

## ПРОБЛЕМНЫЕ ВОПРОСЫ ОРГАНИЗАЦИИ И ПРОВЕДЕНИЯ САНИТАРНО-АВИАЦИОННОЙ ЭВАКУАЦИИ БОЛЬНЫХ И ПОСТРАДАВШИХ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ

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**Резюме.** Цель исследования – изучить современное состояние организации и проведения санитарно-авиационной эвакуации больных и пострадавших в чрезвычайных ситуациях (ЧС) на региональном уровне.

**Материалы и методы исследования.** Исследование проведено в 2022 г. в Федеральном центре медицины катастроф (ФЦМК) ФГБУ «Национальный медико-хирургический центр им. Н.И.Пирогова» Минздрава России. Материалы исследования – публикации в различных научных изданиях; данные анкет о факторах, влияющих на проведение санитарно-авиационной эвакуации с применением вертолетов в регионах Российской Федерации.

**Методы исследования** – литературно-аналитический метод и метод экспертных оценок.

Литературно-аналитический метод использовался для изучения проблем и возможностей применения авиационного транспорта в медицинских целях в Российской Федерации и за рубежом.

Метод экспертных оценок опирался на мнения и опыт работы специалистов при оценке факторов, влияющих на организацию проведения санитарно-авиационной эвакуации в регионах и потребности в ее проведении.

**Объект исследования**

Система организации и проведения санитарно-авиационной эвакуации больных и пострадавших в ЧС в регионах Российской Федерации.

**Результаты исследования и их анализ.** Представлен отечественный и зарубежный опыт оказания медицинской помощи больным и пострадавшим в ЧС с использованием санитарно-авиационной эвакуации.

Проанализированы основные проблемные вопросы организации и проведения санитарно-авиационной эвакуации больных и пострадавших в чрезвычайных ситуациях.

**Ключевые слова:** больные, пострадавшие, регионы Российской Федерации, санитарная авиация, санитарно-авиационная эвакуация, чрезвычайные ситуации, экстренная медицинская помощь

**Конфликт интересов.** Авторы статьи подтверждают отсутствие конфликта интересов

**Для цитирования:** Исаева И.В., Баранова Н.Н. Проблемные вопросы организации и проведения санитарно-авиационной эвакуации больным и пострадавшим в чрезвычайных ситуациях // Медицина катастроф. 2022. №4. С. 58-63. <https://doi.org/10.33266/2070-1004-2022-4-58-63>

## PROBLEMATIC ISSUES IN ORGANIZATION AND CONDUCT OF AIR AMBULANCE EVACUATION OF PATIENTS AND VICTIMS IN EMERGENCY SITUATIONS

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**Summary.** The aim of the study is to investigate the current state of organization and of sanitary aviation evacuation of patients and victims in emergency situations at regional level.

**Materials and research methods.** The study was conducted in 2022 in the Federal Center for Disaster Medicine of the National Medical and Surgical Center named after N.I. Pirogov of the Ministry of Health of Russia. Materials of the study – publications in scientific journals; questionnaire data on the factors affecting the conduct of air ambulance evacuation using helicopters in the regions of the Russian Federation.

**Research methods** – literary-analytical method and method of expert evaluations.

Literary and analytical method was used to study problems and opportunities for the use of air transport for medical purposes in the Russian Federation and abroad.

The method of expert evaluations was based on opinions and experience of specialists in evaluating factors affecting organization of air ambulance evacuation in the regions and of the need for its implementation.

The object of the study is the system of organization and conduct of the sanitary aviation evacuation of patients and victims in emergencies in the regions of the Russian Federation.

*Study results and their analysis.* Domestic and foreign experience of medical care to the patients and victims in emergencies using air ambulance evacuation is presented.

The basic problematic questions of organization and execution of sanitary aviation evacuation of patients and victims in extreme situations have been analyzed.

