медицинской помощи пациентам с COVID-19, был проведен на базе электронной платформы Google с использованием Google Formst (N=236). Для модельной группы врачей была разработана дополнительная анкета, цель которой – субъективная оценка мнения респондентов о необходимости определения готовности врачей к профессиональной деятельности в экстремальных условиях.

Результаты исследования и их анализ. Результаты исследования показали востребованность социально-психологического сопровождения профессиональной деятельности врача в экстремальных условиях для повышения качества оказания медицинской помощи.

Ключевые слова: врачи, пандемия COVID-19, профессиональная готовность, профессиональный стресс, психологическая готовность

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Поройский С.В., Доника А.Д. Еремина М.В. Оценка влияния стресса на профессиональную готовность врача // Медицина катастроф. 2022. №1. С. 44-48. <https://doi.org/10.33266/2070-1004-2022-1-44-48>

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Introduction. The influence of stress factors connected with professional activity has long been a subject of interest of specialists in the field of medicine, psychology, sociology, etc. The coronavirus infection pandemic made the study of the problem highly relevant for the professional group of doctors, as their professionalism today determines life and health of the population.

The aim of the study is to determine the approaches to study the influence of stress caused by the COVID-19 pandemic on the professional preparedness of a physician.

Research objectives:

1. Based on the review of domestic and foreign literature to show the relevance of the problem under consideration.

2. To determine the possibility of application of the methods used in the course of psychodiagnostic diagnostics with the aim to evaluate the socio-psychological preparedness of doctors to work in pandemic.

Materials and research methods. Scientific publications posted on eLIBRARY.RU, CrossRef, Google Scholar, PubMed, Scopus, etc. were used for literature review.

Doctors of medical treatment organizations of Volgograd took part in the study: N=112, mean age – (40.2±1.4) years, mean length of service – (6.2±1.7) years. According to the working hypothesis, assessment of the impact of COVID-19 pandemic stress in its ongoing spread cannot be reliable due to the incompleteness of the process by the time of the study. Thus, psychodiagnostics of physicians involved in the care of patients with COVID-19 creates an additional burden on the professional group and therefore seems unethical. Therefore, we used data obtained from psychodiagnostic testing of emergency medical teams doctors in the pre-pandemic period (November 2019). These are the doctors whose professional activity is associated with increased stress corresponding to pandemic conditions (uncertainty factor, need for emergency decisions, reaction to patient mortality, complex work schedule, etc.), which allows us to consider them as a model group. Volgograd medical treatment organisations general practitioners were involved as a control group. Confidentiality norms were observed in relation to the respondents.

For psychodiagnostic testing the methods "Diagnostics of psychological rigidity" and "Determination of neuropsychological stability and risk of desadaptation under stress" ("Forecast") [1] were applied. The method "Diagnosis of psychological rigidity" allows to identify a high level of rigidity, which indicates the usage of protective mechanisms under the influence of professional stressors, accompanied by a shortage of time, and complicates the decision-making process. Rigidity reaction as a stable personal characteristic interferes with the formation of mental readiness in the situation of changes in the external environment. And, thus, it reduces the abilities of implementing the professional role of the doctor [1].

The "Forecast" ("Prognoz") method for determining the neuropsychological stability and risk of maladaptation in

stress developed at the Kirov Military Medical Academy for the professional selection of doctors involved in emergency situations has shown sufficient validity and informativeness in numerous studies [2, 3].

According to the working hypothesis of our study, the selected techniques involve the use of oppositely directed assessment scales, allowing to determine the personal qualities of the study group in gradations "+" and "-" in the context of resistance to stressogenic factors.

The express survey was conducted on the basis of Google electronic platform using Google Forms (N=236). Medical specialists of Volgograd city and Volgograd region, whose professional activity is connected with rendering medical care to patients with COVID-19, took part in the survey.

An additional questionnaire was developed for the model group of doctors. It's purpose was the subjective evaluation of respondents' opinion on the necessity to determine doctors' readiness for professional activity in extreme conditions.

In the study we analyzed a publicly available questionnaire developed at Stanford University to assess the impact of stress caused by COVID-19 pandemic.

The data were mathematically processed by methods of variance statistics, calculating parametric (Student t-criterion) criteria of variance using the Excel for Windows Statistica 17.0 software package.

Results of the study and their analysis. The analysis of modern scientific research data has shown a significant influence of professional stress on the realisation of the doctor's professional role. The data refers to the three-dimensional structure of professional burnout syndrome by K. Maslak including emotional exhaustion, depersonalization and personal achievements decrease [4]. Emotional exhaustion is manifested by fatigue (doctors have "compassion fatigue"), somatic symptoms, decrease of emotional resources and characterizes a state of emotional overstrain that turns into exhaustion. Depersonalization of doctors manifests itself in a negative, impersonal, cynical attitude toward patients. A decrease in personal achievements means a feeling of incompetence and ineffectiveness of professional activity [5].

Symptom manifestation and formation of professional burnout syndrome phases determine the degree of professional stress influence on professional role realization – from initial manifestations to the symptoms of emotional detachment and depersonalization [6]. In addition, the manifestation of the exhaustion phase is expressed by psychosomatic symptoms reducing the professional functionality of doctors. A number of publications report that physicians experiencing a burnout are subjected to a higher risk of erroneous judgment or medical errors, refusal to work, demonstration of hostility towards patients, as well as to a higher risk of conflicts within the team [7].

Some aspects of the prevalence of professional burnout syndrome among physicians have been assessed differently in foreign studies. For example, publications in the United

States report a higher prevalence of professional burnout syndrome among female physicians, while European studies report the opposite trend, i.e., a higher prevalence of professional burnout syndrome among men [8, 9]. In general, foreign works show the influence of a number of demographic factors on the increased risk of professional burnout syndrome, such as young age, female gender, unstable marital status, long working hours, and low level of job satisfaction [10].

A number of studies have shown a more pronounced resistance to the influence of occupational stress in doctors with a higher level of satisfaction with their medical practice — dermatologists, pediatricians, specialists in preventive medicine, obstetrics and gynecology. Interestingly, a number of studies also showed that specialists in general surgery and therapy, despite the lowest work-life balance satisfaction indexes, had lower than average burnout indexes. Whereas specialists, for example, in neurology, with high burnout indexes were not necessarily the least satisfied with their work [11]. This allows to conclude that achieving a work-life balance or increasing job satisfaction can counteract a burnout and, hence, determine psychotherapeutic strategies of burnout management in doctors.

Despite the discrepancies in the data on certain indicators, the observed prevalence of professional burnout syndrome in the professional group of doctors is of an international nature, which allows us to use the data of foreign researchers to design research tasks in Russian realities.

The modern scientific works determine the risk factors of professional burnout syndrome. They include not only those related to saving life and health (feeling of helplessness, frustration, professional failures), but also those of organizational nature (bureaucracy, necessity of constant improvement of knowledge and skills in conditions of rapidly developing medical technologies, compulsory informatization of medical reporting, etc.). Thus, the impact of professional stressors occurs not only within the doctor-patient relationships, but also outside them. So, in the publication of the World Medical Association it was noted: "In many countries doctors experience great disappointment in professional practice both because of limited resources, governmental or corporate management, and because of sensational media reports about medical errors and unethical behavior of doctors or their professional incompetence...". [12: c.14].

The situation is much similar in Russia. On the eve of the coronavirus pandemic there was an aggressive media attitude towards doctors, provoking the growth of patients' dissatisfaction with the quality of medical care provided. It should be noted that in Russia, perhaps more than in any other country, during the pandemic the position of the mass media sharply changed in the direction of glorification of the medical profession against the background of the obvious growth of doctors' authority. At the same time, the effect of stress has a prolonged effect, and the positive effect of 2-3 months cannot absolutely neutralize the previous information pressure.

Our express survey using Google Forms service (N=236) confirms the influence of COVID-19 pandemic as a stress factor on the professional activity of doctors. When asked, "Do you consider the impact of the COVID-19 spread to be a stressor?" 100% of respondents gave a positive answer. At the same time, when answering the question, "Do you think that the COVID-19 proliferation stress negatively affects

your professional activity?" the respondents' opinions were distributed as follows: 37.3% thought "negatively affects"; 58.9 thought "does not affect"; and 3.7% thought "rather mobilizes", $p < 0.5$.

The results of testing physicians using the Diagnostic of Psychological Rigidity technique did not reveal statistically significant differences between the average rigidity values of the model (30.19 ± 2.04) and control (30.05 ± 2.49) groups (table).

Таблица / Table

Среднее значение ригидности у врачей модельной и контрольной групп
The average value of the rigidity of doctors in the model and control groups

Группа врачей Groups of doctors	Среднее значение ригидности, $M \pm \sigma$ The average value of the rigidity, $M \pm \sigma$	
	психотип «ригидный» "rigid" psychotype	проявляет черты ригидности — не сформировавшийся психотип / exhibits rigidity traits — unformed psychotype
Модельная Model group	30,19±2,04	23,73±2,6
Контрольная Control groups	30,05±2,49*	24,17±2,36*

* $p < 0,05$ между показателями в группах / between indicators in groups

At the same time, according to the distributional analysis, a high level of rigidity was observed in 32.7% of doctors in the model group and in 57.1% in the control group, $p > 0.5$. In both groups, the average gradations of the index prevail — 58.8 and 57.1%, respectively, $p > 0.5$. Among women, the traits of rigidity manifested: in the control group — 76.9%, in the model group — 61.2%. In the control group, 65.2% of men and 23.1% of women possess rigidity traits, $p < 0.01$. For the model group, the indicated values were 45.1 and 38.7% for men and women, respectively, $p > 0.5$.

The results of testing according to the "Forecast" technique showed that the majority of the examinees in both groups had levels of neuro-psychological stability of the gradation "average" or higher. The average score on the NPU scale ($M \pm m$) was $13,8 \pm 0,74$ in all the examinees and had no significant differences in the groups, $p > 0,05$.

At the same time, the distributional analysis revealed reliable differences between individuals with different levels of neuropsychological stability in the groups. Thus, the model group revealed fewer individuals with a low level of neuropsychological stability than the control group - 8,2%; $p < 0,01$. The majority of physicians in the model group had an "above average" level of neuropsychological stability - 74.3%; $p < 0.05$. At the same time, in the control group, approximately half of the examinees had levels of neuropsychological stability of average and above average — 49.2%: 42.4% — average level, 6.8% — above average, $p < 0.5$.

A survey of physicians in the model group showed that most of them (87.8%) believe that not every physician can effectively perform their professional functions in extreme conditions. At the same time, 56,7% of respondents noted that in order to work in such conditions a doctor must have specific personal qualities, and 47,8% of respondents believed that such qualities are formed as a result of professional training. Of interest is the fact that the doctors in the model group almost unanimously denied a gender approach to the problem in question. Thus, to the question

"Do you think that female doctors are more sensitive to stress and therefore less prepared to work in extreme conditions?" 89.2% of respondents chose the answer options "no" and "more likely no than yes." Physicians were also unanimous in recognizing the advisability of socio-psychological monitoring of professional activity in extreme conditions in order to prevent and to timely diagnose psychosomatic reactions to stress — 92.3%.

Thus, the influence of stress associated with the professional activity of the doctor is clearly demonstrated by the high prevalence of professional burnout syndrome noted in modern studies. Its symptomatology and severity characterizes the influence of stress on the realization of the professional role — from "compassion fatigue" to "cynical attitude towards patients". Currently, physicians themselves note the influence of an additional stressor caused by the spread of coronavirus infection. In this connection, an important element in improving the quality of medical care in the current realities is the diagnosis of doctors' preparedness for professional activity in extreme conditions.

Our study has shown that doctors choose their professional field in accordance with their personal characteristics. In the model group of doctors, whose activity is associated with higher neuro-emotional stress, individuals with a high level of neuro-psychological stability and less often individuals with high levels of rigidity, exhibiting excessive emotional impressionability and inability to self-regulate under stressful conditions are observed more frequently.

At the same time, in the model group there were observed from 8.5 to 32.7% of persons with personality traits indicators that do not meet the requirements for the implementation of the professional role in extreme conditions, which allows

to predict an increase in the number of doctors with professional burnout syndrome and other signs of professional maladaptation in pandemic conditions.

To detect COVID-19 stress, a Stanford University-based questionnaire with the ability to progressively fill the database and to statistically process it online has been developed [13]. The questionnaire is the result of a collaboration with the Stanford Department of Neurosurgery and the Stanford Department of Psychiatry; the development team was led by Dr. Maheoo Mausoo Adamson. The developers stated the purpose of the survey was to measure stress levels during the pandemic, with the ability to describe them according to location, gender, income, occupation and other factors — homeschooling, full-time remote work, social distancing, etc. The proposed Coronavirus Anxiety Scale (CAS) is a self-assessment psychoanalytic screening of dysfunctional anxiety associated with the spread of coronavirus, identifying symptoms that may require further assessment or treatment. A separate block of questions is related to professional activity, which suggests the emergence of data on the impact of the stress on the professional group of doctors as well, taking into account a number of socially conditioned criteria.

Conclusion

1. The authors consider, that for increase of efficiency of medical aid rendering in the conditions of pandemic, the psychodiagnostic techniques allowing to estimate both resistance to stress and readiness for work under stress are in great demand.

2. The application of the techniques considered in our work will make it possible to screen doctors for work in the "red zone", which is especially relevant in the case of the predicted second wave of coronavirus infection.

СПИСОК ЛИТЕРАТУРЫ

1. Райгородский Д.Я. Практическая психодиагностика. Методики и тесты: Учебное пособие. Самара: Издательский Дом БАХРАХ-М., 2015. С. 672–688.
2. Поройский С.В. Готовность врача скорой медицинской помощи к профессиональной деятельности в экстремальных ситуациях // Волгоградский научно-медицинский журнал. 2015. №1. С. 8–10.
3. Donika A.D., Poroykiy S.V., Eremina M.V. Methods of evaluation of neuro-psychological stability for the diagnostics of prenozoological status in extreme conditions. *International Journal of Pharmacological Research*. 2019. T. 11. С. 184–187.
4. Maslach C., Jackson S. *Burnout Inventory manual*. 2nd ed. Consulting Psychologist Press; Palo Alto, CA, USA: 1986. [Электронный ресурс]: Режим доступа: https://scholar.google.com/scholar_lookup?title=Maslach+Burnout+Inventory+manual&author=C.+Maslach&author=S.+Jackson&publication_year=1986 (Дата обращения: 12.05.2020).
5. Корехова М.В., Соловьев А.Г., Киров М.Ю. Синдром профессионального «выгорания» у врачей анестезиологов-реаниматологов // Вестник анестезиологии и реаниматологии. 2016. Т.13. С. 19–27.
6. Синбухова Е.В., Лубнин А.Ю. Эмоциональное выгорание врачей анестезиологов-реаниматологов // Акмеология. 2018. Т.4. С. 60–67.
7. Balch C.M., Freischlag J.A., Shanafelt T.D. Stress and burnout among surgeons: Understanding and managing the syndrome and avoiding the adverse consequences. *Arch. Surg.* 2015; 144: 371–376.
8. Dyrbye L.N., Shanafelt T.D., Balch C.M., Satele D., Sloan J., Freischlag J. Relationship between work-home conflicts and burnout among American surgeons: A comparison by sex. *Arch. Surg.* 2015; 146: 211–217.
9. Soler J.K., Yaman H., Esteva M., Dobbs F., Asenova R.S., Katic M., Ozvacic Z., Desgranges J.P., Moreau A., Lionis C., et al.

REFERENCES

1. Raygorodskiy D.Ya. *Prakticheskaya Psikhodiagnostika. Metodiki i Testy* = Practical Psychodiagnos-tics. Methods and tests. Tutorial. Samara, Bakhrahk-M Publ., 2015. P. 672-688 (In Russ.).
2. Poroykiy S.V. Preparedness of an Emergency Doctor for Professional Activities in Extreme Situa-tions. *Volgogradskiy Nauchno-Meditsinskiy Zhurnal* = Volgograd Journal of Medical Research. 2015; 1:8-10 (In Russ.).
3. Donika A.D., Poroykiy S.V., Eremina M.V. Methods of Evaluation of Neuro-Psychological Stability for the Diagnostics of Preno-zological Status in Extreme Conditions. *International Journal of Pharmaceuti-cal Research*. 2019; 11; 1:184-187.
4. Maslach C., Jackson S. *Burnout Inventory Manual*. 2nd ed. Consulting Psychologist Press; Palo Alto, CA, USA: 1986. Available at:https://scholar.google.com/scholar_lookup?title=Maslach+Burnout+Inventory+manual&author=C.+Maslach&author=S.+Jackson&publication_year=1986 (date of access: 12 May, 2020).
5. Korekhova M.V., Solovyev A.G., Kirov M.Yu. Syndrome of Professional "Burnout" by Anesthesiol-ogists-Resuscitators. *Vest-nik Anesteziologii i Reanimatologii* = Messenger of Anesthesiology and Resusci-tation. 2016; 13;3:19-27 (In Russ.).
6. Sinbukhova E.V., Lubnin A.Yu. Emotional Burnout of Resusci-tation Anesthetists. *Akmeologiya*. 2018;4:60-67 (In Russ.).
7. Balch C.M., Freischlag J.A., Shanafelt T.D. Stress and Burnout Among Surgeons: Understanding and Managing the Syndrome and Avoiding the Adverse Consequences. *Arch. Surg.* 2015; 144:371–376.
8. Dyrbye L.N., Shanafelt T.D., Balch C.M., Satele D., Sloan J., Freischlag J. Relationship between Work-Home Conflicts and Burnout among American Surgeons: A Comparison by Sex. *Arch. Surg.* 2015; 146:211–217.
9. Soler J.K., Yaman H., Esteva M., Dobbs F., Asenova R.S., Katic M., Ozvacic Z., Desgranges J.P., Moreau A., Lionis C., et al. Burnout in European Family Doctors: The EGPRN Study. *Fam. Pract.* 2015;25:245–265.

Burnout in European family doctors: The EGPRN study. *Fam. Pract.* 2015; 25: 245–265.

10. Amofo E., Hanbali N., Patel A., Singh P. What are the significant factors associated with burnout in doctors? *Occup. Med.* 2015; 65: 117–121.

11. Shanafelt T.D., Boone S., Tan L., Dyrbye L.N., Sotile W., Satele D., West C.P., Sloan J., Oreskovich M.R. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Arch. Intern. Med.* 2015; 8: 1377–1385.

12. World Medical Association Medical Ethics Manual - 2nd Edition. [Электронный ресурс]: Режим доступа: http://www.wma.net/en/30publications/30ethicsmanual/pdf/chap_6_en.pdf. (Дата обращения: 10.05.2020).

13. Maheen Adamson. Psychological Stress Associated with the COVID-19 Crisis. [Электронный ресурс]: Режим доступа: https://www.nlm.nih.gov/dr2/Psychological_Stress_Associated_with_the_COVID19_Crisis_14.pdf. (Дата обращения: 20.05.2020).

10. Amofo E., Hanbali N., Patel A., Singh P. What are the Significant Factors Associated with Burnout in Doctors? *Occup. Med.* 2015;65:117–121.

11. Shanafelt T.D., Boone S., Tan L., Dyrbye L.N., Sotile W., Satele D., West C.P., Sloan J., Oreskovich M.R. Burnout and Satisfaction with Work-Life Balance among US Physicians Relative to the General US Population. *Arch. Intern. Med.* 2015;8:1377–1385.

12. World Medical Association Medical Ethics Manual. 2nd Edition: Available at: http://www.wma.net/en/30publications/30ethicsmanual/pdf/chap_6_en.pdf. (date of access: May 10, 2020).

13. Maheen Adamson. Psychological Stress Associated with the COVID-19 Crisis. Available at: https://www.nlm.nih.gov/dr2/Psychological_Stress_Associated_with_the_COVID19_Crisis_14.pdf. (date of access: May 20, 2020).

*Материал поступил в редакцию 06.12.21; статья принята после рецензирования 20.12.22; статья принята к публикации 21.03.22
The material was received 06.12.21; the article after peer review procedure 20.12.22; the Editorial Board accepted the article for publication 21.03.22*

CLINICAL ASPECTS OF DISASTER MEDICINE КЛИНИЧЕСКИЕ АСПЕКТЫ МЕДИЦИНЫ КАТАСТРОФ

<https://doi.org/10.33266/2070-1004-2022-1-50-52>
UDC 796.034.6:616.03

Review report
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MODERN POSSIBILITIES OF CORRECTION OF CIRCADIAN RHYTHM DISORDERS

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Abstract. *The aim of the study is to systematize data on modern opportunities for correction of circadian rhythm disorders.*

Materials and research methods. The domestic and foreign literature on the prevention and treatment of desynchronization was analyzed. The search was performed using electronic databases MEDLINE, Embase, Scopus, Web of Science, and eLIBRARY for 2012-2021. The keywords "desynchronization", "treatment", "prevention" and their combinations were used for the search.

