

## INTER-HOSPITAL MEDICAL EVACUATION OF VICTIMS OF ROAD ACCIDENTS ON THE FEDERAL HIGHWAY M-8 "KHOLMOGORY" IN THE ARKHANGELSK REGION

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**Abstract.** The purpose of the study is to evaluate the inter-hospital medical evacuation of victims of road accidents on the Federal highway M-8 "Kholmogory" in the Arkhangelsk region to determine ways of further improvement.

**Materials and methods of research:** a retrospective study is carried out of 112 medical records of victims of accidents on the FAD M-8 "Kholmogory" in the Arkhangelsk region, evacuated for urgent reasons in the period from 01.01.2012 to 31.12.2018 from the Central district hospitals (CRH) to the Arkhangelsk regional clinical hospital – trauma center level I. **Research results and their analysis.** There was an increase in the number of cases of inter-hospital medical evacuation of victims of accidents on the FAD M-8 "Kholmogory", especially its sanitary aviation component-by 2018; all evacuees had severe polytrauma, the vast majority of them were evacuated from the CRH to the level I trauma center within the first day. The need is substantiated to equip a helipad, purchase a helicopter, create full-fledged emergency response teams, and organize routing of victims of accidents on the FAD M-8 Kholmogory in the Shenkursky and Velsky districts of the Arkhangelsk region to the Velsky CRH-level II trauma center.

**Key words:** Arkhangelsk region, Arkhangelsk Regional Clinical Hospital, central district hospitals, Federal Highway M-8 "Kholmogory", inter-hospital medical evacuation, road accidents, sanitary aviation evacuation, trauma centers

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

**For citation:** Baranov A.V. Inter-Hospital Medical Evacuation of Victims of Road Accidents on the Federal Highway M-8 "Kholmogory" in the Arkhangelsk Region. *Meditsina Katastrof = Disaster Medicine.* 2020; 4: 66–69 (In Russ.).  
<https://doi.org/10.33266/2070-1004-2020-4-66-69>

## МЕЖБОЛЬНИЧНАЯ МЕДИЦИНСКАЯ ЭВАКУАЦИЯ ПОСТРАДАВШИХ В ДОРОЖНО-ТРАНСПОРТНЫХ ПРОИСШЕСТВИЯХ НА ФЕДЕРАЛЬНОЙ АВТОДОРОГЕ М-8 «ХОЛМОГОРЫ» В АРХАНГЕЛЬСКОЙ ОБЛАСТИ

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**Резюме.** Цель исследования – оценить проведение межбольничной медицинской эвакуации пострадавших в дорожно-транспортных происшествиях (ДТП) на федеральной автодороге (ФАД) М-8 «Холмогоры» в Архангельской области для определения путей ее дальнейшего совершенствования.

**Материалы и методы исследования:** проведено ретроспективное исследование 112 медицинских карт пострадавших в ДТП на ФАД М-8 «Холмогоры» в Архангельской области, эвакуированных по срочным показаниям в период с 01.01.2012 г. по 31.12.2018 г. из центральных районных больниц (ЦРБ) в Архангельскую областную клиническую больницу – травмоцентр I уровня.

**Результаты исследования и их анализ.** Отмечено увеличение количества случаев проведения межбольничной медицинской эвакуации пострадавших в ДТП на ФАД М-8 «Холмогоры», особенно ее санитарно-авиационного компонента – к 2018 г.; все эвакуированные имели тяжелую политравму, их подавляющее большинство были эвакуированы из ЦРБ в травмоцентр I уровня в первые сутки.

Обоснована необходимость оборудования вертолетной площадки, приобретения вертолета, создания полноценных бригад экстренного реагирования и организации маршрутизации пострадавших в ДТП на ФАД М-8 «Холмогоры» в Шенкурском и Вельском районах Архангельской области в Вельскую ЦРБ – травмоцентр II уровня.