**Key words:** *air ambulance, air ambulance evacuation, emergencies, emergency medical care, patients, regions of the Russian Federation, victims*

**Conflict of interest.** The authors declare no conflict of interest

**For citation:** Isayeva I.V., Baranova N.N. Problematic Issues in Organization and Conduct of Air Ambulance Evacuation of Patients and Victims in Emergency Situations. *Meditsina Katastrof = Disaster Medicine*. 2022;4:58-63 (In Russ.). <https://doi.org/10.33266/2070-1004-2022-4-58-63>

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## **Introduction**

By the present time the problems of organization and performance of sanitary aviation evacuation of patients and victims in emergency situations as well as the use of air ambulance in peacetime and wartime are considered in a number of scientific publications.

In particular, the authors of the publications analyzed the effectiveness of using airplane and helicopter medical modules to reduce lethality when conducting air ambulance evacuation of patients to medical treatment organizations [5, 6].

As a result of the emergence of targeted programs the number of regions that use air ambulance to provide medical care and medical evacuation of patients and victims in emergencies increases every year.

**The aim of the research** is to study the current state of organization and conduct of sanitary aviation evacuation of patients and victims in emergency situations at the regional level.

**Materials and methods of the study.** The study was carried out in 2022 in the Federal Center of Disaster Medicine "National Medical and Surgical Center named after N.I. Pirogov" of the Ministry of Health of Russia. Materials of the study are publications in various scientific journals, questionnaire data on the factors affecting the conduct of air ambulance evacuation using helicopters in the regions of the Russian Federation.

Research methods — literary and analytical method and method of expert evaluations.

Literary and analytical method was used to study the problems and opportunities for the use of air transport for medical purposes in the Russian Federation and abroad.

The method of expert evaluations was based on the opinions and experience of specialists in evaluating the factors affecting the organization of air ambulance evacuation in the regions and its needs.

#### *Object of the research*

The system of organization and conduct of sanitary aviation evacuation of patients and victims in emergency situations in the regions of the Russian Federation.

**Results of the study and their analysis.** The analysis of scientific publications has shown that until the 60's

of the XX century for the purposes of sanitary and aviation evacuation airplanes, and later — helicopters were actively used. The use of helicopters in the system of air ambulance opened up new possibilities for rapid response during air ambulance evacuations, including those associated with the organization of landing of the aircraft near the location of the medical organization [20].

The experience of using helicopters for air ambulance evacuation of the wounded during the war in Afghanistan contributed to a significant improvement in the organization of medical and evacuation support by bringing medical care closer to the wounded and by reducing the number of stages of medical evacuation. Thanks to aviation, more than 50.0% of patients could be evacuated early after surgical intervention, reducing the overall mortality rate from 5.7% to 2.9%. The organization of regular flights by the IL-76 "Scalpel" aircraft helped to increase the number of wounded patients delivered within the first five days to the leading military clinics of the Soviet Union from 1.0% to 9.0% [8, 9, 10, 4, 11, 12].

It is difficult to overestimate the importance of using air transport in disasters and natural calamities, when many people with severe injuries are involved, requiring their immediate evacuation to specialized medical centers, which are usually at a considerable distance from the emergency site [13, 14, 15, 16, 17].

By the example of liquidation of medical and sanitary consequences of the fire in the club "Khromaya Loshad" (Perm, 2009) it was proved that use of medical modules for medical evacuation reduces lethality among the victims in prehospital period — by 3.3 times, in the hospital period — by 2 times [15, 16]. The role of ambulance aviation cannot be overestimated during the liquidation of medical and sanitary consequences of terrorist acts in Ingushetia, Kabardino-Balkaria, North Ossetia, Dagestan, Crimea, in Volgograd and Rostov-on-Don, during "Nevsky Express" train crash, etc.

Reforms of the 1990s in Russia resulted in economic decline and stratification of society, with mass impoverishment of the population. According to various sources, if in 1989 the USSR had 2.0 percent of the

poor, by the end of 1998 they ranged from 23.8 to 40.0 percent. There was almost no financing of sanitary aviation in those years, the aircraft were aging, and their scheduled repairs were irregular [18].