Research results and their analysis. The results of the research showed that the following methods of correction of circadian rhythm disturbances are currently available: diet, taking melatonin, changing sleep regime, changing physical activity schedule. It was noted that when forming an optimal training schedule, it is important to take into account the chronotype of the athlete. Exogenous melatonin can be used to normalize sleep, but turning off artificial light 1.5-2 hours before sleep and not eating at night is considered a better option. This approach will allow the athlete to maximize his/her potential, to achieve better athletic performance and to prevent desynchronization.

Key words: *athletes, chronotype, circadian rhythms, correction, desynchronization*

Conflict of interest. The authors declare no conflict of interest

For citation: Samoylov A.S., Rylova N.V., Bolshakov I.V., Galkina E.V. Modern Opportunities for Correction of Circadian Rhythm Disorders. *Meditsina Katastrof = Disaster Medicine.* 2022;1:49-52 (In Russ.). //doi.org/10.33266/2070-1004-2022-1-49-52

<https://doi.org/10.33266/2070-1004-2022-1-49-52>
УДК 796.034.6:616.03

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СОВРЕМЕННЫЕ ВОЗМОЖНОСТИ КОРРЕКЦИИ НАРУШЕНИЙ ЦИРКАДНЫХ РИТМОВ

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Резюме. *Цель исследования – систематизация данных о современных возможностях коррекции нарушений циркадных ритмов.*

Материалы и методы исследования. Проанализированы данные отечественной и зарубежной литературы о профилактике и лечении десинхронозов. Поиск проводился с использованием электронных баз данных MEDLINE, Embase, Scopus, Web of Science, eLIBRARY за 2012–2021 гг. Для поиска использовались ключевые слова «десинхроноз», «лечение», «профилактика» и их сочетания.

Результаты исследования и их анализ. Результаты исследования показали, что в настоящее время существуют следующие методы коррекции нарушений циркадных ритмов: диета, прием мелатонина, изменение режима сна, изменение графика физической активности. Отмечено, что при формировании оптимального тренировочного графика важно учитывать хронотип спортсмена. Для нормализации сна допустимо применять экзогенный мелатонин, но более оптимальным вариантом считается выключение искусственного освещения за 1,5–2 ч до сна и отказ от приема пищи в ночное время. Данный подход позволит спортсмену максимально эффективно использовать свой потенциал, добиться более высоких спортивных результатов и предотвратит развитие у него десинхроноза.

Ключевые слова: *десинхроноз, коррекция, спортсмены, хронотип, циркадные ритмы*

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: *Самойлов А.С., Рылова Н.В., Большаков И.В., Галкина Е.В. Современные возможности коррекции нарушений циркадных ритмов // Медицина катастроф. 2022. №1. С. 49-52.*
<https://doi.org/10.33266/2070-1004-2022-1-49-52>

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Circadian rhythms (from the Latin words *circa*, "about, around" and *dies*, "day") are systematically repeated changes in various biological processes in the human body associated with the changing times of the day. Many circadian rhythms have been identified, including the rhythms of internal body temperature, rhythms of cortisol and melatonin secretion, sleep and wakefulness cycles [1]. In all mammals, the part of the nervous system responsible for the organization of circadian behavior is located in a paired structure in the hypothalamus known as the suprachiasmatic nuclei (SCN). The suprachiasmatic nuclei are considered to be the main regulator coordinating circadian rhythms. Information about daylight hours is transmitted from the subcortical center via the retinohypothalamic pathway directly to the SCN [2]. The received information is integrated by the brain, which changes the activity of its neurons and forms neural and humoral signals for the whole organism. Thus, SCNs influence other body systems like a clockwork mechanism [3].

Nowadays, especially in an urban environment, humans are subjected to a chaotic life rhythm, which leads to a deterioration in the quality of sleep and daytime activity. In people who work at night or frequently travel in different time zones, disturbances in the rhythm of sleep and wakefulness lead to a conflict between the circadian system and the signals received from the environment [4, 5]. At the same time, a balanced circadian organization is necessary to prepare the body for daytime activity and requires a well-coordinated synchronization with the day-night cycle. Epidemiological and experimental studies show that constant exposure to factors that cause circadian rhythm disruption increases the risk of metabolic, cardiovascular and cancer diseases [5].

Thus, the influence of desynchronization on the human organism is exclusively negative. At the same time, it can be argued that in the future, the deleterious effects of circadian rhythm disturbances caused by frequent time zone changes and unbalanced lifestyle will become more widespread. Therefore, it is currently very relevant to consider the need for pharmacological and non-pharmacological correction of circadian rhythm disturbances. This issue is particularly relevant for athletes, because the state of desynchronization can reduce the effectiveness of training and ultimately affect athletic performance.

Chronotypes

Because many people have a certain similarity and regularity in the functioning of biorhythms, several so-called chronotypes have been identified. A discrepancy between training timetable and an athlete's chronotype can lead to a chronic state of desynchronization. In this case a decrease in performance, poor well-being, headache and bad mood can be observed. In this connection, it is important to consider the issue of circadian typology.

A chronotype is an expression of circadian activity in a person. Three categories of chronotypes have been defined: the

morning type (M-type), the evening type (E-type), and the intermediate type (N-type), which does not belong to the first two. While the M-type shows a peak of activity of a person's psychophysiological parameters mainly in the morning hours, the E-type is characterized by a peak of activity in the evening, the N-type is something in between the M and E-types [6]. Thus, a chronotype is a characteristic predisposition of a person to morning or evening activity, usually assessed with the help of questionnaires. The most commonly used questionnaire is the Morningness-Eveningness Questionnaire — MEQ [7].

Studies have shown that exogenous, endogenous and psychobiological (lifestyle) factors simultaneously influence fluctuations in daily performance. Body temperature is considered to be an endogenous indicator of the human circadian rhythm. There is a connection between body temperature and sports performance: increased body temperature contributes to more intensive use of carbohydrates and facilitates muscle fiber contraction mechanism during physical activity, which in its turn increases an athlete's performance [8]. An important endogenous indicator of circadian rhythm is also cortisol, whose peak concentration is observed in the early morning hours. This substance is considered a marker of psychophysiological stress and is associated with a decrease in athletic performance [9].

In different chronotypes, the time of reaching the maximum values of oral temperature and cortisol levels differs. E-types were found to have a maximum serum cortisol concentration on average 55 min later, and maximum body temperature values 2 h later than M-types. In addition, M-types show an increase in serum melatonin concentration about 3 h earlier than E-types. Consequently, M-types tend to wake up and to go to bed earlier than other chronotypes. It is important to note here that age and gender have a significant effect on chronotype: women and the elderly demonstrate a strong predisposition to morning type activity compared to young people [10]. There is also evidence that M-type athletes feel better when they perform submaximal exercise in the morning, while E-type athletes expend more effort to achieve the same results in the morning hours [11, 12].

Based on the above, it should be emphasized that the determination of an athlete's chronotype can be crucial for the design of effective training programs and the prevention of desynchronization. It is necessary to take into account the activity features of each type: M-types are most active in the morning; E-types in the evening; N-types in the middle of the day.

Nutrition and desynchronization

In addition to preparing the body for daytime activity, the circadian system regulates eating behavior. The rate of peristalsis and motility of the human gastrointestinal (GI) tract peaks in the morning hours. Experimental studies have shown that during wakefulness a certain type of bile acid and protein transporter secretion optimizes digestive functions [5].

It has also been found that diurnal rhythms of the human gut microbiota improve energy metabolism during the active phase of wakefulness and promote detoxification during the sleep phase [5, 13]. Thus, eating during daylight hours is most optimal. However, with the proliferation of artificial light, people have deviated from the original eating regimen only during daylight hours. It has been shown that food intake that does not coincide with natural circadian rhythms negatively affects human health. In particular, disruption of the normal sleep-wake cycle and eating at night have been associated with an increased risk of obesity and metabolic syndrome [5].

Based on the data on the variability of the functional state of the gastrointestinal tract during the day and the influence of meal timing on circadian rhythms, diets potentially effective for the treatment of desynchronization have been proposed. In particular, a study was conducted on the Argonne diet, which can be used when traveling to another time zone and is based on a diet based on the principle: PIR — fasting — PIR — fasting [14]. Four days before the day of arrival at the destination, the diet begins according to the following pattern. The first day is PIR: on this day breakfast and lunch should be rich and high in protein, and dinner should be high in carbohydrates. The second day is a FAST, light meals, low-carbohydrate foods. The third day is FAST again. The fourth day is a FAST, which continues until breakfast at the destination. All four days alcohol intake is prohibited. High-protein breakfasts and lunches stimulate an active physical waking cycle, providing a burst of strength and energy, while high-carbohydrate dinners induce sleep [15]. Light unloading days of "fasting" help restore the biological digestive clock, adapting it to the conditions of the new environment even before arriving in the new time zone.

Another way to restructure circadian rhythms of nutrition is to use the technique of time-restricted feeding (TRF) [16]. The essence of the method consists in fasting intervals, so-called "food windows" between meals. The duration of a food window is 4-10 hours. The general theory behind TRF is that the diet mimics natural eating patterns based on circadian rhythms. Applying TRF in humans results in eating during daylight hours, when the body is in an active waking state, and not eating at a time when the body is preparing for sleep. The results suggest that the use of this diet reduces the risk of weight gain, increases blood lipoprotein levels, provides optimal glucose homeostasis, and promotes faster adaptation to a new time zone [13]. In contrast, disruption of diet and eating at night have a disruptive effect on circadian synchronicity and alter metabolism [17]. Although the relationship between circadian rhythms and metabolism and nutrition still requires further study, it would not be incorrect to state that there is a close relationship between biorhythms and diet.

Thus, in order to adapt more quickly and adjust circadian rhythms to the new regime, one can use a change of habitual diet. This can be done either in advance of the planned trip, or immediately after the flight. Using a diet accelerates adaptation to a new time zone, prevents circadian desynchronization, and has a favorable effect on the metabolism.

Sleep as a criterion for biorhythm optimization

Sleep is the most important function of the body, providing rest and recovery for the entire body. Athletes often have strict training schedules and business trips with a change of time zones, which against the background of mental stress can have a negative impact on the quality and duration of

sleep [18]. Also the frequent use of electronic devices contributes, as many of those devices are capable of increasing nighttime light levels. Some of these devices emit monochromatic blue light (λ max, 460-480 nm), to which light-sensitive retinal ganglion cells are particularly sensitive. Exposure to such light suppresses melatonin production at night [19]. As a result, even low light levels at night delay the onset of sleep, which leads to a worsening of morning well-being in the form of drowsiness and lethargy.

Most adults require 6-8 hours of sleep per night, while athletes may require more. Inadequate sleep in the general population is associated with many negative health outcomes, including neurocognitive, metabolic, immunological, and cardiovascular dysfunction [19]. Sleep disturbance also negatively affects growth hormone and cortisol secretion. It was found that when the circadian rhythm is disturbed and the total duration of sleep is reduced, cortisol levels increase, which leads to the predominance of catabolic processes in the body over anabolic ones [20]. Consequently, athletes who maintained an adequate sleep regimen prior to competition are likely to have an advantage in terms of maximal performance. Increased sleep duration in athletes improves sprint times, accuracy of serve when playing tennis, and increased time spent training with exertion. Cognitive test scores, reaction time, and attention levels also improve [21].

The issue of daytime sleep also deserves attention. If an athlete cannot get a good night's sleep, incorporating daytime sleep into his regimen for the next 24 hours will have a positive effect. This method is worth using when the coach or the athlete himself is aware of the impending disruption of full sleep due to a late return to the place of rest, travel or flight [22].

Melatonin and Sleep

Sleep patterns are mainly regulated by light exposure and melatonin secretion. Melatonin is a derivative of serotonin and is secreted by the pineal gland, which synthesizes and secretes melatonin constantly, but most intensively at night. This process peaks between 2:00 and 4:00 a.m. and is followed by a gradual decrease in secretion. Melatonin has a sedative effect and promotes sleep, which is due to its action on the suprachiasmatic nuclei of the hypothalamus. In addition, melatonin causes a hypothermic effect, reducing the temperature of the internal environment of the body, has an antioxidant and immunomodulatory effect [23].

The use of exogenous melatonin has been found to be effective for the prevention and treatment of circadian rhythm disturbances after crossing several time zones. This drug acts as a chronobiotic and can shorten the time needed to restore one's own circadian rhythms after traveling. Melatonin is recommended when crossing 5 or more time zones. In particularly predisposed individuals, it can be used when crossing time zones. Recommended two to four doses are 0.5 to 5 mg. Higher doses have not been shown to be effective in adapting to a new time zone, but have been more effective as a sleeping aid [24].

In addition to melatonin, benzodiazepine-type medications can be used, but there is a high risk of side effects such as daytime lethargy, somnolence, and development of drug dependence [25]. Since these side effects can reduce the effectiveness of the training process and affect the sports results, the use of these drugs in athletes is limited.

Thus, desynchronization is a rather urgent problem in the modern world. This problem is especially serious for athletes.

In this regard, making an optimal training schedule taking into account your chronotype is the main method of preventing chronic desynchronization. It is also important to stick to a healthy diet and to get enough sleep. Athletes are allowed to use exogenous melatonin to normalize sleep, but elimi-

nation of artificial light 1.5-2 hours before sleep and avoiding meals at night are considered more optimal. The above measures will improve athletic performance, increase training efficiency, and prevent the development of desynchronization.

REFERENCES / СПИСОК ИСТОЧНИКОВ

1. Serin Y, Acar Tek N. Effect of Circadian Rhythm on Metabolic Processes and the Regulation of Energy Balance. *Annals of Nutrition and Metabolism*. 2019;74;4:322-330.
2. Zisapel N. New Perspectives on the Role of Melatonin in Human Sleep, Circadian Rhythms and their Regulation. *British Journal of Pharmacology*. 2018;175;16:3190-3199.
3. Annamneedi V.P., Park J.W., Lee G.S., Kang T.J. Cell Autonomous Circadian Systems and Their Relation to Inflammation. *Biomol. Ther. (Seoul)*. 2021;29;1:31-40.
4. Escobar C., Espitia-Bautista E., Guzmán-Ruiz M.A., Guerrero-Vargas N.N., Hernández-Navarrete M.A., Angeles-Castellanos M., Morales-Pérez B., Buijs R.M. Chocolate for Breakfast Prevents Circadian Desynchrony in Experimental Models of Jet-Lag and Shift-Work. *Sci. Rep.* 2020;10;1:6243.
5. Potter G.D.M., Cade J.E., Grant P.J., Hardie L.J. Nutrition and the Circadian System. *British Journal of Nutrition*. 2016;116;3:434-442.
6. Vitale J.A., Weydahl A. Chronotype, Physical Activity, and Sport Performance: A Systematic Review. *Sports Med.* 2017;47;9:1859-1868.
7. Kanagarajan K., Gou K., Antinora C., Buyukkurt A., Crescenzi O., Beaulieu S., Storch K.F., Mantere O. Morningness-Eveningness Questionnaire in Bipolar Disorder. *Psychiatry Research*. 2018;262:102-107.
8. Racinais S., Cocking S., Périard J.D. Sports and Environmental Temperature: From Warming-up to Heating-up. *Temperature (Austin)*. 2017;4;3:227-257.
9. Мегерян С.Д. Связь параметров гормонального статуса спортсменов с результатами кардиореспираторного нагрузочного тестирования // Клиническая практика. 2018. Т. 9, № 3. С. 16-21 [Megeryan S.D. Association of the Hormonal Status Parameters with the Results of the Cardiorespiratory Exertion Test in Athletes. *Klinicheskaya praktika = Journal of Clinical Practice*. 2018;9;3:16-21 (In Russ.)].
10. Adan A., Archer S.N., Hidalgo M.P., Di Milia L., Natale V., Randler C. Circadian Typology: a Comprehensive Review. *Chronobiology International*. 2012;29;9:1153-1175.
11. Kunorozva L., Roden L.C., Rae D.E. Perception of Effort in Morning-Type Cyclists is Lower when Exercising in the Morning. *Journal of Sports Sciences*. 2014;32;10:917-925.
12. Wehrens S.M.T., Christou S., Isherwood C., Middleton B., Gibbs M.A., Archer S.N., Skene D.J., Johnston J.D. Meal Timing Regulates the Human Circadian System. *Curr. Biol.* 2017;27;12:1768-1775.e3. doi: 10.1016/j.cub.2017.04.059.
13. Kaczmarek J.L., Thompson S.V., Holscher H.D. Complex Interactions of Circadian Rhythms, Eating Behaviors, and the Gastrointestinal Microbiota and Their Potential Impact on Health. *Nutr. Rev.* 2017;75;9:673-682.
14. Halson S.L., Burke L.M., Pearce J. Nutrition for Travel: From Jet lag To Catering. *Int. J. Sport Nutr. Exerc. Metab.* 2019;29;2:228-235.
15. Ruddick-Collins L.C., Johnston J.D., Morgan P.J., Johnstone A.M. The Big Breakfast Study: Chrono-Nutrition Influence on Energy Expenditure and Bodyweight. *Nutr. Bull.* 2018;43;2:174-183.
16. Jamshed H., Beyl R.A., Della Manna D.L., Yang E.S., Ravussin E., Peterson C.M. Early Time-Restricted Feeding Improves 24-Hour Glucose Levels and Affects Markers of the Circadian Clock, Aging, and Autophagy in Humans. *Nutrients*. 2019;11;6:1234.
17. Zerón-Rugiero M.F., Hernández A., Porrás-Loaiza A.P., Cambras T., Izquierdo-Pulido M. Eating Jet Lag: A Marker of the Variability in Meal Timing and Its Association with Body Mass Index. *Nutrients*. 2019;11;12:2980.
18. Fowler P.M., Knez W., Crowcroft S., Mendham A.E., Miller J., Sargent C., Halson S., Duffield R. Greater Effect of East Versus West Travel on Jet Lag, Sleep, and Team Sport Performance. *Med. Sci. Sports Exerc.* 2017;49;12:2548-2561.
19. James S.M., Honn K.A., Gaddameedhi S., Van Dongen H.P.A. Shift Work: Disrupted Circadian Rhythms and Sleep-Implications for Health and Well-Being. *Curr. Sleep Med. Rep.* 2017;3;2:104-112.
20. Morgan E., Schumm L.P., McClintock M., Waite L., Lauderdale D.S. Sleep Characteristics and Daytime Cortisol Levels in Older Adults. *Sleep*. 2017;40;5:zsx043. doi: 10.1093/sleep/zsx043.
21. Chandrasekaran B., Fernandes S., Davis F. Science of Sleep and Sports Performance – a Scoping Review. *Sci. Sports*. 2020;35;1:3-11.
22. O'Donnell S., Beaven C.M., Driller M.W. From Pillow to Podium: a Review on Understanding Sleep for Elite Athletes. *Nature and Science of Sleep*. 2018;10:243-253.
23. Овчаренко А.М., Сидоров А.В. Современные тенденции исследований мелатонина как средства лечения и профилактики отдельных заболеваний // Терапия. 2019. № 2. С. 104-109 [Ovcharenko A.M., Sidorov A.V. Modern Trends in Melatonin Investigations as a Medicine for Treatment and Prevention Certain Diseases. *Terapiya = Therapy*. 2019;2:104-109 (In Russ.)].
24. Arendt J. Approaches to the Pharmacological Management of Jet Lag. *Drugs*. 2018;78;14:1419-1431.
25. Votaw V.R., Geyer R., Rieselbach M.M., McHugh, R.K. The Epidemiology of Benzodiazepine Misuse: a Systematic Review. *Drug and Alcohol Dependence*. 2019;200:95-114.

Материал поступил в редакцию 05.04.21; статья принята после рецензирования 10.03.22; статья принята к публикации 21.03.22
The material was received 05.04.21; the article after peer review procedure 10.03.22; the Editorial Board accepted the article for publication 21.03.22

BIOMECHANICAL COMPARISON OF CERAMIC, TITANIUM AND CHROME COBALT POST INLAYS IN POST-TRAUMATIC DENTAL DEFECTS REPAIR

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Abstract. *The aim of the study is the biomechanical substantiation of restoration of tooth crowns destroyed due to trauma using ceramic post inlays.*

Materials and research methods. In order to experimentally compare the strength of pin inlays, tooth root and ceramic crown depending on the material of the inlays, three-dimensional mathematical modeling of the stress-strain state of the pin structure using the method of finite element analysis was carried out. The physical and mechanical properties and size of a single-rooted tooth with a fractured crown (upper central incisor), a ceramic crown and a peg inlay made of a chrome-cobalt alloy, titanium or ceramics corresponded to the natural ones. Calculations were performed using the properties of both the devital and the intact tooth. Situations of early operation of the post construction with close contact of the root, inlay, and crown, as well as possible decay of tooth tissues along the edge of the crown in the long-term operation of the construction were simulated. A functional load of 150N was applied to two areas: the incisal edge and the upper third of the palatal surface of the crown on post inlays with a change in load direction from 0 to 90°.