**Ключевые слова:** Архангельская областная клиническая больница, Архангельская область, дорожно-транспортные происшествия, межбольничная медицинская эвакуация, санитарно-авиационная эвакуация, травмоцентры, федеральная автодорога М-8 «Холмогоры», центральные районные больницы

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

**Для цитирования:** Баранов А.В. Межбольничная медицинская эвакуация пострадавших в дорожно-транспортных происшествиях на федеральной автодороге М-8 «Холмогоры» в Архангельской области // Медицина катастроф. 2020. №4. С. 66–69. <https://doi.org/10.33266/2070-1004-2020-4-66-69>

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Patients with polytrauma as soon as possible, no later than within 24 hours since they get it, should be hospitalized in level I trauma centers or in federal specialized medical institutions, since diagnostics and treatment of such patients in central district hospitals (CRH) often leads to an increase in mortality [1-3]. Interhospital medical evacuation of injured with severe high-energy injuries requires well-organized joint efforts of all interested structures of the constituent entity of the Russian Federation (hereinafter referred to as the constituent entity) with the obligatory observance of the routing established in this constituent entity and with monitoring of the condition of the injured [4-7].

**The purpose of the study** is to assess the interhospital medical evacuation of injured in road traffic accidents (DTP) on the federal highway (FAD) M-8 "Kholmogory" (hereinafter – FAD M-8, FAD) in Arkhangelsk region to determine ways of its further improvement.

**Materials and research methods.** Research materials - 112 medical records of patients with urgent indications evacuated from CRH to the Arkhangelsk Regional Clinical Hospital (AOCH) – a level I trauma center (hereinafter – AOCH, level I trauma center) after an accident at FAD M-8 in the Arkhangelsk region within the period from 1 January 2012 to December 31, 2018 The registration forms were selected according to the criteria of a retrospective continuous documentary observation – all the medical records of injured in road traffic accidents who received inpatient treatment during the study period were selected.

**Study inclusion criteria:**

1. Gender – male and female.
2. Injured in road accidents at the FAD M-8 section in the Arkhangelsk region, who received inpatient treatment at the level I trauma center.
3. Getting injured within the period from 2012 to 2018 included.
4. Injured in road accidents at FAD M-8 in the Arkhangelsk region, evacuated in the framework of interhospital medical evacuation from CRH to the level I trauma center.

**Exclusion criteria from the study:**

1. Age – less than 18 years.
2. With no trauma in an accident in the patient's history.

Statistical data processing was performed using the SPSS 22 applied statistical software package. The severity of associated injuries was determined using the ISS severity scale, the assessment is presented as a median and the first and third quartiles. All cases of interhospital medical evacuation were divided into 7 groups depending on the study year – 2012–2018.

The study was conducted in accordance with the ethical standards set out in the Declaration of Helsinki. The research protocol was approved by the expert council on biomedical

ethics of the Northern State Medical University (Arkhangelsk), protocol No. 08 / 11-17 of November 29, 2017.

**Research results and their analysis** The federal highway M-8 "Kholmogory" in the Arkhangelsk region passes through 3 medical districts – Velsky, Arkhangelsky and Severodvinsky.

Interhospital medical evacuation of injured in road accidents was carried out from CRH of two medical districts - Arkhangelsk and Velsky, since the length of the FAD in the Severodvinsk medical district is small, and the forces and means of the Severodvinsk and Arkhangelsk regional clinical ambulance stations are sufficient to provide emergency medical care (EMP).

According to the routing of injured at the FAD approved by the Ministry of Health of the Arkhangelsk Region, all injured who needed interhospital medical evacuation were sent to the level I trauma center by the emergency advisory ambulance department (EKSMP) of the territorial center for disaster medicine (TCMC).