Based on the reports of several authors at thematic conferences in 2008-2014 (N.N. Baranova, O.A. Garmash, A.S. Popov, etc.), articles in various literary sources, as well as scientific publications and based on the experience of the author in the Republic of Tatarstan it can be concluded that before 2000 in the system of domestic health care there was no special air transport for emergency medical aid and air ambulance evacuation — for medical purposes aircrafts not equipped with stretchers were used, in which portable medical equipment not intended for operation in the air was placed [1, 3, 4, 10].

Depending on the profile of the incoming call, the team specialists loaded necessary medical equipment into helicopter cabin. Medical equipment was powered by rechargeable batteries, which significantly limited the time of its use in the air.

Since 2017, federal target programs for the development of medical aviation appeared in Russia.

Due to the renewal of the air ambulance fleet, the safety level of air ambulance evacuations increased and the accessibility of medical care for the population living in remote and hard-to-reach areas of Russia increased [21].

As part of the project, 2 regions began to use the aircraft: from 2019 — Zabaikalsky Krai; from 2020 — Khanty-Mansi Autonomous Okrug. Planes are cheaper to operate, have a larger flight radius and higher speed. However, the operation of aircraft becomes feasible if the appropriate infrastructure — runways — is in place. Flight aircrafts for air ambulance evacuations are used in Komi Republic, Khanty-Mansi Autonomous Area, Omsk region, Trans-Baikal Territory and Kamchatka Territory.

According to the results of the expert assessment analysis performed by N.N. Baranova, chief doctor of the Center of Medical Evacuation and Emergency Medical Care of the All-Russian Center for Disaster Medicine "Zaschita", absence of routing coordinator in a subject of the Russian Federation (hereinafter — subjects) significantly complicates timely decision making on sanitary aviation evacuation. We consider it necessary that in each region a coordinator for the organization of medical care during air ambulance evacuation of patients should be one medical organization. Its specialists should promptly receive information about patients, whose condition worsens during air ambulance evacuation, and redirect the air force to the other closest medical organizations of the 3rd level. In addition, the person responsible for organizing medical care during air ambulance evacuation should have up-to-date information about patients in critical condition who are in medical organizations of Level 1 to Level 2 and who need air ambulance evacuation to medical organizations of Level 3.

According to scientific publications, the study did not reveal a reliable decrease in mortality among those evacuated by helicopter, but it was found that heli-

copter transportation increases the chances of survival and reduces the risk of death among patients in life-threatening conditions [2].

We analyzed the answers of specialists from 69 subjects of the Russian Federation to the questions of a questionnaire on the study of factors influencing the organization of air ambulance evacuation and its needs in the subjects. Among these specialists, the proportion of heads of medical organizations was 63.6%; heads of departments, 27.2, including heads of emergency consultative medical service departments, 22.7; heads of operations and dispatch departments, 3.4; training and methodological departments, 1.1; medical specialists providing medical evacuations, 9.0, including anesthesiologists-resuscitators, 3.4.

Questionnaires were developed in evaluation scores: 10 points — factors maximally affecting the organization of air ambulance evacuation or its need in the subject; 0 points — factors not affecting the organization of air ambulance evacuation or its need in the subject.

For each parameter we determined an average calculated score for the sample as a whole among all survey participants and in groups according to geographical features of the regions: mountainous — with mountainous coverage over 75,0% of the territory (12,7%); mountain-level — with mountainous coverage of not more than 75,0% and not less than 25,0% (10,9%); plain — with mountainous coverage of less than 25,0% (76,3%).

For the sample as a whole, the parameter "lack (shortage) of helipads at medical organizations" has the highest value - 6.3 points (table).

Evaluated parameters by groups

For mountainous regions — there is the greatest influence of the following factors on the organization of air ambulance evacuation and its necessity:

- lack (shortage) of helicopter platforms at medical organizations — 10.0 points;
- length of the territory of more than 500 km — 8.3 points;
- hard-to-reach settlements — 8.3 points;
- lack of airfields — 7.8 points;
- low population density — 7.8 points;
- large area of mountainous coverage — 6.5 points.