Research results and their analysis. According to the data of mathematical modeling of functional load, the strength of a post-traumatic tooth defect replacement is sufficient when using both metal and ceramic post inlays; changes in physical and mechanical properties of the tooth with increasing time from the moment of devitalization increase stress in the ceramic crown, and root failure along the edge of the crown causes the ultimate stress at a horizontal shift of load direction.

The biomechanical rationale allows: in case of complete destruction of the crown part of the tooth – to recommend milled dowel ceramic inlays as a support of metal-free artificial crowns; to stick to the technology of their fixation in the root canal and of the fixation of crowns to the inlays; to ensure a strict dispensary of patients with a ceramic crown on milled dowel ceramic inlay to detect and to eliminate tooth root caries in the long term; to provide direction of functional load within 30° from the axis of the restored tooth during prosthetics.

Key words: *ceramics, chrome-cobalt, mathematical modeling, post inlays, post-traumatic tooth defects, stress-strain state*

Conflict of interest. The authors declare no conflict of interest

For citation: Olesova V.N., Ivanov A.S., Olesov E.E., Romanov A.S., Zaslavskiy R.S. Biomechanical Comparison of Ceramic, Titanium and Chrome Cobalt Post Inlays in Post-Traumatic Dental Defects Repair. *Meditsina Katastrof = Disaster Medicine.* 2022;1:53-58 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-53-58>

БИОМЕХАНИЧЕСКОЕ СРАВНЕНИЕ КЕРАМИЧЕСКИХ, ТИТАНОВЫХ И ХРОМКОБАЛЬТОВЫХ ШТИФТОВЫХ ВКЛАДКОВ ПРИ ЗАМЕЩЕНИИ ПОСТТРАВМАТИЧЕСКИХ ДЕФЕКТОВ ЗУБА

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Резюме. *Цель исследования – биомеханическое обоснование восстановления разрушенной вследствие травмы коронки зуба с использованием керамических штифтовых вкладок.*

Материалы и методы исследования. В целях экспериментального сравнения прочности штифтовых вкладок, корня зуба и керамической коронки в зависимости от материала вкладок проведено трехмерное математическое моделирование напряженно-деформированного состояния (НДС) штифтовой конструкции с использованием метода конечно-элементного анализа. Физико-механические свойства и размер однокорневого зуба с разрушенной коронкой (верхний центральный резец), керамической коронки и штифтовой вкладки из хромкобальтового сплава, титана или керамики соответствовали естественным. Расчеты проводились с использованием свойств как девитального, так и интактного зуба. Моделировались ситуации ранних сроков эксплуатации штифтовой конструкции с плотным контактом корня, вкладки и коронки, а также возможного разрушения кариесом тканей зуба по краю коронки в отдаленные сроки эксплуатации конструкции. Функциональная нагрузка 150Н прилагалась к двум зонам: режущему краю и верхней трети небной поверхности коронки на штифтовых вкладках с изменением направления нагрузки от 0 до 90°.

Результаты исследования и их анализ. По данным математического моделирования функциональной нагрузки, прочность штифтовой конструкции, замещающей посттравматический дефект зуба, достаточна при использовании как металлических, так и керамических штифтовых вкладок; изменение физико-механических свойств зуба с увеличением времени от момента девитализации повышает напряжение в керамической коронке, а разрушение корня по краю коронки вызывает в

нем предельное напряжение при горизонтальном смещении направления нагрузки.

Биомеханическое обоснование позволяет: при полном разрушении коронковой части зуба – рекомендовать в качестве опоры безметалловых искусственных коронок фрезерованные штифтовые керамические вкладки; соблюдать технологию их фиксации в корневом канале и коронок – к вкладкам; проводить строгую диспансеризацию пациентов с керамической коронкой на фрезерованной штифтовой керамической вкладке для выявления и устранения кариеса корня зуба в отдаленные сроки; обеспечивать при протезировании направление функциональной нагрузки в пределах 30° от оси восстанавливаемого зуба.

Ключевые слова: керамика, математическое моделирование, напряженно-деформированное состояние, посттравматические дефекты зуба, хром-кобальт, штифтовые вкладки

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Олесова В.Н., Иванов А.С., Олесов Е.Е., Романов А.С., Заславский П.С. Биомеханическое сравнение керамических, титановых и хромкобальтовых штифтовых вкладок при замещении посттравматических дефектов зуба // Медицина катастроф. 2022. №1. С. 53-58. <https://doi.org/10.33266/2070-1004-2022-1-53-58>

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Research relevance. The elimination of medical, sanitary and other consequences of emergency situations is associated with a significant stressogenic impact on those who take part in it (disaster medicine specialists, rescuers, workers of rescue units, etc.). This impact is manifested, in particular, in hypertonus of the muscles of the maxillofacial area and in increased strength and duration of the occlusal load on the teeth. Under these conditions, in the presence of extensive carious cavities, crown restoration with light-curing composites is ineffective and short-lived. In this case there is often a loss of fillings and chipping of dental hard tissue, which is associated with the lack of strength of light-curing composites, as well as the brittleness of the enamel of the remaining tissues of the tooth. In addition, adhesive bonding with bonding materials is not sufficient to retain large fillings. The high occlusal load on the filled teeth due to muscle hypertonicity aggravates these problems in liquidators of accidents and disasters.

In these cases the application of methods of orthopedic dentistry is required. Significant defects of the crown of teeth in orthopedic dentistry are restored by post inlays as supports of artificial crowns [1-7]. The vast majority of post inlays are made using casting of chromium-cobalt alloys; titanium and gold alloys are used much less frequently.

Metal inlays are adequate to the metal-ceramic crowns that cover them, but reduce the aesthetic results of ceramic crowns. Empress pressed or CAD/CAM milled dioxide-zirconia frameworks, ceramic crowns are gradually replacing metal-ceramic crowns among prosthetic replacements [7-12].

In this regard, milled ceramic post inlays are of interest, but the biomechanical substantiation of such inlays is currently insufficient [13].

The aim of the study was to provide a biomechanical justification for the restoration of a tooth crown destroyed due to trauma using ceramic post inlays.

Materials and methods of research. In order to experimentally compare the strength of pin inlays, tooth root and ceramic crown depending on the material of the inlays, three-dimensional mathematical modeling of the stress-strain state of the pin structure using the method of

finite element analysis and Solid Works program [14, 15]. The physical and mechanical properties and size of a single-rooted tooth with a fractured crown (upper central incisor), ceramic crown, and pin inlay made of a chrome-cobalt alloy, titanium, or ceramic corresponded to the natural ones (Fig. 1, Table 1). Calculations were performed using the properties of both the devitalized and intact tooth, in the latter case to simulate the situation of the functioning of the post structure in the early period after tooth devitalization. Tooth devitalization — removal of the tooth pulp — is always performed after a tooth trauma with a fractured crown; over time, the physical and mechanical properties of the remaining tooth root tissues deteriorate.

Situations of early operation of the post construction with close contact of the root, inlay, and crown were simulated, as well as possible destruction of tooth tissues by caries on the edge of the crown in the long term operation of the construction. A functional load of 150N was applied to two areas: the incisal edge and the upper third of the palatal surface of the crown on post inlays with a change in load direction from 0 to 90°.

Maximum stress (MPa) was reflected in the graphs for all situations of modeling the stress-strain state (SSS) of a tooth with posttraumatic defect replaced by a crown on a post inlay (Fig. 2).

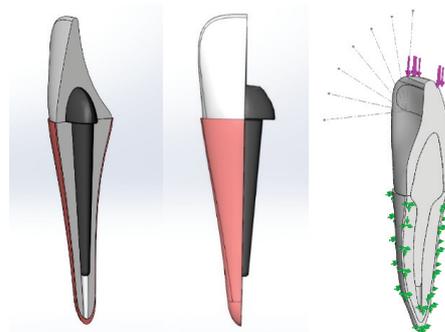


Рис. 1. Модель штифтовой конструкции при замещении посттравматического дефекта зуба
Fig. 1. Model of a pin construction for the replacement of a post-traumatic tooth defect

Физико-механические свойства материалов математической модели
Physical and mechanical properties of materials of the mathematical model

Материал Material	Модуль упругости, МПа Elastic modulus, MPa	Коэффициент Пуассона Poisson's ratio	Предел прочности, МПа Tensile strength, MPa
Хромкобальт / Cobalt-chrome	248000	0,3	690
Титан / Titanium	113800	0,32	880
Керамика / Ceramics	22400	0,19	300
Дентин (сразу после девитализации) / Dentin (immediately after devitalization)	14700	0,31	55
Дентин (в отдаленные сроки после девитализации) / Dentin (long after devitalization)	2600	0,31	20

Those differences were considered statistically significant if the probability of error in deviating from the null hypothesis did not exceed 5%, $p < 0.05$. Arithmetic mean (M) and standard deviation (SD) as ($M \pm SD$) were used to record numerical values.

Results of the study and their analysis. Mathematical modeling has shown the dependence of the SSS in the peg construction (tooth root, peg inlay, ceramic crown): on the material of the peg inlay; the presence of tight contact of the artificial crown with the tooth root; on the direction of the load, as well as on the time elapsed since the tooth devitalization, affecting the physical and mechanical properties of the root dentin.

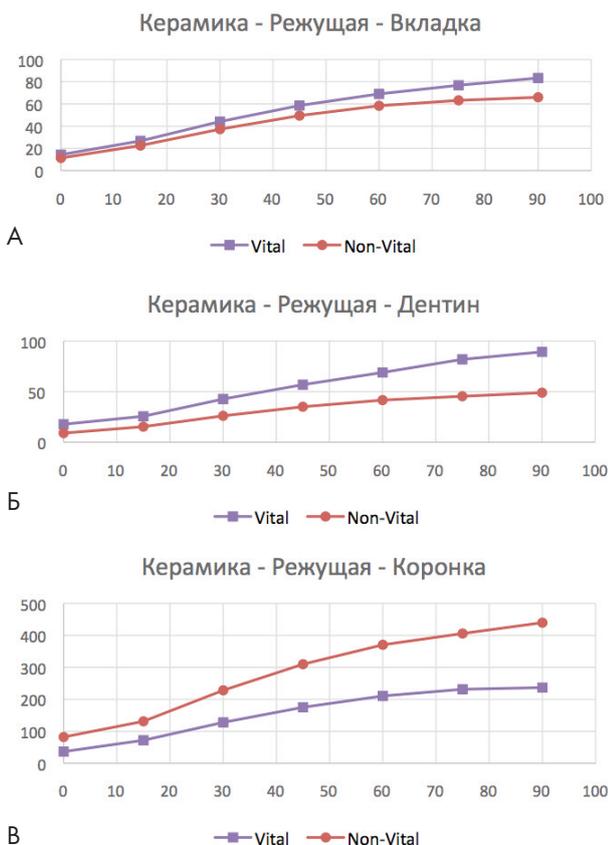


Рис. 2. Графики напряжения (МПа) в керамической вкладке (а), дентине корня (б), керамической коронке (в) при нагрузке режущего края штифтовой конструкции в ранние и отдаленные сроки после девитализации (Vital и Non-Vital)
Fig. 2. Graphs of stresses (MPa) in the ceramic insert (a), ceramic crown (c) under the loading of the incisal edge of the post construction in the early and long term after devitalization (Vital and Non-Vital)

Under standard conditions, the maximum stress in the metal inlay (149.876 MPa under horizontal loading; 24.611 MPa under vertical loading) was far from the strength limit of chromocobalt when using the chromocobalt post inlay (Table 2, Fig. 3). In the tooth root, the stress approached the strength limit: when the incisal edge was loaded at an angle of more than 30° (from 26.332 MPa at 30° to 50.515 MPa at 90°); when the palatal surface was loaded at an angle of more than 45° (from 27.498 MPa at 45° to 41.430 MPa at 90°). In the artificial crown, maximum stress above the strength limit appeared: when the incisal edge was loaded at an angle of more than 45° (from 311.196 MPa — at 45° to 436.003 MPa — at 90°); when the palatal surface was loaded at an angle of more than 60° (from 298.534 MPa — at 60° to 360.323 MPa — at 90°).

The same patterns were repeated when using a titanium post inlay.

When a milled ceramic inlay was used as a support for the artificial crown, no critical stress was detected in the inlay itself (from 11.343 MPa for vertical loading of the incisal edge of the crown to 65.982 MPa for horizontal loading; from 15.177 MPa for vertical loading of the palatal surface of the crown to 56.309 MPa for horizontal loading). In the tooth root, the ultimate stress was detected: with a load of more than 30° of the incisal edge (from 26.030 MPa — at 30° to 48.940 MPa — at 90°); with a palatal surface load — with a load direction more than 45° (from 27.084 MPa — at 45° to 40.061 MPa — at 90°). In the artificial crown, the maximum stress in the incisal edge or palatal surface loading was detected: in the loading angle more than 45° (from 309.942 MPa — at 45° to 439.857 MPa — at 90°); in the loading angle more than 60° (from 296.980 MPa - at 60° to 363.457 MPa - at 90°).

In the pin loading situation, no marginal stress was detected in the VAT of pin inlays and artificial crowns a short time after devitalization of the tooth; in the tooth root, marginal stress was detected with chrome-cobalt and titanium inlays at the same load directions as the dentin model, with a longer time after devitalization, and marginal stress in the dentin developed later when ceramic inlays were used: at 45° loading of the incisal edge and 60° loading of the palatal surface of the crown.

According to the data of mathematical modeling of the post construction, when the contact of the crown edge with the root of the tooth is disturbed due to root caries, there is a strong increase in stress in the post inlays themselves — up to the ultimate stress of 709.505 MPa in the chrome-cobalt

Максимальные напряжения (МПа) по Мизесу в модели корня зуба, искусственной коронке и в штифтовой вкладке из разных материалов

Maximum Mises stresses (MPa) in the model of the tooth root, artificial crown and pin inlay made of different materials

CoCr		0°	15°	30°	45°	60°	75°	90°
Режущий кран Cutting edge	вкладка inlay	24,6	48,3	80,6	107,4	126,9	138,4	149,9
	дентин dentin	9,2	15,6	26,3	35,4	41,9	46,4	50,5
	коронка crown	79,3	132,7	229,6	311,2	371,6	406,7	436,0
Нёбная поверхность Palatal surface	вкладка inlay	33,9	33,9	61,7	85,2	102,9	113,7	126,3
	дентин dentin	12,7	10,7	19,7	27,5	33,5	37,2	41,4
	коронка crown	103,1	90,1	172,4	243,7	298,5	333,1	360,3
Ti		0°	15°	30°	45°	60°	75°	90°
Режущий кран Cutting edge	вкладка inlay	21,7	42,2	69,7	92,6	109,1	120,1	130,2
	дентин dentin	9,1	15,9	26,2	35,3	41,9	46,0	50,1
	коронка crown	79,9	132,6	229,8	311,5	372,0	407,3	435,9
Нёбная поверхность Palatal surface	вкладка inlay	29,8	29,9	53,7	73,8	88,9	98,5	109,9
	дентин dentin	12,6	10,6	19,6	27,4	33,3	37,0	41,1
	коронка crown	102,9	89,9	172,4	243,8	298,8	333,5	360,3
Ceramic		0°	15°	30°	45°	60°	75°	90°
Режущий кран Cutting edge	вкладка inlay	11,3	22,5	37,3	49,5	58,3	63,2	65,9
	дентин dentin	8,9	15,3	26,0	35,0	41,6	45,4	48,9
	коронка crown	82,1	131,1	228,3	309,9	370,6	406,0	439,9
Нёбная поверхность Palatal surface	вкладка inlay	15,2	16,7	29,3	40,2	48,3	53,1	56,3
	дентин dentin	12,5	10,4	19,3	27,1	33,0	36,7	40,1
	коронка crown	103,8	88,0	170,5	241,9	296,9	331,9	363,5

inlay at 75° load direction of the incisal edge of the crown. In ceramic crowns — irrespective of the pin inlay material — the stress is considerably reduced. At the same time, the stress in the tooth root increases: when the vertical load is displaced by 15°, the ultimate stress when the load is applied to both the incisal edge and the palatal surface is recorded: with chrome-cobalt inlay — 26.683 and 19.005 MPa respectively; with titanium inlay — 30.555 and 20.946 MPa respectively; with ceramic inlay — 38.355 and 25.351 MPa respectively.

Thus, tooth devitalization followed by the fabrication of a ceramic crown on a post support does not cause ultimate stress in the crown and post support regardless of its material — chrome-cobalt, titanium or ceramic; in dentin ultimate stress appears when the incisal edge is loaded at 30°

and the palatal surface at 45°. The stress in inlays does not change with increasing time from tooth devitalization; it decreases 1.5-3 times in dentin — with a corresponding decrease in tooth strength and increases up to two times in a ceramic crown. Fracture of a devitalized tooth with an inlay on the crown margin, especially after a long period of time, significantly reduces the stress in the crown, but increases the stress in the inlays and — especially — in the dentin, in which the strength limit appears at 15-30° of the incisal edge and the palatal slope of the crown.

Conclusion

1. According to the data of mathematical modeling of functional load, the strength of the post-traumatic tooth defect replacement is sufficient when using both metal and ceramic post inlays; the change in the physical and

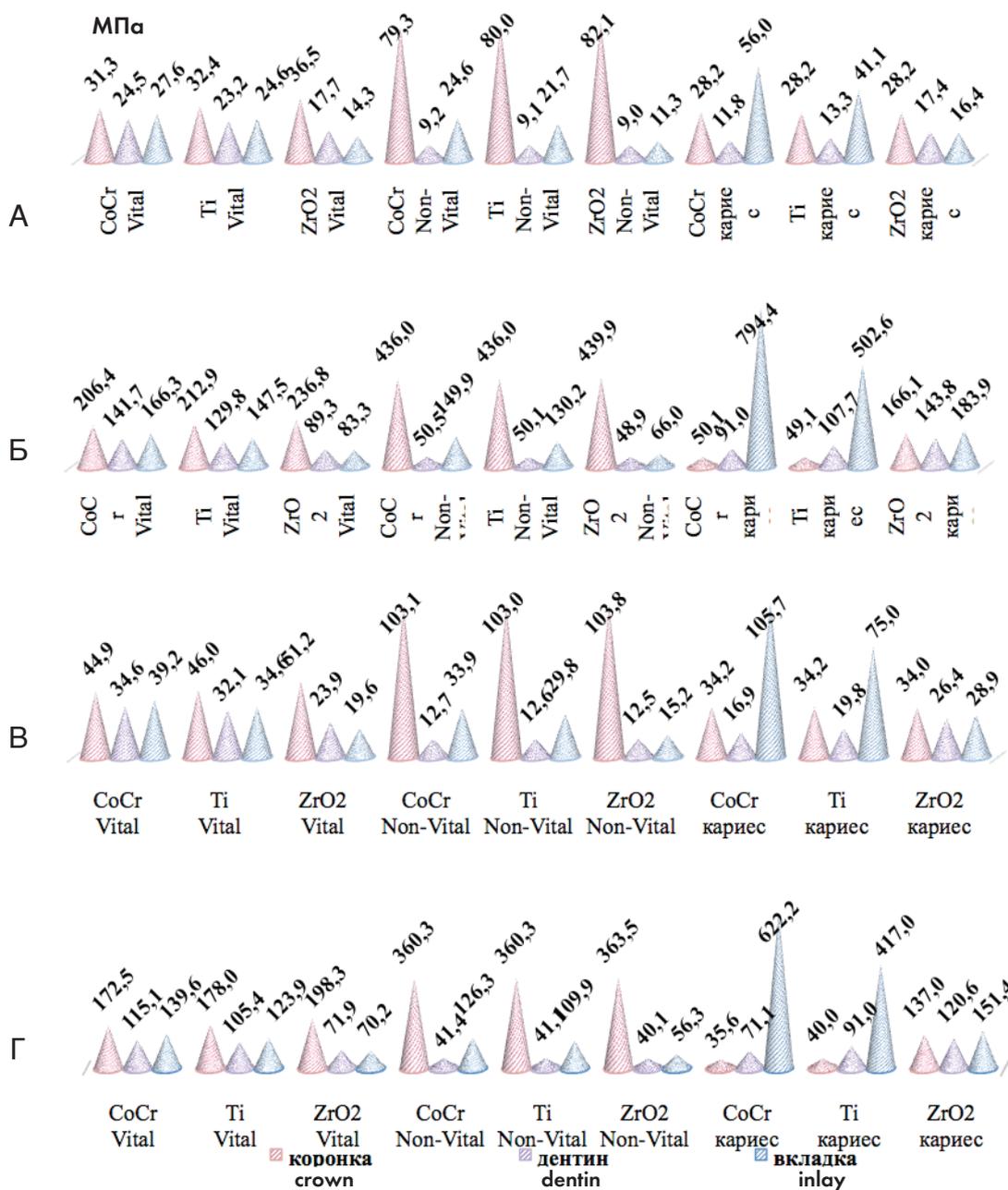


Рис. 3. Сравнение максимального напряжения в компонентах штифтовой конструкции в зависимости от материала штифтовой вкладки, сроков от момента девитализации зуба и целостности тканей корня: а – вертикальная нагрузка, режущий край; б – 90°, режущий край; в – вертикальная нагрузка, небная поверхность; г – 90°, небная поверхность
Fig. 3. Comparison of the maximum stresses in the components of the pin structure, depending on the material of the pin inlay, the timing of the devitalization of the tooth and the integrity of the root tissue: a) vertical load, cutting edge; b) 90°, cutting edge; c) vertical load, palatal surface; d) 90°, palatal surface

mechanical properties of the tooth with increasing time from the moment of devitalization increases the stress in the ceramic crown, and the root destruction along the edge of the crown causes a limit stress in it when the load direction is shifted horizontally.