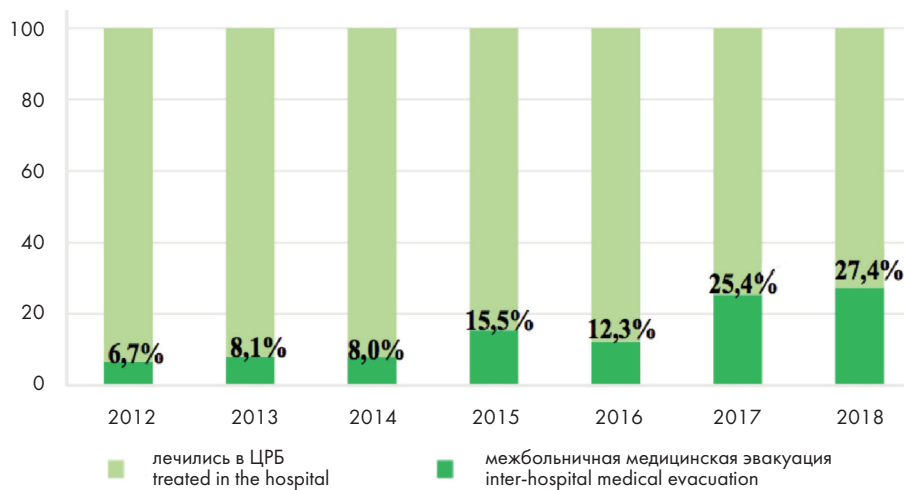
In the EKSMP highly qualified specialists work around the clock: anesthesiologist-resuscitator, traumatologist-orthopedist, general surgeon, thoracic surgeon, neurosurgeon, maxillofacial surgeon, vascular surgeon, obstetrician-gynecologist and otorhinolaryngologist. The department is staffed by highly qualified nurse anesthetists and operating nurses. From these specialists, if necessary, teams with constant readiness for immediate departure to the scene of an accident at the FAD M-8 are formed to provide specialized medical care in CRH or to conduct interhospital medical evacuation by road or by air to a level I trauma center.

Interhospital medical evacuation of injured in road accidents by ambulance vehicles is carried out on class C reanimobiles; if necessary, interhospital air ambulance evacuation (SAE) is carried out using Mi-8 helicopters, L-410 and An-2 aircraft belonging to "the 2nd Arkhangelsk United Air Squadron" JSC on a contract basis.

Over a seven-year period, interhospital medical evacuation of 112 injured in road accidents was carried out on the FAD M-8, of which men – 72 (64.3%), women -- 40 (35.7%); 66 people were evacuated by air, 46 people were evacuated by road.

Considering the dynamics of interhospital medical evacuations, a statistically significant increase in their number ( $p < 0.001$ ) by 2018 was revealed (Fig. 1).

An analysis of interhospital sanitary and aviation evacuations to the level I trauma center showed a statistically significant increase in their number by 2018 ( $p < 0.001$ ), which may be associated with the need to timely transport patients to the level I trauma center for the provision of specialized medical care (Fig. 2) ... When analysing the frequency of in-



**Рис. 1.** Доля эвакуированных в травмоцентр I уровня в общем числе пострадавших в ДТП на ФАД М-8 в 2012–2018 гг., %

**Fig. 1.** The share of evacuees to the level I trauma center in the total number of victims of road traffic accidents on the FAD M-8 in 2012–2018, %



**Рис. 2.** Доля эвакуированных в травмоцентр I уровня воздушным и наземным транспортом в общем числе пострадавших в ДТП на ФАД М-8 в 2012–2018 гг., %

**Fig. 2.** The share of those evacuated to the level I trauma center by air and ground transport in the total number of victims of road traffic accidents on the FAD M-8 in 2012–2018, %

terhospital medical evacuation by ambulance vehicles, a tendency to increase by 2018 was detected as well, but without statistically significant differences (see Fig. 2).

There has been a significant increase in the demand for inter-hospital medical evacuation in recent years. This is due to the fact that, when providing specialized medical care, the evacuation increases the availability of high-tech medical care for the population. Also, the evacuation allows meeting the standards of medical care for polytrauma, which is impossible in lower profile district hospitals.

The peculiarity of carrying out interhospital medical evacuation of injured in road accidents in the Arkhangelsk region (with an emphasis on sanitary aviation evacuations) is typical for most regions of Russia with low density and territorial dispersion of the population. In our opinion, this approach is absolutely justified, since the time for providing specialized medical care to injured reduces significantly.