Climatic conditions have almost no influence on the organization of sanitary and aviation evacuation in mountainous areas.

For mountain-level regions, a moderate influence of the following factors on the organization of sanitary aviation evacuation and its need has been revealed:

- length of the territory of more than 500 km — 4 points;
- high average age of population — 4 points;
- lack (shortage) of helicopter platforms at medical organizations — 4 points.

Low population density and lack of medical organizations providing specialized medical care do not affect the organization of air ambulance evacuation in mountainous regions.

For plain regions, a moderate impact on the organization of air ambulance evacuation and its need for the following factors has been revealed:

**Количество вертолетных (посадочных) площадок, используемых в медицинских целях,  
данные на 1 августа 2022 г.**

Number of helicopter (landing) sites used for medical purposes in the Russian Federation, as of 01.08.2022

Российская Федерация, федеральный округ Российской Федерации Subject of the Russian Federation	Количество вертолетных (посадочных) площадок Number of helicopter (landing) sites	
	всего total	в т.ч. около медицинских организаций of medical organizations
<b>Российская Федерация / Russian Federation</b>	<b>1458</b>	<b>287</b>
Центральный федеральный округ – ЦФО / Central Federal District	277	63
Северо-Западный федеральный округ – СЗФО / Northwestern Federal District	202	37
Южный федеральный округ – ЮФО / Southern Federal District	130	78
Северо-Кавказский федеральный округ – СКФО / North Caucasian Federal District	19	13
Приволжский федеральный округ – ПФО / Volga Federal District	402	39
Уральский федеральный округ – УФО / Ural Federal District	65	24
Сибирский федеральный округ – СибФО / Siberian Federal District	290	28
Дальневосточный федеральный округ – ДФО / Far Eastern Federal District	73	5

- lack (shortage) of helicopter landing sites at medical organizations — 4.6 points;
- hard-to-reach settlements — 4.3 points;
- climatic conditions — 4 points;
- low population density — 3.6 points;
- low length of paved roads — 3,4 points;
- length of the territory over 500 km - 3,3 points.

The lack of medical organizations providing specialized medical care does not affect the organization of air ambulance evacuation in the plain regions.

The analysis of the results of the survey indicates the following.

The factor that most influences the organization of air ambulance evacuations is the lack (shortage) of helipads at medical organizations. This factor leads the sample as a whole — 6.3 points and in each group under consideration with significance from 10 to 4 points. Also in each group there is a length of territory more than 500 km — from 8.3 to 4 points.

It is reasonable to consider the remaining factors taking into account the geographical features of the studied groups.

For mountainous territories the following factors are important — lack of airfields, low population density and a large area of mountain cover.

In mountain-level territories, the need for air ambulance evacuation is moderately influenced by the high average age of the population.

In the plain areas the need for air ambulance evacuation is moderately influenced by hard-to-reach settlements, low population density, climatic conditions and low length of paved roads.

The lack (insufficient number) of medical organizations providing specialized medical care remains a problem for the mountainous regions of the Russian Federation.

According to the information system "Forces and means of the Disaster Medicine Service" (the system was created for special tasks of the Disaster Medicine Service and is not publicly accessible) in the Russian Federation 19.7% of the helicopter sites used for med-

ical purposes are located near medical organizations, which indicates an insufficiently developed infrastructure. The information in this system is entered by specialists of medical organizations at the regional level.

In the Russian Federation air ambulance services are provided by more than 50 companies, but there is no single center of responsibility for the flights of aircraft performing sanitary missions.

In many regions of the Russian Federation the response time to a call remains long, more than 1 hour from the reception of the call to the takeoff of the medical helicopter. There is also not always well-organized interaction between related ministries and departments, unstable communication during the flight and, as a result, loss of efficiency in handling the call, limited opportunities to fly at night. The use of medical aviation is considerably limited by the high cost of aircraft operation; the lack of regulatory acts on the medical direction of the federal level, including the official inclusion of the medical helicopter (aircraft) in the list of emergency medical care transport.