2. In case of complete destruction of the crown part of the tooth the biomechanical justification allows to recommend milled post ceramic inlays as a support of metal-free

artificial crowns. At the same time it is necessary to strictly observe the technology of their fixation in the root canal and fixation of crowns to the inlays. As the lifetime of the ceramic crown on a milled ceramic inlay increases, a strict follow-up examination is required to identify and eliminate tooth root caries. When fabricating a milled dowel-retained ceramic crown, the direction of the functional load must be within 30° of the axis of the tooth to be restored.

REFERENCES

1. Manatina V.I. Clinical Substantiation of Indications for the Use of Endocrowns. *Sovremennaya Stomatologiya = Modern Dentistry*. 2019; 2: 69-74 (In Russ.).
2. Razakov D.Kh., Arutyunov E.I. Comparative Characteristics of the Use of Zirconium, Metal and Combined Pin Stump Inlays in the Treatment of the Anterior Group of the Teeth of the Upper Jaw. *Byulleten Meditsinskikh Internet-Konferentsiy = Bulletin of Medical Internet Conferences*. 2019; 7: 305 (In Russ.).
3. Fisyunov A.D., Rubnikov S.P. The Use of a Composite-Reinforced Stump Pin Inlay for Prosthetics of a Complete Defect in the Coronal Part of the Tooth. *Stomatologiya. Estetika. Innovatsii = Dentistry. Aesthetics. Innovation*. 2019; 3: 292-302 (In Russ.).
4. Bersanov R.U. Funktsionalnaya i Ekonomicheskaya Effektivnost Sovremennykh Metodov Ortopedicheskoy Reabilitatsii Bolnykh s Chastichnoy i Polnoy Adentiei = Functional and Economic Efficiency of Modern Methods of Orthopedic Rehabilitation of Patients with Partial and Complete Adentia. Extended abstract of Doctor's thesis in Medicine. Moscow Publ., 2016, 48 p. (In Russ.).
5. Klemin V.A., Kubarenko V.V. Artificial Tooth Crown Stump: Components, Classification, Design Options. *Sovremennaya Ortopedicheskaya Stomatologiya = Modern Orthopedic Dentistry*. 2016; 26: 39-42 (In Russ.).
6. Soares P.V. Replacing a Cast Post with a Glass Fiber Post Using an Adhesive Retention Technique. *Kafedra. Stomatologicheskoe Obrazovanie = Cathedra-Chair. Dental Education*. 2015; 52: 8-10 (In Russ.).
7. Ertesyan A.R. Sovershenstvovanie Ortopedicheskogo Lecheniya Bolnykh s Nizkimi i Razrushennymi Klinicheskimi Koronkami Opornykh Zubov = Improvement of Orthopedic Treatment of Patients with Low and Destroyed Clinical Crowns of Abutment Teeth. Diss. Candidate's thesis in Medicine. Samara Publ., 2017, 132 p. (In Russ.).
8. Grishkova N.O. Eksperimentalno-Klinicheskoe i Ekonomicheskoe Sravnenie Tekhnologiy Izgotovleniya Iskusstvennykh Zubnykh Koronok = Experimental-Clinical and Economic Comparison of Technologies for the Manufacture of Artificial Dental Crowns. Extended abstract of candidate's thesis in Medicine. 2017; 24 p. (In Russ.).
9. Iskenderov R.M. Accounting for Materials to Manage the Cost of Manufacturing One Orthopedic Unit of Production Using CAD-CAM Technologies in Dentistry. *Sovremennye Problemy Nauki i Obrazovaniya = Modern Problems of Science and Education*. 2016; 2:33 (In Russ.).
10. Retinskaya M.V., Goryainova K.E., Rusanov F.S., Lebedenko I.Yu. Scientific Basis for the Choice of Material for CEREC Crowns. *Stomatologiya = Dentistry*. 2016; 6: 110-111 (In Russ.).
11. Kelly J.R. Ceramics in Dentistry: Principles and Practice. Quintessence Publishing Co., Inc. 2016; 128 p.
12. Verma M., Meena N. Dental Ceramics Material and Applications. LAP LAMBERT Academic Publishing. 2016; 224 p.
13. Oganyan A.I., Tsalikova N.A., Salamov M.Ya., Grishkina M.G. The Use of Zirconium Dioxide Post Stump Structures for Restoration of the Crown Parts of Teeth in Various Parts of the Dentition. *Rossiyskaya Stomatologiya = Russian Dentistry*. 2016; 1: 24-25 (In Russ.).
14. Dubrov V.E., Zyuzin D.A., Kuzkin I.A., Shcherbakov I.M., Donchenko S.V., Saprykina K.A. Application of the Finite Element Method in Modeling Biological Systems in Traumatology and Orthopedics. *Rossiyskiy Zhurnal Biomekhaniki = Russian Journal of Biomechanics*. 2019; 1: 140-152 (In Russ.).
15. Manatina V.I. Comparative Analysis of the Stress-Strain States of the Structures of the Pulped Tooth and Orthopedic Structures in the Elimination of Defects in the Coronal Part. *Stomatologicheskii Zhurnal = Dental Journal*. 2019; 1: 47-53 (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. Манатина В.И. Клиническое обоснование показаний к применению эндокоронки // Современная стоматология. 2019. №2. С. 69–74.
2. Разаков Д.Х., Арутюнов Э.И. Сравнительная характеристика применения циркониевых, металлических и комбинированных штифтовых культевых вкладок при лечении передней группы зубов верхней челюсти // Бюллетень медицинских интернет-конференций. 2019. №7. С. 305.
3. Фисюнов А.Д., Рубникович С.П. Применение композитно-армированной культевой штифтовой вкладки при протезировании полного дефекта коронковой части зуба // Стоматология. Эстетика. Инновации. 2019. №3. С. 292–302.
4. Берсанов Р.У. Функциональная и экономическая эффективность современных методов ортопедической реабилитации больных с частичной и полной адентией: Автореф. дис... докт. мед. наук. М., 2016. 48 с.
5. Клемин В.А., Кубаренко В.В. Искусственная культя коронки зуба: составные элементы, классификация, варианты конструкции // Современная ортопедическая стоматология. 2016. №26. С. 39–42.
6. Соареш П.В. Замена литого штифта стекловолоконным штифтом с использованием методики адгезивной фиксации // Стоматологическое образование. 2015. №52. С. 8–10.
7. Эртесян А.Р. Совершенствование ортопедического лечения больных с низкими и разрушенными клиническими коронками опорных зубов: Дис. ... канд. мед. наук. Самара, 2017. 132 с.
8. Гришкова Н.О. Экспериментально-клиническое и экономическое сравнение технологий изготовления искусственных зубных коронок: Автореф. дис... канд. мед. наук. 2017. 24 с.
9. Исхендеров Р.М. Учет материалов для управления себестоимостью изготовления одной ортопедической единицы продукции с использованием CAD-CAM-технологий в стоматологии // Современные проблемы науки и образования. 2016. №2. С. 33.
10. Ретинская М.В., Горяинова К.Э., Рusanов Ф.С., Лебеденко И.Ю. Научное обоснование выбора материала для CEREC коронок // Стоматология. 2016. №6. С. 110–111.
11. Kelly J.R. Ceramics in Dentistry: Principles and Practice. Quintessence Publishing Co., Inc. 2016; 128 p.
12. Verma M., Meena N. Dental Ceramics Material and Applications. LAP LAMBERT Academic Publishing. 2016; 224 p.
13. Оганян А.И., Цаликова Н.А., Саламов М.Я., Гришкина М.Г. Применение штифтовых культевых конструкций из диоксида циркония для восстановления коронковых частей зубов в различных участках зубного ряда // Российская стоматология. 2016. №1. С. 24–25.
14. Дубров В.Э., Зюзин Д.А., Кузькин И.А., Щербаков И.М., Донченко С.В., Сапрыкина К.А. Применение метода конечных элементов при моделировании биологических систем в травматологии и ортопедии // Российский журнал биомеханики. 2019. №1. С. 140–152.
15. Манатина В.И. Сравнительный анализ напряженно-деформированных состояний структур депульпированного зуба и ортопедических конструкций при устранении дефектов коронковой части // Стоматологический журнал. 2019. №1. С. 47–53.

Материал поступил в редакцию 01.03.21; статья принята после рецензирования 08.02.22; статья принята к публикации 21.03.22
 The material was received 01.03.21; the article after peer review procedure 08.02.22; the Editorial Board accepted the article for publication 21.03.22

INFLUENCE OF TOXIC COMBUSTION PRODUCTS ON THE STATE OF INTESTINAL MICROBIOTA IN THE PATHOGENESIS OF NON-ALCOHOLIC FATTY LIVER DISEASE IN FIREFIGHTERS

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Abstract. Medical and psychological support of professional activity of firefighters does not take into account their chronic poisoning by toxic products of burning. Such diagnoses are made to the firefighters of the State Fire Service of the Federal Fire Service of EMERCOM of Russia only in case of acute poisoning. Insufficient attention paid to the impact of fire-specific toxicants, including dioxins, does not allow timely detection of disturbances in the regulation of physiological systems of firefighters' organisms, which leads to the emergence of diseases.

The aim of the study was to determine the effect of dioxins on the state of the microbiota.

Materials and research methods. The study involved 246 male patients, of whom 121 were employees of the State Fire Service of the Federal Fire Service of EMERCOM of Russia and 125 were civilians and rescuers of EMERCOM of Russia.

Research results and their analysis. The data obtained in the study of the blood microbiota by chromatography-mass spectrometry of microbial markers indicate a pronounced intestinal dysbiosis in firefighters with non-alcoholic fatty liver disease due to decreased number of microbial markers of the normal microbiota along with increased total number of microbial markers and opportunistic microorganisms.

The dysbacteriosis revealed in the firefighters having no health complaints can be a predictor of liver pathology development that testifies to necessity of control and timely correction of microecological status.

Key words: combustion products, dioxins, dysbiosis, Firefighterstoxic microbiota.

Conflict of interest. The authors declare no conflict of interest

For citation: Gatsura V.Y., Gumanenko K.E., Sannikov M.V., Kriyt V.E., Pyatibrat E.D., Pyatibrat A.O. Influence of Toxic Combustion Products on the State of Intestinal Microbiota in the Pathogenesis of Nonalcoholic Fatty Liver Disease in Firefighters. *Meditsina Katastrof = Disaster Medicine*. 2022; 1:59-65 (In Russ.).
<https://doi.org/10.33266/2070-1004-2022-1-59-65>

ВЛИЯНИЕ ТОКСИЧНЫХ ПРОДУКТОВ ГОРЕНИЯ НА СОСТОЯНИЕ МИКРОБИОТЫ КИШЕЧНИКА У ПОЖАРНЫХ В ПАТОГЕНЕЗЕ НЕАЛКОГОЛЬНОЙ ЖИРОВОЙ БОЛЕЗНИ ПЕЧЕНИ

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Резюме. Медико-психологическое сопровождение профессиональной деятельности пожарных не учитывает их хронического отравления токсичными продуктами горения. Такие диагнозы сотрудникам Государственной противопожарной службы Федеральной противопожарной службы (ГПС ФПС) МЧС России ставятся только при острых отравлениях. Недостаточное внимание, уделяемое воздействию токсикантов, специфических для пожаров, в том числе диоксинов, не позволяет своевременно выявлять нарушения регуляции физиологических систем организма пожарных, что приводит к возникновению болезней.

Цель исследования – определить влияние диоксинов на состояние микробиоты.

Материалы и методы исследования. В исследовании участвовали 246 пациентов – мужчин, из них 121 – сотрудники ГПС ФПС МЧС России; 125 – гражданские лица и спасатели МЧС России.

Результаты исследования и их анализ. Результаты исследования микробиоты крови методом хромато-масс-спектрометрии микробных маркеров свидетельствуют о выраженном дисбиозе кишечника у пожарных, страдающих неалкогольной жировой болезнью печени (НЖБП), обусловленном снижением количества микробных маркеров нормальной микробиоты, на фоне увеличения общего количества микробных маркеров и условно-патогенной флоры. Дисбактериоз, выявленный у пожарных, не предъявляющих жалоб на состояние здоровья, может являться предиктором развития патологии печени, что свидетельствует о необходимости контроля и своевременной коррекции микробиологического статуса.

Ключевые слова: диоксины, дисбактериоз, микробиота кишечника, неалкогольная жировая болезнь печени, пожарные, токсичные продукты горения

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Гацура В.Ю., Гуманенко К.Е., Санников М.В., Крийт В.Е., Пятибрат Е.Д., Пятибрат А.О. Влияние токсичных продуктов горения на состояние микробиоты кишечника у пожарных в патогенезе неалкогольной жировой болезни печени // Медицина катастроф. 2022. №1. С. 59-65. <https://doi.org/10.33266/2070-1004-2022-1-59-65>

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Introduction

The professional activity of firefighters in conditions of extreme influence of physical, chemical and psychophysiological factors of fires is one of the most dangerous kinds of activity.

The urgency of revealing the chronic intoxication by substances with cumulative effect is determined by the lack of registration in the system of Russian Ministry of Emergency Situations the duration of the influence of toxic products of burning on the organism of firemen. Substances with a high cumulative effect and a very long elimination period include persistent organic pollutants, among which there are dioxins and dioxin-like substances [1]. Analysis of the morbidity of firefighters, presented by the scientific department "Medical registry of the Ministry of Emergency Situations of Russia" of the All-Russian Center of Emergency and Radiation Medicine named after A.M. Nikiforov of EMERCOM of Russia, testifies that the structure of morbidity of firefighters differs from the average values in the population.

Thus, in contrast to population data, where cardiovascular diseases prevail, firefighters face mostly diseases of the gastrointestinal tract (GIT), a quarter of which accounts for non-alcoholic fatty liver disease (NAFLD).

Liver damage, manifested by its fatty degeneration, is one of the main manifestations of intoxication and is accompanied, as a rule, by disorders of fat-soluble vitamin metabolism, porphyrin metabolism and insulin regulation [2].

Despite the fact that dioxins (even in extremely low concentrations) have a negative impact on metabolic processes, mechanisms of intoxication in firefighters are poorly studied. In chronic poisoning by dioxins there is a mutual aggravation of interaction between intestinal microbiota and immune system [3-5].

Y.I. Chernyak noted that cellular enzymatic disorders associated with the activation of detoxification enzymes of such xenobiotics as cytochrome CYP1A2 through aryl hydrocarbon receptor complex with dioxins can lead to disruption of hepatocyte metabolism [6]. One of the mechanisms of gut microbiota composition disorders are changes in the process of synthesis and excretion of bile components, which lead to disorders of internal organ function and microbiota composition. Currently, increased interest in the role of the microbiota in the formation of var-

ious pathologies is due to the widespread introduction of innovative molecular genetic DNA sequencing technologies that allow to identify numerous bacterial species that cannot be cultivated [7].

The aim of the study was to investigate the complex effect of persistent organic pollutants, component of toxic products of combustion, on the organism of firefighters during firefighting; to analyze the peculiarities of liver diseases formation in persons of this contingent.

Materials and methods of the study. The study covered 246 male patients, including 121 state fire-fighting service personnel of the Federal Fire-Fighting Service of the Russian Ministry of Emergency Situations and 125 civilian rescuers of the Russian Ministry of Emergency Situations (hereafter, "civilians"). The age of the subjects was 31-46 years; mean age was (38.5±7.5) years. All employees of the state fire-fighting service of the Russian Ministry of Emergency Situations had at least 5 years of work experience in firefighting. None of the civilians were exposed to toxic products of combustion. The groups of Russian EMERCOM personnel and civilians were divided into persons suffering from nonalcoholic fatty liver disease (128), including 63 EMERCOM of Russia and 65 persons of other professions, and those without NAFL (118), including 58 EMERCOM of Russia and 60 persons of other professions.

Based on the blood lipid dioxin concentration estimation the firefighters were divided into 3 groups: Group 1 consisted of 41 people with blood lipid dioxin concentration under 100 pg/g; Group 2 consisted of 37 people with lipid concentration from 101 to 350 pg/g; Group 3 consisted of 43 people with lipid concentration over 350 pg/g. The control group consisted of 125 people with blood lipid dioxin concentrations below 55 pg/g lipids. In 36% of the observed firefighters, blood lipid dioxin concentrations exceeded 350 pg/g lipids. Twenty-five percent of firefighters with NAFL had dioxin concentrations above 350 pg/g lipids; 14% had 101 to 350 pg/g lipids; and 11% of firefighters with NAFL had less than 100 pg/g lipids.

For reference: pg (picogram) is 10⁻¹² grams, i.e., 350 pg of dioxins in 1 g of lipids

Dysbiosis, diagnosed in accordance with OST 91500.11.0004-2003, was determined in 104 firefighters (86%), of which 52% were firefighters with a concentration

of dioxins above 350 pg/g lipids; 21% — firefighters with a concentration from 101 to 350 pg/g lipids; 13% — firefighters with a concentration of less than 100 pg/g lipids.

Exclusion criteria were: cancer, gross somatic pathology, and alcohol abuse.

To assess the state of intestinal microbiota we performed gas chromatography-mass spectrometry (GC-MS) study of microbial markers in blood [8]. The method is based on quantitative determination of microbial markers (fatty acids, aldehydes, alcohols and sterols) directly in clinical material. This method enables the decomposition of the entire pool of microbial markers, which allows the contribution of each of the hundreds of species of microorganisms inhabiting different systems and organs to be assessed.

Whole venous blood with heparin or ethylenediaminetetraacetic acid (EDTA) was pipetted into a 1.5 ml vial with a screw cap and Teflon-lined gasket and dried in the thermostat at 80 °C with 40 µl methanol added to accelerate drying, while the cap was removed. To the thickened sample, 400 µl of 1 M hydrochloric acid (this means that 1 L of solution contains 1 mol HCl = 36.5 g HCl) in methanol was added, the lid was tightly screwed on, and acid methanolysis was performed at 80 °C for one hour. To the cooled reaction medium 300 ng (ng — nanograms — 10⁻⁹ grams) of the standard, tridecanoic acid deuteromethyl ester dissolved in hexane, was added. The mixture was then extracted in two 200 µl portions of hexane by shaking it on a vortex and allowing it to stand for 5 min at room temperature. The combined extract was transferred to a clean vial, dried for 5-7 min at 80°C, and the dry residue was treated with 20 l of N, O-bis(trimethylsilyl)-trifluoroacetamide for 15 min at 80°C with the lid closed. To the reaction mixture 80 µl of hexane was added — in this form the sample is suitable for analysis for one week if it is hermetically sealed and no evaporation occurs.

For the analysis, a 2 µl mixture of esters was injected into the injector of an Agilent 7890 gas chromatograph with an Agilent 5975C mass-selective detector (Agilent Technologies, USA) through an automatic sample introduction system (autosampler), which provides reproducibility of the retention times of chromatographic peaks and increases the accuracy of automatic data processing. The chromatographic separation of the samples was carried out on a capillary column with methyl silicone grafted phase HP-5ms (Agilent Technologies, USA), the length of 25 m and an inner diameter of 0.25 mm; the carrier gas was helium. Analysis mode — programmed, column ther-

mostat heating rate 7 °C/min in the range 135-320 °C. Delay time at initial temperature — 1.5 min. Evaporator temperature — 250 °C, interface — 250-300 °C.

Results of the study and their analysis. The results of the WHO-TEQ estimation of the blood serum dioxin concentration in lipids of the Federal Fire-fighting Service of Russia and the control group examined show a 16-fold increase in the blood lipid dioxin concentration in firemen compared to the control group.

The analysis of correlation between concentration of blood lipid dioxins and level of microbiota according to OST 91500.11.0004-2003 shows the reduction of concentration of normal microflora of bifidobacteria, eubacteria and lactobacilli among firemen. The decrease in normal microflora values depended on the content of blood lipid dioxins. A more pronounced dysbacteriosis was observed in the groups with a higher concentration of blood lipid dioxins. Along with a decrease in the normal flora there was an increase in the conditionally pathogenic microflora *Bacteroides fragilis*, *Fusobacterium/ Haemophilus*, *Clostridium perfringens*, *Peptostreptococcus anaerobius*, *Enterobacteriaceae* (*E. coli*), *Staphylococcus intermedius*, *Bacillus cereus*, *Bacillus megaterium*, *Mycobacterium/Candida* compared to firefighters with lower blood lipid dioxin concentration as well as control group.