The number of interhospital medical evacuations of injured in road accidents to the level I trauma center, has been analysed focusing on the place of the FAD M-8 where an injury occurred. In the Arkhangelsk Medical District, the frequency of interhospital medical evacuations increased from 6/139 cases (4.3%) in 2012 to 13/53 cases (24.5%) in 2018 -  $p < 0.001$ ,  $\chi^2$  s criterion with Bonferroni amendment. The growth was detected in number of evacuations both by ground and air transport. In Velsky medical district, there was also an increase, however, no statistically significant differences by year were found.

Compliance with routing during interhospital medical evacuation is one of the most important factors for saving the lives of injured persons. The Ministry of Health of the Arkhangelsk Region made a decision to route the injured in road accidents with polytrauma at the FAD M-8 "Kholmogory" to the level I trauma center. However, given a huge

area of Arkhangelsk region, different climate conditions of its north and its south, often aggravated by non-flying weather, as well as significant territorial dispersion and low population density, it can take a very long time to carry out interhospital medical evacuation of injured from remote areas. In this regard, we propose to organize a permanent helicopter base in the Velskaya CRH, to form there full-fledged emergency response teams and to assign the routing of injured at the FAD sections currently assigned to Velskaya and Shenkurskaya CRH, to the Velskaya CRH – a level II trauma center, which includes full-fledged traumatology, orthopedic, surgical and intensive care units staffed with highly qualified specialists. This will reduce by 2 times – up to 200-250 km – the distance of evacuation, increase the availability of emergency medical care to injured in road accidents and, thus, reduce mortality and disability of the injured.

Of the 112 evacuees, 86 (76.8%) had associated injuries; 26 (23.2%) – multiple injuries. The vast majority of patients – 101/112 (90.2%) – were in a state of traumatic or hemorrhagic shock at the time of the interhospital medical evacuation.

When determining the severity of the evacuees' condition according to the ISS (Injury Severity Score) scale, an average value was 13 [6; 24] points, so the dynamics of their vital functions was subject to constant monitoring.

Urgent surgical interventions on the spot – in the central regional hospital closest to the accident site – were performed by a specialized medical team for more than half of the injured – 65 people. (58%). The surgeries were followed by interhospital medical evacuation to a level I trauma center.

These interventions included: craniotomy with removal of hematomas of various localization; emergency thoracotomy with pleural drainage or bleeding control; emergency laparotomy with bleeding control; stabilization of fractures of

the pelvic ring, spine or extremities with their fixation in devices for external fixation. These surgical interventions were carried out to urgently stabilize the condition of injured in the absence of a properly qualified specialist doctor or of necessary medical equipment at the CRH.

Over 70% of all injured evacuated to the level I trauma center were transferred to AOC in the first day after an injury; 19.6 – in one to three days; 9.8% of injured – at a later date, not exceeding one week.

Thus, the interhospital medical evacuation of injured in road accidents at the FAD M-8 "Kholmogory" in the Arkhangelsk region is characterized by:

- an increase in the number of evacuees ( $p < 0.001$ ) by 2018 compared to 2012;
- a statistically significant ( $p < 0.001$ ) increase in the number of air medical evacuations by 2018;
- all evacuated patients got polytrauma: 76.8% – combined injuries; 23.2% – multiple injuries;
- the vast majority of injured who had indications for transfer to the level I trauma center were evacuated on the first day;
- more than half of all evacuees underwent urgent surgical interventions in the CRH with their subsequent transfer to the level I trauma center.

In our opinion, in order to improve the efficiency and quality of the interhospital medical evacuation of injured in road accidents at the FAD M-8 "Kholmogory" in the Arkhangelsk region, it is necessary:

1. To install a helipad, to purchase a helicopter, to form full-fledged emergency response teams and to route those injured in road accidents at the FAD in the Shenkur and Velsky districts to Velskaya CRH - a level II trauma center.
2. To monitor the dynamics of vital functions in injured with polytrauma in the prehospital period and during interhospital medical evacuation.

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Материал поступил в редакцию 17.09.20; статья поступила после рецензирования 24.11.20; принята к публикации 30.11.20

The material was received 17.09.20; the article after peer review procedure 24.11.20; the Editorial Board accepts the article for publication 30.11.20