In connection with the topic of the study it will be appropriate to briefly characterize the work on the organization and conduct of air ambulance evacuation in such a developed European country as Germany.

It is believed that Germany has one of the most modern and efficient air ambulance evacuation systems in the world. German rescue helicopters are used both domestically and in neighboring countries (based on agreements). Some of the helicopters are used for air ambulance evacuations; some are used as rescue helicopters [22].

All multidisciplinary medical centers have medical helicopters. When building clinics, the infrastructure of the air ambulance evacuation system is provided. An equipped helipad is located on the roof of each medical center or on its territory [23].

In the case of mass arrivals of victims of emergencies, a system of rapid staged evacuation of patients to highly specialized medical centers using air ambulance is organized all over Germany [24].

There is a unified standard for the volume of medical care provided to patients regardless of their location — both outside the medical organization, including in-flight, and in the medical organization.

There is a list of indications for the use of air ambulance and normatively approved routing.

In Germany, there are no absolute medical contraindications for air ambulance evacuation and special attention is paid to patient preparation. Every year patients are evacuated in more and more serious conditions, and the role of physicians in the air ambulance evacuation system is becoming more and more important. Therefore, the physician of the hospital where the patient is located must ensure that the patient is properly prepared for medical evacuation and calculate the volume of infusions during the period of transportation. If the patient's condition is serious, the intubation is carried out before the air ambulance evacuation — the list of indications for intubation is formed by the regulations. All life-threatening conditions — stroke, acute coronary syndrome (ACS), comas and shocks of various etiologies, etc. are grounds for emergency air ambulance evacuation in the prehospital period. Medical indications for interhospital air ambulance evacuation include acute and chronic diseases or injuries after relative stabilization, requiring further treatment in specialized medical centers.

There is an internationally standardized algorithm of personnel actions and compatible — adapted to different aircrafts — medical equipment, including intensive medical monitoring [19].

In Germany, air ambulance evacuation of patients has gradually acquired a new status with regard to its quality and quantity, and the work of medical personnel in the system of emergency medical care and air ambulance evacuations is prestigious and well-paid [23, 24].

In the process of developing and improving air ambulance evacuations, its advantages became evident and aircraft began to be used for rapid medical evacuations of patients to specialized medical centers.

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#### Conclusion

Considering the analyzed publications and expert evaluations, the following problems of organization and performance of sanitary aviation evacuation of patients and victims in emergencies can be singled out among topical problems:

Providing medical care to patients in a serious condition in the conditions of the aircraft requires great psycho-emotional efforts, in this regard, stimulating measures are necessary, including increasing the prestige of working in the aviation medical teams and normative determination of the frequency of passage of medical personnel of the course of psychological discharge.

In order to make decisions about departures and redirections of aircraft promptly, it is advisable to consider creating a single center of responsibility for medical aircraft flights in the Russian Federation.

When designing aviation and medical equipment used in medical aviation, it is necessary to study the issues of compatibility of medical and aviation equipment on different types of aircraft in different countries of the world.

Issues of interaction between related ministries and agencies in the organization and conduct of air ambulance evacuation (employees of airports, customs, pilots and technical staff of the company — operator of aviation services, etc.) require further regulation.

Infrastructure should be further developed at the regional level in order to organize the operation of aircraft in "24/7" mode in all regions.

The issues of reducing the cost of aircraft operation require elaboration.

Regulations should define the status of the aviation medical team and the patient on board the aircraft.

The feasibility of including a medical helicopter (airplane) as an emergency medical aid transport in the regulations should be considered.

The combination of a coordinated system of medical care for the sick and injured in emergency situations with their air ambulance evacuation forms the basis for highly effective work of the health care system in the medical and evacuation support of the population.

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Материал поступил в редакцию 06.09.22; статья принята после рецензирования 29.11.22; статья принята к публикации 23.12.22  
The material was received 06.09.22; the article after peer review procedure 29.11.22; the Editorial Board accepted the article for publication 23.12.22