Analysis of the quantitative content in the blood of microbial markers of different groups of microorganisms showed a number of significant differences in the groups examined. A significant increase in the number of microbial markers of aerobic or facultative gram-positive cocci was observed in firefighters with NAFL compared to patients with NAFL of other professions and healthy firefighters. There was a significant increase in microbial markers of aerobic or facultative gram-positive cocci in healthy firefighters compared with healthy individuals in other professions, and a number of indicators exceeded the limits of reference values (Table 1).

The data presented in Table 2 indicate that the increase in the number of microbial markers of opportunistic pathogenic flora in firefighters is mainly due to anaerobic microorganisms. When examining the microbiota in the blood (adherent microbiota) in all examined firefighters was found to increase by more than 35% the total number of microbial markers compared with the examined persons of other professions. At the same time the number of conditionally pathogenic microflora increased by more than 2 times. Also according to a number of indicators there was

Таблица 1 /Table No. 1

Содержание микробных маркеров аэробных или факультативных Gr (+) кокков у обследованных в группах наблюдения, M±m, кл/г × 10⁵

Assessment of the content of microbial markers of aerobic or facultative Gr (+) cocci in the observation groups, M±m, cells/g × 10⁵

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные / firefighters, n=63	контроль / control, n=65	пожарные / firefighters, n=58	контроль / control, n=60
<i>Streptococcus</i> (оральные /oral)	362,4±6,8*#	224,5±5,1#	141,5±2,7*	57,1±1,4
<i>Staphylococcus intermedius</i>	4223,7±32,7**	2682,7±27,4#	527,3±4,6*	542,4±8,5
<i>Enterococcus</i>	312,4±4,8*#	214,6±1,3#	72,7±2,5*	51,7±1,2
<i>Streptococcus mutans</i>	5218,3±21,5**	2048,2±23,8#	1432,6±22,4*	198,9±3,1

* различия достоверны (p<0,05) по сравнению с аналогичной контрольной группой (КГ); # различия достоверны (p<0,05) по сравнению с группой здоровых пожарных

* differences are significant (p<0.05) compared to the same control group (CG); # differences are significant (p<0.05) compared to the healthy firefighters group

a reliable increase in conditionally pathogenic microflora in firefighters with NAFL relative to patients of other professions. It is worth noting a reliable decrease in firefighters in comparison with patients with NAFL and healthy other professions, as well as a clear trend to a decrease in microbial markers (Bifidobacterium) in healthy firefighters relative to healthy other professions. The multidirectional changes in the microbiota, a decrease in bifidobacteria, actinomycetes and, at the same time, an increase in bacteroides and ruminococci in firefighters with NAFL in comparison with NAFL patients from the control group, draw attention.

The results of the evaluation of the content of microbial markers of aerobic or facultative Gr(+) bacilli indicate that firefighters suffering from NAFL have significantly higher values of microbial markers of aerobic or facultative Gr(+) bacilli compared with patients from the control group and healthy firefighters. Noteworthy is the significant decrease (Lactobacillus) in all firefighter groups compared to other occupational groups (Table 3).

Evaluation of microbial markers of aerobic or facultative Gr(-) bacilli showed a significant increase in markers of some microorganisms (Helicobacter pylori, h 18, Enterobacteriaceae (E. coli)) in firefighters with NAFL compared to those in other occupations and increased markers

of some microorganisms (Helicobacter pylori, h 18, Achromobacter, Enterobacteriaceae (E. coli)) compared to sick and healthy control groups (Table 4).

The results of the analysis of the content of microbial markers of fungi, viruses and other microorganisms in firefighters with NAFL indicate significantly higher content indicators (Mycobacterium/ Candida, Streptomyces, Micr. fungi, sitosterol) than in patients from the control group. At the same time, the content of microbial markers in firefighters with NAFL is also significantly higher than in healthy firefighters. At the same time the indices of content of microbial markers in healthy firefighters are reliably higher than in the patients and healthy control group.

The increased viral load (Herpes) in firefighters of both groups also draws attention (Table 5).

Table 6 shows the distribution of reduced content of normal microbiota, draws attention to the decrease in the number of microbial markers Bifidobacterium, Eubacterium/Cl. Coocoides and Lactobacillus in the blood of firefighters both with and without GI disease.

It was found that more than half of the firefighters with NAFL had increased total number of microbial markers in the blood. At the same time, the main changes in the microbiota composition occur due to the increase of

Таблица 2 /Table No.2

Содержание микробных маркеров анаэробных микроорганизмов у обследованных в группах наблюдения, М±m, кл/г ×10⁵

Assessment of the content of microbial markers of anaerobic microorganisms in the observation groups, M±m, cells/g ×10⁵

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные / firefighters, n=63	контроль / control, n=65	пожарные / firefighters, n=58	контроль / control, n=60
Actinomyces viscosus	2132,6±18,4**	1844,5±23,5*	178,5±2,3*	89,4±1,5
Bacteroides fragilis	836,4±5,4**	72,1±1,4*	541,3±1,3*	112,4±1,6
Bacteroides hypermegas	248,7±4,2**	42,5±1,1*	172,3±2,7*	36,5±1,4
Bifidobacterium	1489,2±21,5**	4631,3±18,3*	1978,2±23,6*	6243,4±19,5
Butyrivibrio/ Cl/ fimetarium	3142,4±12,3*	2437,2±16,4*	1024,6±9,6	-
Cl. Difficile	689,4±3,7#	492,2±7,6*	298,7±5,4	128,7±6,5
Clostridium histolyticum	862,5±14,3**	82,3±2,3*	378,4±13,4*	-
Clostridium perfringens	752,2±14,3**	579,1±9,3*	142,4±3,2*	24,7±2,1
Clostridium ramosum	4126,3±37,2**	2372,4±23,7*	3825,3±27,3*	841,4±5,7
Eubacterium	26,7±1,1**	72,3±2,5*	28,3±1,4*	79,5±2,4
Eubacterium lentum (группа А)	524,1±6,3**	292,2±5,6*	334,5±4,7*	128,5±3,1
Eubacterium moniliforme sbsp	6542,5 ± 58,6	3218,5 ± 37,4	0,0	0,0
Eubacterium/Cl. Coocoides	3824,3±34,6	5916,7±53,7	4482,0±23,6	7214,4±31,5
Fusobacterium/ Haemophylus	187,4±3,7**	45,2±1,4	152,8±2,4	24,1±1,2
Peptostreptococcus anaerobius (Гр. 1)	756,1±11,4#	256,0±6,5	421,5±4,1	0,0
Porphyromonas	189,4±3,8**	525,7±4,3	72,1±2,4	36,8±1,4
Prevotella	24,1±0,7	82,3±2,1	19,3±1,6	32,6±0,9
Propionibacterium	1734,2±4,7**	293,6±8,2	1245,1±7,3*	97,12±4,1
Propionibacterium acnes	182,3±2,7**	0,0	214,5±3,2	0,0
Propionibacterium jensenii	952,4±5,4	398,7±3,6	724,3±2,4*	218,4±2,3
Propionibacterium spp. (P. freuden)	986,4±2,4**	4125,3±18,6	1746,2±6,5	4536,8±28,4
Ruminococcus	1745,2±12,3**	426,3±14,5	1264,5±13,4	352,4±11,6
Актиномицеты / Actinomycetes	286,5±2,7*	1234,6±4,1	318,4±2,6*	1190 ± 21,3

*различия достоверны (p<0,05) по сравнению с аналогичной КГ; # различия достоверны (p<0,05) по сравнению с группой здоровых пожарных
* differences are significant (p<0.05) compared to the same control group (CG);
differences are significant (p<0.05) compared to the healthy firefighters group

Таблица 3 /Table No.3

Содержание микробных маркеров аэробных или факультативных Gr(+) палочек, M±m, кл/г × 10⁵
 Assessment of the content of microbial markers of aerobic or facultative Gr (+) bacilli, M±m, cells/g × 10⁵

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные / firefighters, n=63	контроль / control, n=65	пожарные / firefighters, n=58	контроль / control, n=60
Bacillus cereus	252,2±2,5**	182,4±6,5	156,7±4,9	21,8±1,2
Nocardia (14:1d11)	252,9 ± 7,5* #	281,1±7,3	196,2±6,7	263,4±3,1
Nocardia asteroides	326,8±2,9*	482,6±4,3	512,8±5,6	468,5±8,2
Lactobacillus	3225,3±8,6*	5283,3±6,2	3615,4±7,4	6834,4±3,6
Rhodococcus	527,4±134,8*	286,5±8,2	295,4±6,3	482,3±3,7
Bacillus megaterium	5236,5±42,9**	3982,4±23,4	4621,6±34,1	2380,4±27,4

*различия достоверны (p<0,05) по сравнению с аналогичной КГ; # различия достоверны (p<0,05) по сравнению с группой здоровых пожарных
 * differences are significant (p<0.05) compared to the same control group (CG);
 # differences are significant (p<0.05) compared to the healthy firefighters group

Таблица 4 //Table No.4

Содержание микробных маркеров аэробных или факультативных Gr (-) палочек, M±m, кл/г × 10⁵
 Assessment of the content of microbial markers of aerobic or facultative Gr (-) bacilli, M±m, cells/g × 10⁵

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные / firefighters, n=63	контроль / control, n=65	пожарные / firefighters, n=58	контроль / control, n=60
Achromobacter	156,4±2,4##	162,5±1,7	148,2±1,2	52,3±1,7
Campylobacter mucosalis	232,4±3,2	126,3±1,4	57,5±1,1	44,8±1,6
Helicobacter pylori, h 18	176,4±2,5**	26,2±2,7	124,8±3,5*	17,5±0,9
Сем. Enterobacteriaceae (E. coli)	59,7±1,3***	0	52,7±1,5*	0

* различия достоверны (p<0,05) по сравнению с аналогичной КГ; # различия достоверны (p<0,05) по сравнению с группой здоровых пожарных
 * differences are significant (p<0.05) compared to the same control group (CG);
 # differences are significant (p<0.05) compared to the healthy firefighters group

opportunistic-pathogenic flora against the background of a decrease in the normal microflora.

The vast majority of firefighters with NAFL have increased concentrations of Bacteroides fragilis, Fusobacterium/ Haemophilus, Clostridium perfringens, Peptostreptococcus anaerobius, Enterobacteriaceae (E. coli), Staphylococcus intermedius, Bacillus cereus, Bacillus megaterium, Mycobacterium/ Candida.

Conclusion

The research of the blood microbiota by chromatography-mass-spectrometry method of microbial markers testi-

fies to the presence of the expressed intestinal dysbiosis at the examined firemen which is much more expressed at the firemen with NAFL which is caused by the increase of the total number of microbial markers and conditionally-pathogenic flora as well as the reduction of the number of microbial markers of normal microbiota.

It is known that, in chronic liver disease, the concentration of normal microflora, which includes bifidobacteria, bacteroides and lactobacilli, decreases. At the same time, the concentration of conditionally pathogenic flora increases. Nonalcoholic fatty liver disease is accompanied by

Таблица 5 /Table No.5

Содержание микробных маркеров грибов, вирусов и прочих микроорганизмов в группах наблюдения, M±m, кл/г × 10⁵

Assessment of the content of microbial markers of fungi, viruses, and other microorganisms in the observation groups, M±m, cells/g × 10⁵

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные / firefighters, n=63	контроль / control, n=65	пожарные / firefighters, n=58	контроль / control, n=60
Микр. грибы, кампестерол / Microbial fungi, campesterol	1562,3±23,6*	464,3±25,4	1254,6 ± 31,8	637,2±27,5
Микр. грибы, ситостерол / Microbial fungi, sitosterol	764,4±26,5*	242,4±19,7#	518,6±23,7	184,3±9,2
Mycobacterium/ Candida	264,5±3,5*	0,00##	182,5±4,2	0,00
Streptomyces	1825,8±32,6*	256,4±14,3#	1687,3±41,5*	189,6±12,4
Herpes	582,6±12,4*	282,3±8,9	497,7±14,7	126,4±7,6
Pseudonocardia	512,57±8,9*	97,5±7,4	482,6±12,5	72,9±3,2

* различия достоверны (p<0,05) по сравнению с аналогичной КГ; # различия достоверны (p<0,05) по сравнению с группой здоровых пожарных
 * differences are significant (p<0.05) compared to the same control group (CG);
 # differences are significant (p<0.05) compared to the healthy firefighters group

**Распространенность изменения содержания микробных маркеров микрофлоры в группах наблюдения
(ОСТ 91500.11.0004-2003), %**

Prevalence of changes in the content of microbial markers of microflora in observation groups (OST 91500.11.0004-2003), %

Показатель Indicator	Больные НЖБП Patients with nonalcoholic fatty liver disease, n=128		Не страдающие болезнями ЖКТ Not suffering from gastrointestinal diseases, n=118	
	пожарные firefighters, n=63	контроль control, n=65	пожарные firefighters, n=58	контроль control, n=60
Сниженное содержание микробных маркеров нормальной микрофлоры в крови Reduced content of microbial markers of normal microflora in blood				
Bifidobacterium (5067)	62,0	12,0	46,0	0,0
Lactobacillus (6613)	58,0	18,0	43,0	0,0
Eubacterium/Cl. Coocoides (6912)	48,0	12,0	24,0	0,0
Eubacterium (59)	51,0	0,0	47,0	0,0
Повышенное содержание микробных маркеров условно-патогенных микрофлоры в крови Increased content of microbial markers of opportunistic microflora in blood				
Bacteroides fragilis	32,0	0,0	21,0	0,0
Fusobacterium/ Haemophilus	23,0	6,0	12,0	2,0
Clostridium perfringens	57,0	41,0	32,0	1,0
Eubacterium	0,0	5,0	4,0	6,0
Peptostreptococcus anaerobius (Гр. 1)	72,0	36,0	63,0	0,0
Enterobacteriaceae (E. coli)	26,0	0,0	21,0	0,0
Enterococcus (290)	7,0	0,0	0,0	0,0
Staphylococcus intermedius (756)	72,0	48,0	0,0	0,0
Bacillus cereus (23)	67,0	52,0	36,0	0,0
Bacillus megaterium	81,0	32,0	29,0	3,0
Mycobacterium/ Candida	72,0	0,0	49,0	0,0

changes in composition of human microflora, which is manifested by deficiency of obligate microorganisms and microbial insemination of small intestine, resulting in formation of vicious circle, which supports mutual aggravation of pathological changes of intestine and liver. A key link in pathogenesis of formation of intestinal microbiota composition disorders are changes in synthesis and excretion of bile components, which result in dysfunction of internal organs. At the same time excessive bacterial growth leads to increased intake of products of bacterial life activity and putrefaction into the blood stream, which results in disturbances of immune system regulation, increased cytokine production, dysregulation of secretory immunoglobulins (IgA), decreased phagocytic activity, changes of water and electrolyte balance and acid-base equilibrium. Studies have shown the ability of microorganisms to recombinant DNA changes during their phagocytosis, which can lead to the synthesis of specific antibodies to these DNA fragments.

Most of the mechanisms of NAFL are realized through an increase in fat deposition and development of insulin resistance (IR), which has a significant impact on the regulation of metabolism in general. Also a number of products of bacterial life activity have hepatotoxicity. In the pathogenesis of NAFL there is a theory of "two blows" — entry of unesterified fatty acids into the hepatocyte and damage of hepatocytes by oxidative stress. When analyzing the pathogenesis of NAFL, it is necessary to pay special attention to the weighty contribution to the formation of pathology of bile acids dysregulation, which play an important role in lipid metabolism. Activation of systemic inflammatory response against oxidative stress is aggravated by activation of proinflammatory cytokine synthesis by tissue macrophages influenced by increased concentration of bacterial lipopolysaccharides.

The results of the present study indicate that firefighters are characterized by peculiarities in the pathogenesis of

NAFL that do not fit into the mechanisms presented in the scientific literature. It should be taken into account that firefighters are exposed to many toxic products of combustion while performing professional tasks. One such product is dioxins, the collective name for polychlorinated biphenyls, which include a large number of different congeners. Despite the fact that the main route of dioxin intake into the human body is alimentary, their commulative properties, high concentration and long exposure to firefighting allow dioxins to accumulate in firefighters' bodies. According to scientific publications, the metabolic activity of dioxins is mediated through the aryl hydrocarbon receptor (AhR), which is a metabolic regulator and is expressed on almost all cells in the body. Through aryl receptors, dioxin affects the regulation of glucose and lipid metabolism and modifies the expression of genes regulating insulin transport and receptor interactions in human adipose tissue, and also affects cholesterol biosynthesis, fatty acid synthesis, adipocyte differentiation and leptin regulation.

Thus, firefighters had a syndrome of excessive growth of intestinal microbiota due to an increase in the number of conditionally pathogenic flora on the background of a decrease in the number of normal microflora. The revealed increases and changes in the composition of the intestinal microbiota suggest the presence of dysbiosis of the intestinal wall flora in the examined firefighters, which seems to be associated with a decrease in both general and local immunity against the background of exposure to toxic products of combustion, including dioxins, when performing professional tasks of firefighting. The presence of severe dysbiosis, typical for firefighters with NAFL, significantly complicates the course of the disease. Manifestations of dysbiosis detected in healthy firefighters can serve as predictors of liver pathology development, which indicates the need for monitoring and targeted correction of somatic condition and microecological status of this contingent.

REFERENCES

1. Kriyt V.E., Sannikov M.V., Sladkova Yu.N., Pyatibrat A.O. Influence of Xenobiotic Detoxication Gene Polymorphisms and Experience on the Level of Accumulation of Dioxins in Emercom of Russia Employees. *Mediko-Biologicheskiye i Sotsial'no-Psikhologicheskiye Problemy Bezopasnosti v Chrezvychaynykh Situatsiyakh* = Medico-Biological and Socio-Psychological Problems of Safety in Emergency Situations. 2020;2:55–68. DOI 10.25016/2541-7487-2020-0-2-55-68 (In Russ.).
2. Abu-Shanab A., Quigley E.M. The Role of the Gut Microbiota in Nonalcoholic Fatty Liver Disease // *Nat. Rev. Gastroenterol Hepatol.* 2010;7:691–701.
3. Mouzaki M., Comelli E.M., Arendt B.M., Bonengel J., Fung S.K., Fischer S.E., et al. Intestinal Microbiota in Patients with Nonalcoholic Fatty Liver Disease. *Hepatology.* 2013;58:120–127. doi: 10.1002/hep.26319.
4. Nieuwdorp M., Gilijamse P.W., Pai N., Kaplan L.M. Role of the Microbiome in Energy Regulation and Metabolism. *Gastroenterology.* 2014;146:1525–1533. doi: 10.1053/j.gastro.2014.02.008.
5. Zhu L., Baker S.S., Gill C., et al. Characterization of Gut Microbiomes in Nonalcoholic Steatohepatitis (NASH) Patients: a Connection Between Endogenous Alcohol and NASH. *Hepatology.* 2013;57;2:601–609.
6. Chernyak Yu.I., Grassman J.A. Impact of AhRR (565C>G) Polymorphism on Dioxin Dependent CYP1A2 Induction. *Toxicology Letters.* 2020;320:58–63.
7. Viluksela M., Unkila M., Pohjanvirta R., Tuomisto J.T., Stahl B.U., Rozman K.K., et al. Effects of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) on Liver Phosphoenolpyruvate Carboxykinase (PEPCK) Activity, Glucose Homeostasis and Plasma Amino Acid Concentrations in the Most TCDD-Susceptible and the Most TCDD-Resistant Rat Strains. *Arch. Toxicol.* 1999;73;6:323–336.
8. Osipov G.A., Demina A.M. Chromato-Mass Spectrometric Detection of Microorganisms in Anaerobic Infectious Processes. *Vestnik RAMN* = Annals of the Russian Academy of Medical Sciences. 1996;3;2:52–59 (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. Крийт В.Е., Санников М.В., Сладкова Ю.Н., Пятибрат А.О. Влияние полиморфизмов генов детоксикации ксенобиотиков и стажа работы на уровень кумуляции диоксинов в организме сотрудников МЧС России // *Медико-биологические и социально-психологические проблемы безопасности в чрезвычайных ситуациях.* 2020. № 2. С. 55–68. DOI 10.25016/2541-7487-2020-0-2-55-68.
2. Abu-Shanab A., Quigley E.M. The Role of the Gut Microbiota in Nonalcoholic Fatty Liver Disease // *Nat. Rev. Gastroenterol Hepatol.* 2010. V.7. P. 691–701.
3. Mouzaki M., Comelli E.M., Arendt B.M., Bonengel J., Fung S.K., Fischer S.E., et al. Intestinal Microbiota in Patients with Nonalcoholic Fatty Liver Disease // *Hepatology.* 2013. No. 58. P. 120–127. doi: 10.1002/hep.26319.
4. Nieuwdorp M., Gilijamse P.W., Pai N., Kaplan L.M. Role of the Microbiome in Energy Regulation and Metabolism // *Gastroenterology.* 2014. No. 146. P. 1525–1533. doi: 10.1053/j.gastro.2014.02.008.
5. Zhu L., Baker S.S., Gill C., et al. Characterization of Gut Microbiomes in Nonalcoholic Steatohepatitis (NASH) Patients: a Connection Between Endogenous Alcohol and NASH // *Hepatology.* 2013. V.57, No. 2. P. 601–609.
6. Chernyak Yu.I., Grassman J.A. Impact of AhRR (565C>G) Polymorphism on Dioxin Dependent CYP1A2 Induction // *Toxicology Letters.* 2020. T.320. C. 58–63.
7. Viluksela M., Unkila M., Pohjanvirta R., Tuomisto J.T., Stahl B.U., Rozman K.K., et al. Effects of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) on Liver Phosphoenolpyruvate Carboxykinase (PEPCK) Activity, Glucose Homeostasis and Plasma Amino Acid Concentrations in the Most TCDD-Susceptible and the Most TCDD-Resistant Rat Strains // *Arch. Toxicol.* 1999. V.73, No. 6. P. 323–336.
8. Осипов Г.А., Демина А.М. Хромато-масс-спектрометрическое обнаружение микроорганизмов в анаэробных инфекционных процессах // *Вестник РАМН.* 1996. Т.3, №2. С. 52–59.

Материал поступил в редакцию 04.07.21; статья принята после рецензирования 17.12.21; статья принята к публикации 21.03.22
 The material was received 04.07.21; the article after peer review procedure 17.12.21; the Editorial Board accepted the article for publication 21.03.22

ADAPTATION DISORDERS IN EMPLOYEES OF THE MINISTRY OF INTERNAL AFFAIRS OF RUSSIA: THE STYLE OF ADAPTIVE RESPONSE IN THE CONDITIONS OF PROFESSIONAL FUNCTIONING

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Abstract. The objectives of the study are to determine the resistance of personality to stressogenic factors, to prevent possible adaptation failures and to differentiate stylistic disorders of adaptive response from the formation of distorted schemes of adaptive response.

Materials and research methods. The study was conducted on the basis of the polyclinic of the Federal Medical and Health Care Department of the Russian Ministry of Internal Affairs in Moscow in 2019-2020. The study group included 74 employees of the Moscow subdivisions of the Russian Ministry of Internal Affairs, suffering from adaptation disorders. Distribution of patients by sex: men – 23 (31%); women – 51 (69%); age of patients – 20-45 years; average age – 35.2 years. Mean duration of the disease was 3-4 months.

Research results and their analysis. Study results showed:

- all the elements characterizing the profile of adaptive response of patients with adaptive disorder turn out to be associated to varying degrees both with certain protective mechanisms and with affective states. The latter testifies to the fact that these complex and multidimensional mental states are interconnected and interdependent with the features of the adaptive response;
- formed individual profile of protective-adaptive mechanisms and preferred response style in employees of internal affairs bodies allow to favourably assess the prospects of "successful" adaptation of persons of this category;
- professional activity tensions and daily difficulties of employees of internal affairs bodies cause activation of adaptive mechanisms focused on stabilization of intrapersonal state. The degree of intertwining of connections within individual protective profile is closely connected with features of asthenization, anxiety and depressiveness;
- process of defensive mechanisms formation is determined, in particular, by individual predisposition to certain ways of regulation, peculiarities of personal response, flexibility and stability of links formation between response variants in order to achieve effective adaptive response.

Key words: adaptation disorders, coping strategies, employees of police, protective response mechanisms, response style.

For citation: Bezchasnyy K.V. Adaptation Disorders in Employees of the Ministry of Internal Affairs of Russia: Style of Adaptive Response in Conditions of Professional Functioning. *Meditsina Katastrof = Disaster Medicine*. 2022; 1:66-70 (In Russ.).
<https://doi.org/10.33266/2070-1004-2022-1-66-70>

РАССТРОЙСТВА АДАПТАЦИИ У СОТРУДНИКОВ ОРГАНОВ ВНУТРЕННИХ ДЕЛ РОССИЙСКОЙ ФЕДЕРАЦИИ: СТИЛИСТИКА ПРИСПОСОБИТЕЛЬНОГО РЕАГИРОВАНИЯ В УСЛОВИЯХ ПРОФЕССИОНАЛЬНОГО ФУНКЦИОНИРОВАНИЯ

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Резюме. Цели исследования – определить устойчивость личности к воздействию стрессогенных факторов, предупредить возможные срывы адаптации и дифференцировать стилистические нарушения реагирования от формирования искаженных схем приспособительного ответа.

Материалы и методы исследования. Исследование проводилось на базе поликлиники ФКУЗ «Медико-санитарная часть МВД России по г. Москве» в 2019–2020 гг. В группу исследования вошли 74 сотрудника подразделений МВД России по г. Москве, страдающие расстройствами адаптации. Распределение пациентов по полу: мужчин – 23 (31%); женщин – 51 (69%); возраст пациентов – 20–45 лет; средний возраст – 35,2 года. Средняя длительность заболевания – 3–4 мес.

Результаты исследования и их анализ. Анализ результатов исследования показал:

- все элементы, характеризующие профиль приспособительного реагирования пациентов с расстройством адаптации, оказываются в разной степени связанными как с определенными защитными механизмами, так и с аффективными состояниями. Последнее свидетельствует о том, что эти сложные и многомерные психические состояния взаимосвязаны и взаимобусловлены особенностями приспособительного реагирования;
- сформировавшийся индивидуальный профиль защитно-совладающих механизмов и предпочтительная стилистика реагирования у сотрудников органов внутренних дел (ОВД) позволяют прогностически благоприятно оценивать перспективу «успешного» приспособления лиц этой категории;
- напряженность профессиональной деятельности и высокие повседневные трудности деятельности сотрудников ОВД обуславливают включение приспособительных механизмов, ориентированных на стабилизацию внутриличностного состояния, а степень переплетения связей внутри индивидуального защитного профиля тесно связана с особенностями астенизации, тревожности и депрессивности;

– процесс оформления защитных механизмов определяется, в частности, индивидуальной предрасположенностью к тем или иным способам регуляции, особенностями личностного реагирования, гибкостью и устойчивостью образования связей между вариантами реагирования в целях достижения эффективного приспособительного ответа.

Ключевые слова: механизмы защитного реагирования, профессиональное функционирование, расстройства адаптации, сотрудники органов внутренних дел, стилистика приспособительного реагирования, стратегии совладающего поведения

Для цитирования: Безчасный К.В. Расстройства адаптации у сотрудников органов внутренних дел Российской Федерации: стилистика приспособительного реагирования в условиях профессионального функционирования // Медицина катастроф. 2022. №1. С. 66-70. <https://doi.org/10.33266/2070-1004-2022-1-66-70>

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The comparative studies of the issues of adaptation disorders (F.43.2) are rather complicated and often have fragmentary and even contradictory character [1, 2]. Moreover, the field of "minor" psychiatry urgently requires not only the study of psychological aspects of adaptation in these disorders, but also a system analysis of patients' personality aspects, which turns out to be important in the issues of early diagnosis and psychohygienic measures [3, 4]. In this connection, the view on disorders of adaptation from the standpoint of compensatory-adaptive mechanisms is justified, which allows not only to better understand the whole range of phenomena related to the category "adaptation" and helps to identify a number of specific mechanisms, as well as to study the level of their interaction, which can be called adaptive [5-7].

Understanding the determining role of compensatory mechanisms in the pathogenetic picture of the disease is fundamental in the context of the adaptive response of individuals whose professional activities are often accompanied by out-of-the-ordinary situations [8]. In this connection, the interpretation of adaptation disorders in the framework of compensatory-adaptive processes allows to present the problem of their early detection and treatment in connection with the tasks of psychohygiene differently.

An attempt has been made to formulate and to present a holistic structural-dynamic picture of adaptive reactions disorders, determined by the complexity of compensatory-adaptive response, which allows to analyze the stylistics and variability of defense mechanisms from the position of personality behavior in conditions of disease. In other words, prediction of adaptive behavior is designed to determine resistance of the individual to stressors, to anticipate possible breakdowns of adaptation and to differentiate stylistic disorders of response from the formation of distorted schemes of adaptive response.

Materials and research methods. The study was conducted on the basis of the Polyclinic of the Federal Clinical Hospital of the Medical and Healthcare Unit of the Russian Ministry of Internal Affairs in Moscow in 2019-2020. The study group included 74 employees of the Moscow subdivisions of the Russian Ministry of Internal Affairs, suffering from adaptation disorders. Distribution of patients: by sex — men 23 (31%) and women — 51 (69%); age of patients — 20-45 years, average age — 35.2 years. Average duration of the disease was 3-4 months. The study was conducted by a panel of psychia-

trists using the clinical method and the developed Psychosocial Questionnaire. Diagnostic selection of patients was performed on the basis of ICD-10 criteria under heading (F. 43.2), among those who gave voluntary informed consent for the study. Exclusion criteria: presence of somatic disease or refusal to participate.

The following psychological instruments were used for the study:

1. Asthenic state scale (Malkova L.D., 1977).
2. Depression Detection Questionnaire — BDI — (Beck A., et al., 1961).
3. Scale of personal and situational anxiety (Spielberger C.D., 1972; Khanin Y.L., 1976).
4. Plutchik-Kellerman-Conte (1979) method of evaluation of psychological defense mechanisms.
5. "Strategies of coping behavior" questionnaire by Lazarus (1988).

Statistical processing of the material was performed using SPSS-22.0 application software package. Most of the indicators in the study group were characterized by a normal distribution. Data evaluation was performed using parametric Student's t-criterion. Pearson's criterion (r) was used to identify correlation. A difference of at least $p < 0.05$ was considered statistically significant.

Results of the study and their analysis. The study group was divided into male and female samples, whose socio-professional characteristics were taken into account in further work.

Fig. 1 shows that in the study subgroups, the ratio of married, single/unmarried, and divorced IAB officers was different. Obviously, the number of married men was 2.5 times more than the number of married women. At the same time the number of divorced women was almost twice the number of divorced men.

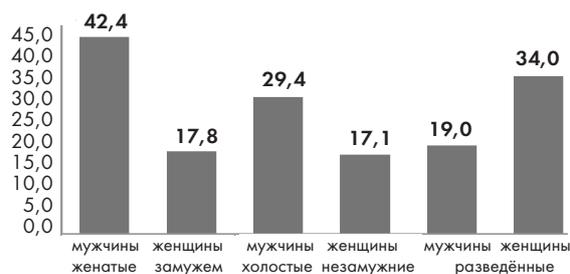


Рис. 1. Семейное положение пациентов в подгруппах исследования, %
Fig. 1. Family status of patients in study subgroups, %

The number of women with an education was twice as high as the number of men with an education, and in most cases it was higher education (Fig. 2).

Accordingly, women were significantly more likely to hold leadership positions (Fig. 3). It is also noteworthy that men with higher education continued to work as privates and junior officers because they were satisfied with their work schedule (daily shifts, internal posts), which gave them the opportunity to earn extra money or to leave more time for household and domestic chores (Fig. 3).

As for a length of service, we should note the greater proportion of women in all its stages, with the highest proportion of women (30%) being in the 11-20-year stage, which characterizes this period of service as a "turning point" in the life of internal affairs officers and their desire to "serve up" to retirement / pre-retirement age, to retire on illness and in this regard ready to add to their "therapeutic baggage" (Fig. 4).

Patients' complaints were reduced to general weakness, increased fatigue, difficulty concentrating, unstable mood, blood pressure fluctuations, sleepiness during the day and difficulty falling asleep at night, and absent-mindedness. A significant manifestation of these conditions was a distorted sleep pattern both quantitatively (superficial intermittent sleep with frequent awakenings) and qualitatively (no sense of rest in the morning after awakening, difficulty falling asleep, disturbing dreams). As the disease progressed, anxiety, joylessness increased, along with vegetative-somatic manifestations.

The average values of asthenic manifestations, complaints of depressive state and anxiety were within the norm (Fig. 5). It should be noted, however, that the level of depression in both men and women corresponded to the level of mild depression — 8.6 and 9.7 points, respectively. At the same time, the level of situational anxiety in women was higher than in men — 40.3 and 36.4 points, respectively. Significant correlations were observed for asthenia ($r=0.227$; $p=0.01$), depression ($r=0.168$; $p=0.01$), personality anxiety ($r=0.190$; $p=0.01$) and situational anxiety ($r=0.251$; $p=0.01$) in women. Thus, it is evident from these data that women are more prone to asthenization, irritability and mood instability in the conditions of the disease. Probably, it is not only a clinical expression of a disease, but also serves the purpose of the adaptive response to a difficult situation.

According to the "Strategies of coping behaviour" technique, the results obtained in the study subgroups were within the normative interval (40-60 T-points), which indicated a moderate degree of strategy preference. However, a comparative analysis of coping strategies

revealed that men preferred "seeking social support", "planning problem solving", "distancing", and "confrontation" (Table 1). Such behavior is understood as purposeful efforts to change the situation by seeking help, advice from other people who have the necessary information. Taking into account the new information, the situation and possible options and ways of solving the problem are analyzed. Men also resort to attempts to subjectively reduce the significance of a problematic situation by excessive rationalization, shifting attention, withdrawing from it or devaluing it. In this case, difficulties in planning one's behavior and predicting its consequences are revealed, sometimes even unjustified obstinacy and stubbornness.

Women are characterized by strategies of "planning a solution to a problem" and "distancing", which indicates their ability to purposefully analyze a situation and possible options for behavior, to develop a tactical plan of action taking into account their life experience and objective conditions, which indicates their constructive approach to solving difficult problems. As well as men, women resort to attempts to subjectively lower the significance of a problem situation by way of reducing their emotional involvement in it by switching their attention or treating it ironically. It should be noted that men and women have both similarities and differences in the use of a repertoire of coping strategies. If men were more inclined to search for people who could help them, with whom they could discuss the problem situation and often to distance themselves from it by excessive rationalization, detachment and lack of targeting, they nevertheless planned ways to solve the problem and ways out of it. At the same time, women were characterized by an analysis of the situation, an assessment of the options for getting out of a difficult situation, and a depreciation of its significance by reducing the degree of emotional involvement. However, along with this, they underestimated the significance and possibilities

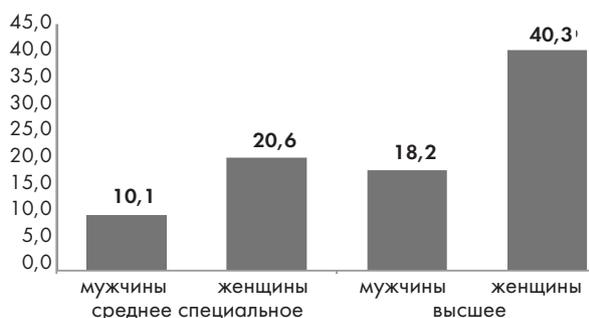


Рис. 2. Образование пациентов в подгруппах исследования, %
Fig. 2. Education level of patients in study subgroups, %



Рис. 3. Состав, к которому относятся пациенты в подгруппах исследования, %
Fig. 3. Personnel to which patients in study subgroups belong, %

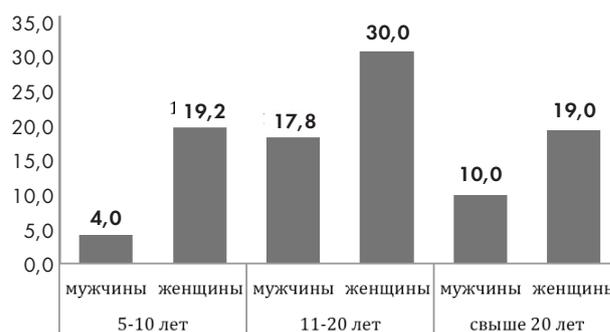


Рис. 4. Выслуга лет у пациентов в подгруппах исследования, %
Fig. 4. Length of service of patients in study subgroups, %

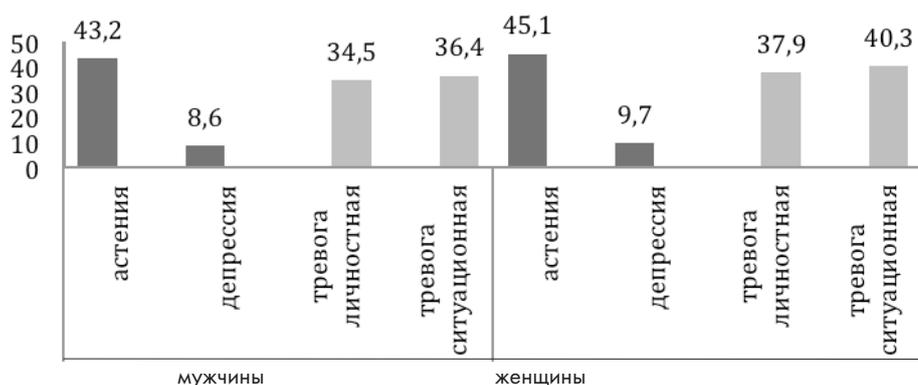


Рис. 5. Расстройства адаптации у сотрудников ОВД, баллы
Fig. 5. Adaptation disorders in police employees, points

of effectively overcoming a problematic situation. An analysis of the structure of defensive mechanisms in men and women using the Life Style Index technique showed the following differences: the total intensity of defensive mechanisms did not exceed a threshold value of 50 points: in men — (27,69±2,4) points; in women — (28,2±1,77) points, which denotes the absence of significant unresolved conflicts.

It is necessary to note enough "motley" picture of protective psychological mechanisms: so, for example, men gave preference to such mechanisms, as "displacement", "denial" and "rationalization". The justifying attitude to the behavior, the inconsistency explained by the presence of painful manifestations led ultimately to a kind of "flight into illness", but there was no "pleasant conditionality and desirability" of the disorders — on the contrary, patients were weighed down by their condition and tried to struggle with it according to their concept of illness. The sufficient level of "rationalization" was combined with a low level of disadaptive manifestations, impaired interpersonal interaction: its activity correlated with personal maturity and a high level of self-esteem. In an effort to suppress the fear for their health, the patients sought help from internal medicine doctors, underwent numerous examinations, and received symptomatic treatment, which brought them relief for a while.

In women, "regression", "substitution", "projection" and "hypercompensation" mechanisms were significantly more prevalent, which, in general, can be viewed as an infantile attitude toward dependent behavior and receiving help from others. At the same time, weakness of emotional-will control can induce the personality to provoke conflict situations. This is realized through indirect aggression, and

high commitment to social norms and lack of confidence in their own abilities does not allow them to openly show aggressive behavior. Women were highly critical and demanding of those around them, which allowed them to justify their behavior and thereby cope with the feeling of insecurity. They were characterized by over-normativity, excessive sociality and a high desire to conform to generally accepted standards of behavior, which indicates the suppression of aspirations that are socially disapproved of.

At the same time, the cross-cutting character of the mechanisms of "denial," "compensation," and "rationalization," preferred by patients with adaptation disorders, forming a stable configuration, can be interpreted as a marker of prolonged and pronounced intrapsychic conflict, as a manifestation of a greater tension of the general level of neurotic protective reactions. Obviously, the presence of such a configuration of protective mechanisms reflects a weakness of the defense system, indicating its low adaptability, which complicates the awareness of intrapersonal problems. At the same time, it is possible to specify some features of such configuration — the presence of high criticism and insistence on others allows patients to justify their behavior and to cope with the feeling of inferiority.

The results of comparing the mechanisms of defensive reaction in the study group indicate a rather wide range of adaptive reactions in the conditions of the disease: the women's preferred repertoire of defense and the degree of its intensity allow us to conclude that they are based on a sense of insecurity and a low degree of self-sufficiency. Men were characterized by a distorted perception of the surrounding reality, which allowed a more sober assessment and a less painful perception of the events around them even in the conditions of the disease.

Таблица 1 / Table No. 1

Структура стратегий совладающего поведения (по Лазарусу) у сотрудников ОВД, (M±m), баллы
Structure of coping strategies (Lazarus scale) of police employees (M±m), points

	Самоконтроль Self-control	Поиск социальной поддержки Seek social support	Принятие ответственности Accept responsibility	Планирование решения проблемы Problem solving	Положительная переоценка Positive revaluation	Дистанцирование Distancing	Бегство избегание Escape avoidance	Конфронтация Confrontive coping
Мужчины Men	54,22±2,87	60±1,53	51,57±1,95	65,96±1,3	56,96±2,45	59,52±2,83	51,3±2,49	59,78±2,88
Женщины Women	58,55±1,5	56,16±1,34	53,76±1,66	65,82±0,86	57,31±1,45	63,59±1,42	52,41±1,69	56,86±1,69
T	2,123	1,581	2,823	3,012	2,984	1,912	2,017	1,852
P	0,037	0,001	—	—	—	0,005	—	0,04

**Структура механизмов защитного реагирования по методике «Индекс жизненного стиля»
у сотрудников ОВД, (M±m), баллы**

Structure of protective response mechanisms according to the Life Style Index methodology in police employees (M±m), points

	Вытеснение Displacement	Регрессия Regression	Замещение Replacement	Отрицание Denial	Проекция Projection	Компенсация Compensation	Гиперком- пенсация Hypercom- pensation	Рационализация Rationalization
Мужчины Men	27,8±3,56	17,65±3,52	4,35±1,5	46,65±3,5	37,54±5,1	28,7±3,8	13,04±3,52	44,93±3,66
Женщины Women	24,71±2,2	21,86±2,38	10,59±1,8	44,25±2,34	41,35±3,45	27,65±3,1	22,35±2,65	41,24±2,4
T	1,309	2,014	3,612	2,492	1,834	1,395	3,051	1,852
P	0,043	0,01	0,005	–	0,001	–	0,001	–

Conclusions

1. All of the elements that characterize the adaptive response profile of patients with adaptation disorder appear, to varying degrees, to be associated with both certain defensive mechanisms and affective states. The latter indicates that these complex and multidimensional mental states are interconnected and interdependent on the features of the adaptive response.

2. Formed individual profile of protective-cooperative mechanisms and preferable response style in internal affairs employees allows to assess the prospect of "successful" adaptation of the persons of this category as prognostically favorable.

3. Tension of professional activity and high daily difficulties of activity of internal affairs employees cause application of adaptive mechanisms, oriented on stabilization of intrapersonal state, degree of intertwining of connections within individual protective profile is closely connected with features of asthenization, anxiety and depressiveness.

4. The process of formation of protective mechanisms, in a sense, is determined by individual predisposition to these or those ways of regulation, features of personal reaction, flexibility and stability of formation of connections between variants of reaction in order to achieve an effective adaptive response.

REFERENCES

1. Bezchasnyy K.V. Adaptive Response in Interior Ministry Employees Suffering from Adjustment Disorder. *Voprosy Material'no-Tekhnicheskogo i Meditsinskogo Obespecheniya MVD*. 2020;3;120:40-44 (In Russ.).
2. Isayeva E.R. *Sovladayushcheye so Stressom i Zashchitnoye Povedeniye Lichnosti pri Rasstroystvakh Psikhicheskoy Adaptatsii Razlichnogo Geneza = Coping with Stress and Protective Behavior of the Individual in Mental Adaptation Disorders of Various Origins*. Extended Abstract of Doctor's thesis in Medicine. St. Petersburg, NIPNI im. V.M. Bekhtereva Publ., 2010. 48 p. (In Russ.).
3. Rasskazova E.I. Latent Personality Profiles in Mental Illness: An Analysis of the Restructured MMPI-2 Clinical Scales. *Obzrenie Psikhiiatrii i Meditsinskoy Psikhologii im. V.M. Bekhtereva*. 2019;1:52–60 (In Russ.).
4. Solovyev A.G., Bogdasarov Yu.V., Ichitovkina E.G. Structure and Levels of Mental Disorders Morbidity of the Employees of the Internal Affairs Bodies. *Prakticheskaya Meditsina = Practical Medicine*. 2019;3:73-78 (In Russ.).
5. Litvinsev S.V. Some Problem and Debatable Questions of Psychosomatic Correlations and Somatoform Disorders from Positions of Clinical Psychiatry. *Obzrenie Psikhiiatrii i Meditsinskoy Psikhologii im. V.M. Bekhtereva*. 2018;3:80–89 (In Russ.).
6. Bezchasnyy K.V. Features of the Adaptive Response of Employees of Internal Affairs Bodies, as a Reflection of the Potential of the Individual in Conditions of the Disease with Somatized Disorder. *Psikhicheskoe Zdravoye*. 2021;1:22-28 (In Russ.).
7. Vasserman L.I., Ababkov V.A., Trifonova E.A. *Sovladanie so Stressom. Teoriya i Psikhodiagnostika = Controlling with Stress. Theory and Psychoactivator*. St. Petersburg, Rech' Publ., 2011. 191 p. (In Russ.).
8. Ichitovkina YE.G., Zlokazova M.V., Bogdasarov YU.V., Solov'yev A.G., Epshteyn A.G. A Comprehensive Approach to Psychopreventive Examination of Police Officers. *Ekologiya Cheloveka = Human Ecology*. 2019;3:4-8 (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. Безчасный К.В. Приспособительное реагирование у сотрудников МВД, страдающих расстройством адаптации // *Вопросы материально-технического и медицинского обеспечения МВД*. 2020. № 3. С. 40-44.
2. Исаева Е.Р. Совладающее со стрессом и защитное поведение личности при расстройствах психической адаптации различного генеза: Автореф. ... дис. д-ра мед. наук. СПб.: НИПНИ им. В.М. Бехтерева, 2010. С. 48.
3. Рассказова Е.И. Латентные личностные профили при психических заболеваниях: анализ реструктурированных клинических шкал MMPI-2 // *Обзор психиатрии и медицинской психологии им. В.М. Бехтерева*. 2019. № 1. С. 52-60.
4. Соловьев А.Г., Богdasarov Ю.В., Ичитовкина Е.Г. Структура уровня заболеваемости психическими расстройствами сотрудников органов внутренних дел // *Практическая медицина*. 2019. № 3. С. 73-78.
5. Литвинцев С.В. Некоторые проблемные и дискуссионные вопросы психосоматических соотношений и соматоформных расстройств с позиций клинической психиатрии // *Обзор психиатрии и медицинской психологии им. В.М. Бехтерева*. 2018. №3. С. 80–89.
6. Безчасный К.В. Особенности приспособительного реагирования сотрудников органов внутренних дел, как отражение потенциала личности в условиях заболевания соматизированным расстройством // *Психическое здоровье*. 2021. № 1. С. 22-28.
7. Вассерман Л.И., Абабков В.А., Трифонова Е.А. *Совладание со стрессом. Теория и психодиагностика*. СПб.: Речь, 2011. 191 с.
8. Ичитовкина Е.Г., Злоказова М.В., Богdasarov Ю.В., Соловьев А.Г., Эпштейн А.Г. Комплексный подход к психопрофилактическому обследованию сотрудников полиции // *Экология человека*. 2019. № 3. С. 4-8.

Материал поступил в редакцию 21.06.21; статья принята после рецензирования 05.02.22; статья принята к публикации 21.03.22
The material was received 21.06.21; the article after peer review procedure 05.02.22; the Editorial Board accepted the article for publication 21.03.22

ACTUAL PROBLEMS OF MEDICAL EVACUATION АКТУАЛЬНЫЕ ПРОБЛЕМЫ МЕДИЦИНСКОЙ ЭВАКУАЦИИ

<https://doi.org/10.33266/2070-1004-2022-1-71-77>
UDC 614.883 (470.25)

Original article
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EVALUATION OF THE EFFICIENCY OF WORK AND PROSPECTS FOR THE DEVELOPMENT OF AMBULANCE AVIATION IN THE CONDITIONS OF A MEGAPOLIS ON THE EXAMPLE OF THE CITY OF MOSCOW

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Abstract. *The objectives of the study are to develop a structural and functional model, principles and algorithms of organizational and methodological support of helicopter evacuation of patients to specialized medical organizations of megapolis; to evaluate their effectiveness analysing the results of treatment of patients with significant urgent pathology.*

Materials and research methods. The results of treatment of 241 patients with urgent pathology at the treatment facilities of the Moscow Health Department — City Clinical Hospital No.15 named after O.M. Filatov, S.S. Yudin State Clinical Hospital and N.S. Sklifosovskiy Research Institute of Emergency Medicine in 2016-2019 — were analyzed. Inclusion criteria: patients with bleeding (isolated or in combination with acute trauma) requiring surgical intervention; with acute coronary syndrome (unstable angina pectoris, myocardial infarction with and without ST-segment elevation); with vascular pathology of central nervous system or cranio-cerebral trauma, requiring emergency hospitalization of the patient in a specialized medical institution — provided that the time of delivery of all these patients to the hospital was at least 30 minutes from the time of call.

Exclusion criteria: patients with mental illness, infectious-inflammatory processes, severe comorbid somatic diseases in decompensation stage (established by anamnesis, examination or autopsy reports); incurable cancer patients and any urgent patients whose delivery time to the specialized hospital was less than 30 minutes from the time of call.

All patients included in the study were divided into 2 groups:

The main — 1st group — included 112 patients delivered to the profile medical institution of the megapolis on a medical helicopter. The comparison group — 2nd group — consisted of 129 patients with similar urgent pathology, hospitalized to the specialized hospitals of the city by ground ambulance transport.

Research results and their analysis. The analysis of the study results showed:

- performance of air medical teams is comparable to or exceeds that of ground ambulance teams;
- number of total bed-days in the group hospitalized by air ambulance was higher than in the comparison group;
- inpatient outcomes and long-term outcomes were comparable in both groups;
- pilot study of the use of mobile diagnostic ultrasound in providing emergency and urgent medical care allows us to consider this method as a promising one, but it requires further evidence accumulation.

Thus, the performance of medical aviation is not inferior to the performance of ground ambulance teams, and in some aspects, even exceed them, which confirms the high potential of its use in megapolis conditions and in remote and hard-to-reach areas.

Key words: : *air ambulance, air medical teams, algorithms, development prospects, efficiency, megapolis, Moscow, organization, patients, urgent pathology*

Conflict of interest. The authors declare no conflict of interest

For citation: Gumenyuk S.A., Aleksanin S.S., Yarygin N.V. Evaluation of the Efficiency of Work and Prospects of Sanitary Aviation Development in Megapolic Environment on the Example of Moscow City. *Meditsina Katastrof* = Disaster Medicine. 2022;1:71-77 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-1-71-77>

<https://doi.org/10.33266/2070-1004-2022-1-71-77>
УДК 614.883 (470.25)

Оригинальная статья
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ОЦЕНКА ЭФФЕКТИВНОСТИ РАБОТЫ И ПЕРСПЕКТИВ РАЗВИТИЯ САНИТАРНОЙ АВИАЦИИ В УСЛОВИЯХ МЕГАПОЛИСА НА ПРИМЕРЕ г.МОСКВЫ

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Резюме. Цели исследования – разработать и внедрить в практическое здравоохранение структурно-функциональную модель, принципы и алгоритмы организационно-методического обеспечения вертолетной эвакуации пациентов в профильные медицинские организации мегаполиса; оценить их эффективность на примере результатов лечения пациентов со значимой ургентной патологией.

Материалы и методы исследования. Для сравнительной оценки работы санитарной авиации в условиях мегаполиса были проанализированы результаты лечения 241 пациента с ургентной патологией, осуществлявшегося в лечебных учреждениях Департамента здравоохранения г.Москвы (ДЗМ) – городской клинической больницы (ГКБ) №15 им. О.М.Филатова, ГКБ им. С.С.Юдина и НИИ скорой помощи им. Н.В.Склифосовского – в 2016–2019 гг.

Критерии включения в исследование – пациенты с кровотечениями (изолированными или в сочетании с острой травмой), требующими оперативного вмешательства; с острым коронарным синдромом (нестабильная стенокардия, инфаркт миокарда с подъемом и без подъема сегмента ST); с сосудистой патологией центральной нервной системы (ЦНС) или черепно-мозговой травмой (ЧМТ), требующими экстренной госпитализации пациента в профильное медицинское учреждение – при условии, что время доставки всех указанных пациентов в стационар составляло не менее 30 мин от момента вызова.

Критерии исключения из исследования – пациенты с наличием, помимо основной ургентной патологии, психических заболеваний, инфекционно-воспалительных процессов, тяжелых сопутствующих соматических заболеваний в стадии декомпенсации (установленных по анамнезу, обследованию или по протоколам вскрытия); инкурабельные онкологические пациенты и любые ургентные пациенты, время доставки которых в профильный стационар составляло менее 30 мин от момента вызова.

Все пациенты, включенные в исследование, были разделены на 2 группы:

В основную – 1-ю – группу вошли 112 пациентов, доставленных в профильное медицинское учреждение мегаполиса с использованием медицинского вертолета.

В группу сравнения (2-ю группу) вошли 129 пациентов с аналогичной ургентной патологией, госпитализированных в профильные стационары города наземным транспортом скорой медицинской помощи (СМП).

Результаты исследования и их анализ. Анализ результатов исследования показал:

- проанализированные в ходе исследования показатели эффективности работы авиамедицинских бригад (АМБр) сравнимы или превышают таковые у наземных бригад СМП;
- количество общих койко-дней в группе госпитализированных санитарным вертолетом было больше, чем в группе сравнения;
- результаты лечения в стационаре и отдаленные исходы у пациентов обеих групп были сравнимы;
- пилотное исследование использования мобильного диагностического УЗИ при оказании неотложной и экстренной медицинской помощи пациентам АМБр позволяет расценить данный метод как перспективный, но требующий дальнейшего накопления доказательной базы.

Таким образом, показатели эффективности работы санитарной авиации не уступают аналогичным показателям наземных бригад СМП, а в некоторых аспектах – даже превышают их, что подтверждает высокий потенциал использования АМБр в условиях мегаполиса и большие перспективы применения авиамедицинских бригад на удаленных и труднодоступных для автомобильного транспорта территориях.

Ключевые слова: авиамедицинские бригады, алгоритмы, г.Москва, мегаполис, организация, пациенты, перспективы развития, санитарная авиация, ургентная патология, эффективность

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: Гуменюк С.А., Алексанин С.С., Ярыгин Н.В. Оценка эффективности работы и перспектив развития санитарной авиации в условиях мегаполиса на примере г.Москвы // Медицина катастроф. 2022. №1. С. 71-77. <https://doi.org/10.33266/2070-1004-2022-1-71-77>

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In our country and abroad every third inhabitant applies annually for emergency medical assistance (EMT), and every tenth of them are immediately hospitalized afterwards. The reasons for people seeking EMT are: in 45-55% of cases – diseases of the cardiovascular system; 15-20 – diseases of the central and peripheral nervous system; in 8-10% of cases – respiratory diseases and acute surgical abdominal pathology. In Moscow in 2018, emergency and urgent medical care was provided to more than 3.9 million people. [1-7].

In addition, the number of emergencies in the world is increasing every year, including man-made ones, accompanied by a large number of victims, requiring emergency medical care and often requiring immediate medical evacuation [4, 8, 9]. World experience shows that the use of medical helicopters for evacuating victims and patients to hospitals leads to a high survival rate and a decrease in the level of disability [10-14].

In the Russian Federation, the development, improvement and new aspects of the use of helicopters for

emergency medical evacuation in metropolitan conditions require the development of an appropriate organizational structure and regulatory legal framework. At the same time, it should be noted that direct extrapolation of foreign experience to the conditions of Russia is impossible, given the significant socio-economic peculiarities of regions and, especially, megacities.

The aim of the study is to develop and to implement in practical healthcare a structural and functional model, principles and algorithms of organizational and methodological support of helicopter evacuation of patients to specialized medical organizations of a megacity with assessment of their efficiency.

Principles of air ambulance operation in the megacity

At the present time the work of the sanitary aviation of Moscow is realized by the interaction of two departments — the Moscow Health Department and the Moscow Department of Civil Defense and Fire Safety, the work of which is coordinated by the Moscow City Government. Based on the regulations, in day-to-day operation mode it is now possible for an air ambulance helicopter to fly over the administrative territory of the city; in emergency mode, an air ambulance helicopter can fly to any place in Moscow region or any other region, provided it is able to return safely to its base and Moscow mayor issues relevant directives.

The work of sanitary aviation in the megacity begins with training of highly qualified personnel. The Moscow Territorial Scientific and Practical Center of Disaster Medicine of the Moscow Department of Health has formed individual training programs for all specialists participating in the process of medical and air ambulance evacuation. The main principles of training of the medical specialists are: understanding of the mechanisms of pathological processes in patients during takeoff, flight and landing of the helicopter, as well as the skills of their prevention and correction.

Important components of the work of aviation medical teams (AMTs) specialists are: knowledge and observance of helicopter safety techniques; observance of the algorithm of interaction with flight personnel, employees of medical organizations and other services involved in transporting and providing assistance to patients; organization of safe work on board the air ambulance helicopter and near the aircraft.

The development of air ambulance and the increase in the number of indications for the use of AMTs in the metropolitan area required additional medical resources, which were calculated on the basis of the population of the city and the need for emergency medical care. Since January 2016, 3 helicopters have been on permanent duty in Moscow, which is optimal for the metropolis; 2 more helicopters, if necessary, can fly to an emergency with a large number of victims at any time. Given the optimization of the service, the number of flights increased from 222 — in 2005-2007 to 743 — in 2017-2019 years, that is 3.35 times.

In addition, the following algorithms for the use of a helicopter to provide medical assistance to the population of Moscow have been developed and, since 2009, have been successfully used:

- "Arrival of helicopter before ambulance";
- "Arrival of helicopter after ambulance";
- "Medical evacuation from medical facilities";

- "Work of AMT in an emergency situation";
- "Transfer of a victim from the ambulance to the ambulance if the flight is impossible".

The use of these algorithms allows in each case to determine the most optimal indications, to reduce time and to adapt approaches to the hospitalization of patients in specialized medical institutions using a medical helicopter in a metropolitan area.

An important criterion in providing medical care is the time of doctor's arrival to the patient. The overwhelming majority of EMTs (78.6%) arrived to patients within 15 min from the moment of call. The average time taken to prepare an ambulance helicopter for a flight was: in 2005-2007 — (26.48 ± 1.91) min; in 2017-2019 — (10.97 ± 1.34) min.

Thus, in 2017-2019, the total time — from call receipt to arrival to the patient — in 91.8% of flights did not go beyond 40 min, while in 2005-2007, only 88.3% of flights fell within this time frame. The time of flight to and return of a patient from the place of his localization to the specialized medical institution was not more than 10 min, the average time — (6.83 ± 0.49) min, in 2007 and 2019 it actually did not differ.

Materials and methods of the research. For a comparative assessment of air ambulance performance in metropolitan conditions, we analyzed the results of treatment in 2016-2019 of 241 patients with urgent pathology, carried out in specialized departments of hospitals of the Moscow Department of Health: City Clinical Hospital No. 15 named after O.M. Filatov, City Clinical Hospital named after S.S. Yudin, and Research Institute of Emergency Medicine named after N.V. Sklifosovsky.

Inclusion criteria — patients with bleeding (isolated or combined with acute trauma) requiring surgical intervention; with acute coronary syndrome (unstable angina pectoris, myocardial infarction with and without ST-segment elevation); with vascular pathology of central nervous system (CNS) or craniocerebral injury (CCI), requiring emergency hospitalization and medical evacuation to specialized medical institution; medical evacuation time — at least 30 min from the moment of call.

Exclusion criteria from the study — in patients with urgent pathology: mental illness, infectious inflammatory processes, severe comorbid somatic diseases in decompensation stage, established on the anamnesis, examination or autopsy reports; incurable cancer patients and any urgent patients whose evacuation time to a specialized hospital was less than 30 minutes from the time of the call.

Taking these criteria into account, all the patients under study were divided into 2 groups:

The main (1st) group consisted of 112 patients delivered to the profile medical institution of the metropolis by medical helicopter, whose causes of hospitalization were acute coronary syndrome (ACS), acute stroke, traumatic brain injury and bleeding of various genesis, requiring urgent surgical intervention.

The control group comprised 129 patients with the similar urgent pathologies hospitalized to the specialized hospitals of the city by ground ambulance transport.

The distribution of patients in the study groups by age and sex is presented in Table 1.

There were no significant differences between the number of men and women in the main group and the comparison group, $p=0.893$. There were also no differences in the distribution of men and women within age groups,

$p=0.794$. The mean age of patients hospitalized for emergency indications was: in the main group — (59.9 ± 1.7) years; in the comparison group — (61.1 ± 1.7) ; no significant differences were found, $p=0.47$.

Methods of medical evacuation of patients to the hospital

A. Hospitalization using an ambulance

In the comparison group, a class C ambulance was used to transport patients to the specialized departments of hospitals.

These resuscitation ambulances are designed to perform therapeutic measures of emergency medical care by a resuscitation or specialized team, as well as to evacuate and to monitor the condition of evacuated patients in the prehospital period.

B. Hospitalization using an air ambulance helicopter

BK-117C-2 helicopters were used for medical evacuation of the main group patients to medical treatment facilities.

Each aircraft is equipped with a dielectric floor, which allows performing electropulse therapy in flight. All equipment used for the work is certified for use on aircrafts.

The stock of drugs and dressing material in the helicopter is designed for 25 patients. For mobile work, medical personnel of AMTs use medical offloading vests with a set we developed.

Both in ambulances and in air ambulance helicopters, patients were examined to confirm the main diagnosis and possible concomitant pathology, including electrocardiography (ECG), pulse oximetry, glucometry in all patients, as well as ultrasound examination, conducted on portable diagnostic ultrasound scanners in patients of the main group: in 22 cases for combined trauma; in 24 cases for cardiac pathology and suspected pulmonary embolism; and in 69 cases for the purpose of ultrasound navigation during central vein catheterization.

Comparing the standard equipment of ambulance helicopter and ambulance car class C, we can note the presence in the ambulance basic set of medical equipment and equipment, similar to those used in medical helicopters, except for medical vest unloading, which allows to optimize the work of AMT doctor in conditions of lack of time and limited space.

Conditions in the air ambulance helicopter allow intensive therapy at the scene and in the process of medical evacuation of patients, including full resuscitation and anesthesia allowance — in a volume sufficient to maintain a stable condition of severe and extremely severe somatic patients and victims of emergencies during their medical evacuation to the hospital.

In the pre-hospital period the methods of treatment in the ambulance and ambulance helicopter were almost identical and were carried out in accordance with the standards

of medical care — the orders of the Department of Health of Moscow dated 27.01.2016 and 10.10.2018. All patients were admitted to the hospital within 118 minutes of first contact with a medical professional. Treatment of patients in the hospital was carried out in accordance with international and Russian clinical guidelines.

Total number of invasive interventions (surgeries) performed was: in the main group — 112 patients — 102 interventions (91,1%); in the comparison group — 129 people. — 107 interventions (83,0%).

The patients of both groups were examined 6 months after discharge from the hospital to assess the long-term results of treatment.

Statistical analysis of the data was performed using the software package IBM SPSS Statistics 26. The data for the analysis were preliminarily prepared and analyzed for outliers. In all statistical studies, the level of significance of differences was taken as 0.05.

Results of the study and their analysis. The spectrum of nosologies (main and concomitant pathology) and the distance of patients from the specialized hospital were studied in hospitalized urgent patients of both groups. The main diagnosis, which was made by the doctors of emergency medical teams taking into account clinical examination data and objective examination methods, was confirmed in the specialized hospital, where a comprehensive clinical and diagnostic examination was carried out. The comparative number of nosologies encountered in the study groups is presented in the figure.

The main and concomitant pathologies occurred in the groups with approximately equal frequency. Overall, more than 2/3 of those hospitalized (81.7%) had one or more comorbid chronic diseases that were in remission and therefore patients did not require additional treatment.

The remoteness of patients from the specialized medical institution is presented in Table 2.

The mean distance from the patient's location to the specialized hospital was: in the main group — $(62,6 \pm 2,1)$ km; in the comparison group — $(12,7 \pm 1,1)$ km, thus, there were significant differences between the groups with regard to this parameter, $p < 0,05$.

The maximum distance from the patient's location to the specialized hospital was: in the study group, 129.2 km; in the comparison group, 50.3 km.

In order to assess the efficiency of air ambulance use in a metropolitan area, we performed a comparative analysis of a number of indicators: duration of stay of patient groups in hospital departments; mortality rate and long-term results of treatment.

At the initial examination the condition of patients in the study groups was as follows: satisfactory condition — 7 persons. (2,9%); moderate — 79 (32,8%); severe — 133

Таблица 1 / Table No. 1

Распределение пациентов по возрасту и полу

Distribution of patients by age and gender

Возраст, лет Age, years	Основная группа, n=112, чел./% Main group, n=112 pers./%		Итого, % Total, %	Группа сравнения, n=129, чел./% Comparison group, n=129, pers./%		Итого, % Total, %
	М / Male	Ж / Female		М / Male	Ж / Female	
20-40	12/10,7	5/4,5	15,2	24/18,6	0/0	18,6
41-60	26/23,2	9/8,0	31,3	25/19,4	5/4,7	24,0
61 и старше 61 and older	35/31,3	25/22,3	53,6	33/25,6	41/31,8	57,4
Всего / Total	73/65,2	39/34,8	100,0	82/63,6 %	47/36,4	100,0

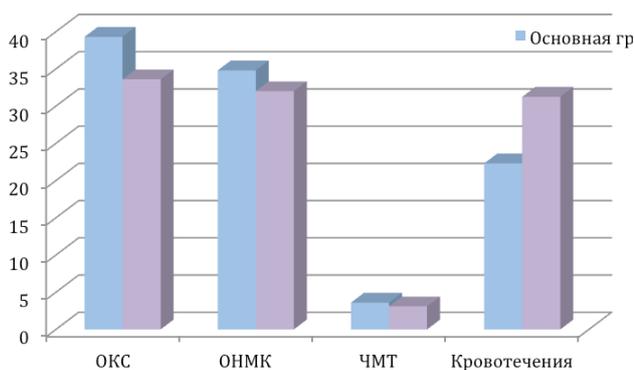


Рисунок. Нозологии в сравниваемых группах, %
Figure Nosologies in compared groups, %

(55,2%); extremely severe — 22 persons. (9,1%). The patients of the main group were hospitalized in a more severe condition. Severe and extremely severe were 77 patients (68.8%) in the study group and 78 patients (60.9%) in the control group; impaired consciousness of varying severity was detected in 11 patients (9.8%) in the study group and in 1 patient (0.8%) in the control group.

Cardiopulmonary resuscitation (CPR) was performed by helicopter in 12 cases (10.7%) and only in one case (0.8%) in a comparison group patient — by ambulance. The indication for resuscitation measures was cardiac arrest. There were no complications of mechanical chest compressions using an automatic compression device. All patients of both groups were delivered to the hospital alive.

The efficacy of central venous catheterization using ultrasound on a mobile scanner was confirmed: in the main group — in 83 cases of invasive procedures with 100% success; in the comparison group — in 94 successful cases (91.3%) out of 103 attempts with the "blind" method.

The use of diagnostic ultrasound during air ambulance evacuations can be considered as a near-term prospect, since in some cases the presence and approximate volume of intracranial hematomas can be diagnosed, including by indirect signs (optic nerve edema). The technique requires high proficiency in diagnostic ultrasound and experience in performing such examinations — it is currently at the stage of implementation and accumulation of experience.

During the initial examination, use of an ultrasound on a mobile device allowed 11 patients of the main group to be

admitted directly to the operating room of the surgical hospital, without additional diagnostic and therapeutic measures in the emergency room or in the anesthesiology and intensive care unit of the hospital. At the time of surgery, intracavitary bleeding of 1.5 liters or more was present in 6 patients with helicopter ultrasound and in 13 patients without it. Thus, if ultrasound and laparoscopy were performed on an emergency patient with in-hospital bleeding, it resulted in time loss and increased mortality from 9.1 to 28.6%. When the diagnosis was confirmed in flight with the mobile ultrasound from the moment of helicopter arrival to the hospital until the start of surgery, it took 2.5 times less time, which allows us to recommend its use by all AMT doctors and ambulance service for suspected intracavitary bleeding.

One of the controversial points of using prehospital ultrasound in an emergency patient in an air ambulance helicopter is the possible loss of time for the examination. However, if rationally organized, in-flight ultrasound can be performed quickly and without compromising other therapeutic and diagnostic manipulations. According to scientific publications, the average duration of pre-hospital ultrasound examination of an emergency patient usually does not exceed 5-6 min [15, 16].

The mean number of bed-days spent in the intensive care unit was (2.93±0.38) and (3.3±0.41) in patients in the study and control groups, respectively. Daily mortality during hospitalization by ambulance was 5.5%, during hospitalization by ambulance helicopter — 2.8%. Total mortality in the main group and comparison group was 16.1 and 19.5%, respectively.

The total number of bed-days was 1.91 more in the main group, which could be explained by a more severe contingent and almost 2 times higher mortality in the comparison group in the first day of hospitalization. When patients who died in the first day were excluded from our statistics, this difference was insignificant at 1.7 bed-days, 10.6 and 8.9 bed-days, respectively.

There was no correlation between the distance to the specialized medical organization and mortality in the studied groups. Priority in hospitalization by ambulance helicopter in a metropolitan area should be given to patients in severe and extremely severe condition, since no lethal outcomes were observed when it took up to 30 minutes to get to a profile hospital from the moment of doctor's call to the patient.

This confirms the fact that with ACS, CCI, stroke and massive bleeding, there is a correlation between the outcome of the disease and the time it took to get to a specialist. And we are talking not only about hours, but also — in some cases — about minutes.

During the hospitalization of patients with urgent pathology, the following patients received high-tech medical care: in the main group — 47 patients (45.9%), in the comparison group — 40 patients (32.3%), which emphasizes the effectiveness of the created algorithms of hospitalization when providing medical care by AMT doctors in a megapolis.

Within 6 months after discharge from the specialized hospital, the disability was established in 79 patients, 35 (31.3%) in the main group and 44 (34.8%) in the comparison group, mainly as a consequence of neurological pathology. According to the results of treatment of patients with bleeding disorders, disability was observed only in

Таблица 2 /Table No. 2

Распределение пациентов по удаленности от профильного стационара, чел./%

Distribution of patients by distance from the specialized hospital, pers./%

Расстояние от профильного стационара, км / Distance from the specialized hospital, km	Группы, чел./% / Groups, pers./%		Итого, чел. Total, pers.
	основная группа/ main group, n=112	группа сравнения/ comparison group, n=129	
0-10	3/2,7	74/57,4	77
11-15	0	27/20,9	27
16-20	1/0,9	18/14,0	19
21-25	5/4,5	7/5,4	12
26-30	5/4,5	0	5
31-50	18/16,1	3/2,3	21
Более 51 / More than 51	81/71,4	0	81
Всего / Total	112/100,0	129/100,0	241

one patient when the main diagnosis was combined with pelvic bone fractures. Disability as an outcome of ACS 6 months after the event was a rare issue: one patient in the main group versus three in the comparison group, which shows a high level of medical care for this category of patients in Moscow and is a natural result of the coordinated and algorithmic functioning of the "heart attack" network of vascular hospitals in the capital [17].

The need for palliative care in patients of both groups was not recorded.

Conclusion

1. The main directions of improvement and development of AMTs operation in the metropolitan area include: training and education of qualified AMT personnel; equipping the ambulance helicopter with modern medical equipment; using pre-hospital diagnostic ultrasonography in flight; improving and strictly observing the algorithms of interaction between AMT personnel and employees of ground services and medical organizations; determining the optimal number of helicopters used in a particular locality.

REFERENCES

1. Fedotov S.A., Kostomarova L.G., Potapov V.I., Buk T.N. Readiness of the Territorial Moscow Disaster Medicine Service to Eliminate the Medical Consequences of Emergency Situations in 2016. *Vrach Skoroy Pomoshchi = Emergency doctor*. 2017;4:75-81 (In Russ.).
2. Blackwell D.L., Lucas J.W., Clarke T.C. Summary Health Statistics for U.S. Adults: National Health Interview Survey. National Center for Health Statistics. *Vital Health Stat*. 2014;10(260).
3. Klochikhina O.A., Shprakh V.V., Stakhovskaya L.V., Polunina Ye.A. An Analysis of the Long-Term Stroke Morbidity and Mortality in the Regions of the Russian Federation Included in the Federal Patient Assistance Reorganization Program. *Zhurnal Nevrologii i Psikiatrii im. S.S. Korsakova = Neuroscience and Behavioral Physiology*. 2020;120:12-2:37-41 (In Russ.).
4. Sander A., Spence R.T., McPherson D., et al. Prospective Audit of 805 Consecutive Patients with Penetrating Abdominal Trauma: Evolving Beyond Injury Mechanism Dictating Management. *Ann Surg*. 2020. doi: 10.1097/SLA.0000000000004045. Epub ahead of print. PMID: 32568748.
5. Wejnarski A., Leszczyński P., Świeżewski S., et al. Characteristics of Aeromedical Transport, Both Interhospital and Directly from the Scene of the Incident, in Patients with Acute Myocardial Infarction or Acute Trauma Between 2011-2016 in Poland: A Case-Control Study. *Adv. Clin. Exp. Med*. 2019;28;11:1495-1505.
6. Vechorko V.I., Shapsigova O.A., Averkov O.V., et al. Search for Diagnostic Correlations in Females with Cerebral Infarction. *Consilium Medicum*. 2019;21;2:37-42 (In Russ.).
7. Petrikov S.S., Parfenov V.Ye., Mitiš V.A. Scientific Achievements in the Field of Emergency Medical Care in the Russian Federation in 2017. Issue 7. Moscow, NII Skoroy Pomoshchi Im. N.V. Sklifosovskogo Publ., 2018. 126 p. (In Russ.).
8. Aleksanin S.S., Gud'z' Yu.V., Rybnikov V.Yu. *Kontseptsiya i Tekhnologii Organizatsii Okazaniya Meditsinskoy Pomoshchi Postradavshim v Chrezvychaynykh Situatsiyakh s Travmami Silami i Sredstvami MCHS Rossii = The Concept and Technologies of Organizing the Provision of Medical Care to Victims in Emergency Situations with Injuries by the Forces and Means of the Ministry of Emergency Situations of Russia*. Monograph. St. Petersburg Publ., 2019, 303 p. (In Russ.).
9. Baranova N.N. Medical Evacuation of Victims: Their State, Problems. Report 1. *Meditsina Katastrof = Disaster Medicine*. 2018;4:37-40 (In Russ.).
10. Garmash O.A. Sanitary Aviation of the Russian Federation: History, State, Prospects. *Informatsionnyy Sbornik Meditsina Katastrof, Sluzhba Meditsiny Katastrof = Information Collection Disaster Medicine. Service for Disaster Medicine*. 2013;3:1-19 (In Russ.).
11. Kozыrev D.V., Khupov M.T. Sanitary Aviation Evacuation with Use of Light Helicopters in Megapolis Environment. *Meditsina katastrof = Disaster Medicine*. 2017;1:31-33 (In Russ.).
12. Johnsen A.S., Sollid S.J.M., Vigerust T., et al. Helicopter Emergency Medical Services in Major Incident Management: A National Norwegian Cross-Sectional Survey. Ed. Abe T. *PLoS ONE*. 2017;12;2:e0171436.
13. Stewart C.L., Metzger R.R., Pyle L., et al. Helicopter Versus Ground Emergency Medical Services for the Transportation of Traumatically Injured Children. *J. Pediatr. Surg*. 2015;50:347-352.

2. The application of the developed algorithms for the use of ambulance aviation in a megacity makes it possible to evacuate urgent patients from remote areas of the megacity to specialized medical institutions in the same time as it takes ambulances to pick up patients within a radius of up to 15 km from the hospital; at the same time daily and overall mortality during hospitalization by ambulance helicopter was lower and was 2.8 and 16.1% respectively; total number of bed-days in the study group was greater than in the comparison group — 10.36 and 8.45 respectively — due to more severe contingent hospitalized and comparable figures of ICU stay (3.12 — in the study group; 3.27 — in the comparison group). The proportion of persons who were disabled after discharge from hospital was comparable in both groups (31.3% — in the main group; 34.8% — in the comparison group).

Thus, the performance indicators of the air ambulance are not inferior to those of ground ambulance teams and even, in some aspects, exceed them, which makes the use of air ambulance promising and indicates its great potential when used in remote areas of the metropolis.

СПИСОК ИСТОЧНИКОВ

1. Федотов С.А., Костомарова Л.Г., Потапов В.И., Бук Т.Н. Готовность территориальной службы медицины катастроф Москвы к ликвидации медицинских последствий чрезвычайных ситуаций в 2016 году // *Врач скорой помощи*. 2017. № 4. С. 75-81.
2. Blackwell D.L., Lucas J.W., Clarke T.C. Summary Health Statistics for U.S. Adults: National Health Interview Survey. National Center for Health Statistics // *Vital Health Stat*. 2014. No. 10(260).
3. Ключихина О.А., Шпрах В.В., Стаховская Л.В., Полунина Е.А. Анализ среднемноголетней заболеваемости и смертности от инсульта в регионах Российской Федерации, вошедших в федеральную программу реорганизации помощи пациентам с инсультом // *Журнал неврологии и психиатрии им. С.С.Корсакова*. 2020. Т. 120. № 12-2. С. 37-41.
4. Sander A., Spence R.T. McPherson D., et al. A Prospective Audit of 805 Consecutive Patients with Penetrating Abdominal Trauma: Evolving Beyond Injury Mechanism Dictating Management // *Ann. Surg*. 2020. doi: 10.1097/SLA.0000000000004045. Epub Ahead of Print. PMID: 32568748.
5. Wejnarski A., Leszczyński P., Świeżewski S., et al. Characteristics of Aeromedical Transport, Both Interhospital and Directly from the Scene of the Incident, in Patients with Acute Myocardial Infarction or Acute Trauma Between 2011-2016 in Poland: A Case-Control Study // *Adv. Clin. Exp. Med*. 2019. V.28, No. 11. P. 1495-1505.
6. Вечорко В.И., Шапсигова О.А., Аверков О.В. и др. Поиск диагностических корреляций у лиц женского пола с инфарктом головного мозга // *Consilium Medicum*. 2019. Т.21, № 2. С. 37-42.
7. Петриков С.С., Парфенов В.Е., Митиш В.А. Научные достижения в области скорой медицинской помощи в Российской Федерации за 2017 год. Выпуск 7. М.: НИИ скорой помощи им. Н.В. Склифосовского, 2018. 126 с.
8. Алексанин С.С., Гудзь Ю.В., Рыбников В.Ю. Концепция и технологии организации оказания медицинской помощи пострадавшим в чрезвычайных ситуациях с травмами силами и средствами МЧС России: Монография. СПб: ФГБУ "Всероссийский центр экстренной и радиационной медицины им. А.М. Никифорова" МЧС России, 2019. 303 с.
9. Баранова Н.Н. Медицинская эвакуация пострадавших: состояние, проблемы. Сообщение 1 // *Медицина катастроф*. 2018. № 4. С. 37-40.
10. Гармаш О.А. Санитарная авиация Российской Федерации: история, состояние, перспективы // Информационный сборник «Медицина катастроф. Служба медицины катастроф». ВНИИТИ, серия Медицина. 2013. № 3. С. 1-19.
11. Козырев Д.В., Хупов М.Т. Санитарно-авиационная эвакуация с использованием лёгких вертолётов в условиях мегаполиса // *Медицина катастроф*. 2017. № 1. С. 31-33.
12. Johnsen A.S., Sollid S.J.M., Vigerust T., et al. Helicopter Emergency Medical Services in Major Incident Management: A National Norwegian Cross-Sectional Survey / Ed. Abe T. // *PLoS ONE*. 2017. V.12, No. 2. P. e0171436.
13. Stewart C.L., Metzger R.R., Pyle L., et al. Helicopter Versus Ground Emergency Medical Services for the Transportation of Traumatically Injured Children // *J. Pediatr. Surg*. 2015. No. 50. P. 347-352.

14. Vankov D.V., Ivanova S.A. Department of Air Ambulance as Part of Multidisciplinary Hospital: Advantages and Disadvantages. *Sovremennyye Problemy Zdravookhraneniya i Meditsinskoy Statistiki* = Current Problems of Health Care and Medical Statistics. 2019;4:170-178 (In Russ.).

15. Hoyer H.X., Vogl S., Schiemann U., et al. Prehospital Ultrasound In Emergency Medicine: Incidence, Feasibility, Indications And Diagnoses. *Eur. J. Emerg. Med.* 2010;17(5): 254–259.

16. Jorgensen H., Jensen C.H., Dirks J. Does Prehospital Ultrasound Improve Treatment of the Trauma Patient? A systematic review. *Eur. J. Emerg. Med.* 2010;17(5):249–253.

17. Vasilyeva E.Yu., Plavunov N.F., Kalinskaya A.I., et al. Organization of "Infarct Network" in Moscow and the Results of its Work over the Five-Year Period. *Russian Journal of Endovascular Surgery.* 2018;5(2):288-94 (In Russ.).

14. Ваньков Д.В., Иванова С.А. Отделение санитарной авиации в составе многопрофильного стационара: преимущества и недостатки // *Современные проблемы здравоохранения и медицинской статистики.* 2019. № 4. С. 170-178.

15. Hoyer H.X., Vogl S., Schiemann U., et al. Prehospital Ultrasound in Emergency Medicine: Incidence, Feasibility, Indications and Diagnoses // *Eur. J. Emerg. Med.* 2010. V. 17(5). P. 254–259.

16. Jorgensen H., Jensen C.H., Dirks J. Does Prehospital Ultrasound Improve Treatment of the Trauma Patient? A systematic review // *Eur. J. Emerg. Med.* 2010. V. 17(5). P. 249–253.

17. Васильева Е.Ю., Плавунув Н.Ф., Калинская А.И. и др. Организация "инфарктной сети" в Москве и результаты ее работы за пятилетний период // *Эндоваскулярная хирургия.* 2018. Т. 5(2). С. 288-94.

Материал поступил в редакцию 26.04.21; статья принята после рецензирования 04.03.22; статья принята к публикации 21.03.22
The material was received 26.04.21; the article after peer review procedure 04.03.22; the Editorial Board accepted the article for publication 21.03.22

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