Research Article

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Providing Emergency Medical Care at the Prehospital Stage to Patients with Acute Myocardial Infarction and Acute Ischemic Stroke in Moscow: the Role of the Aviation Medical Teams of the Emergency Medical Care Center (Territorial Center of Disaster Medicine)

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ABSTRACT The increase in the number of patients with complications of cardiovascular diseases and the need for early diagnosis of such complications and the early initiation of treatment already at the prehospital stage leads to an increasing need for more frequent use of helicopter medical equipment, as well as for equipping aviation medical teams with highly qualified specialists. The formation of a network of vascular invasive centers in the Moscow region, modern equipment and its use in air ambulance conditions require constant improvement of skills among medical workers. All this undoubtedly leads to positive results, the mortality rate from heart attacks and strokes decreases, the duration of treatment and the period of rehabilitation of patients are reduced. It should be noted that even 10 years ago, medical helicopters were used in the elimination of medical consequences in road accidents, fires and emergencies. Today, aviation medical teams are involved in more than 50% of cases with cardiovascular diseases, which undoubtedly speaks of the prospects for the development of medical aviation in large cities.

Keywords: acute myocardial infarction, acute ischemic stroke, endovascular care, aviation medical teams

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IS – ischemic stroke
MI – myocardial infarction
LV – left ventricle
ACS – acute coronary syndrome

AMI – acute myocardial infarction
ACVA – acute cerebrovascular accident
CVD – cardiovascular diseases
CEMA – Center for Emergency Medical Aid
PCI – percutaneous coronary intervention

INTRODUCTION

Cardiovascular diseases (CVD) are one of the global problems of world health, for a long time they have been the leading cause of death in the world - according to WHO, more than 17,000,000 people die from them every year, which is about 1/3 of all deaths in the world. According to experts, the medical and social significance of cardiovascular pathology in the coming years will only increase - by 2030, the estimated number of deaths from CVD may reach 23 600 000 people. At the same time, 85% of cardiovascular mortality is accounted for heart attack and stroke. Stroke is a pathology that most often leads to severe disability, while the average age of patients with acute cerebrovascular accident (ACVA) tends to decrease - in 1/3 of patients, stroke occurs at the age of less than 65 years, against the background of high professional and social activity [1].

At the same time, over the past decade, significant progress has been noted in the provision of medical care to patients with acute myocardial infarction (AMI) and stroke. The appearance and improvement of emergency endovascular methods for the treatment of vascular occlusion - stenting of an infarct-associated coronary artery and extraction of a thrombus from the cerebral artery, made it possible to bring the quality of medical care in acute vascular accidents to a new level. In a number of cases, timely vascular intervention in these two categories of patients allows to completely avoid the loss of organ functions, preserving the contractility of the left ventricular (LV) myocardium in myocardial infarction (MI) and contributing to the restoration of neurological status without significant deficit in ischemic stroke (IS). One of the main components of successful surgical treatment of coronary or cerebral artery occlusion is the time of its implementation - it is necessary to have time to carry out revascularization within the so-called "therapeutic window" (the time from the appearance of the first symptoms to the intervention), which for MI is 120 minutes after the ischemic event has occurred. American recommendations of 2018 extended the interval of possible effective use of thrombectomy in acute IS up to 24 hours, however, the “time is brain” formula remains relevant [2]. Endovascular thrombus extraction is most effective in patients with preserved consciousness, but severe motor impairment, which is characteristic of the defeat of a large cerebral artery [3].

All of the above necessitates the fastest possible provision of medical care to these patients at all its stages - initial examination, evacuation to the hospital, routing inside the hospital with a referral to the X-ray operating room and the performance of endovascular intervention. Emergency medical care for patients with ACS and acute ischemic stroke is carried out in accordance with the order of the Ministry of Health of the Russian Federation dated November 15, 2012 No. 918n "On approval of the procedure for providing medical care to patients with cardiovascular diseases", based on national and European clinical guidelines [4, 5].

PROVIDING EMERGENCY INVASIVE MEDICAL CARE TO PATIENTS WITH INFARCTION AND STROKE IN MOSCOW

In 2013, an “infarction network” of invasive vascular centers was created in Moscow, which currently includes 23 city hospitals that receive patients with ACS around the clock. The organization of the process of hospitalization of the patient in the infarction center assumes the maximum reduction in the time from admission to the hospital to the implementation of reperfusion intervention - the patient is hospitalized, bypassing the emergency department, he immediately goes to the X-ray operating room. The optimal time to restore patency of the infarct-associated coronary artery is 60–90 minutes after the first medical contact with the patient; this makes it possible to restore the maximum volume of potentially viable myocardium. Early intervention on the coronary arteries significantly improves the prognosis compared to later: with percutaneous coronary intervention (PCI) performed within 180 minutes from the onset of clinical symptoms, the mortality rate within a year is 3.8%, from 180 to 360 minutes – 5.6%, more than 360 minutes – 6,9%. Today, 98% of all patients with ACS in Moscow are hospitalized in invasive hospitals of the "infarction network" for emergency PCI; there is a significant decrease in mortality from myocardial infarction, comparable to world standards [4, 6].

In 2017, on the basis of the "infarction network", a "stroke network" was created, which includes 10 hospitals in the city. The existing algorithms for routing, transporting and performing emergency invasive interventions in patients with ACS have been successfully used to provide high-tech endovascular care for patients with ACVA, and the clinical results obtained are also comparable with the data of European randomized trials. [3].

The functioning of the "infarction network" and "stroke network" in the city of Moscow has created the need for the fastest possible transportation of emergency vascular patients to an invasive hospital. The frequent congestion of the main highways of Moscow, as well as the presence of the territory of "New Moscow" with a large transport distance from invasive centers predetermined the important role of the aviation medical (helicopter) crews of the Scientific and Practical Center for Emergency Medical Aid of the Moscow Department of Healthcare (CEMA) in medical evacuation emergency patients with myocardial infarction and stroke; in some cases, the transportation of patient data by a medical helicopter is uncontested [7].

INTERNATIONAL EXPERIENCE IN USING SANITARY HELICOPTERS IN PROVIDING EMERGENCY CARE TO PATIENTS WITH INFARCTION AND STROKE

The international experience of using the Helicopter Emergency Medical Service (HEMS) for the emergency aviation medical evacuation of patients with ACS and acute ischemic stroke is quite extensive; similar practice is used in many countries - Poland, Norway, Sweden, Denmark, Austria, the United States of America (USA) and others [8–13]. Polish authors conducted a retrospective analysis of the use of HEMS in the transportation of 6099 patients with ST-segment elevation AMI. (ST segment elevation myocardial infarction, STEMI), based on the results of which they concluded about the advantage of using helicopter technology in rural areas. The average duration of transportation of a patient with STEMI from rural areas of Poland was 18.2 minutes [8].

A study in Denmark compared the performance of helicopter and ground medical services in transporting the same patient population (STEMI) for PCI. The authors did not find a significant positive effect of HEMS transportation on the mortality and disability of these patients. [9]. However, other Danish studies have shown the importance of HEMS for the medical evacuation of patients with myocardial infarction from rural areas. [14, 16]. The advantage of transportation by helicopter was revealed when long-term transportation is necessary, with the patient's remoteness from the hospital with the possibility of PCI more than 75 km; After the introduction of HEMS into the Danish emergency medical service, the average time from a patient with STEMI for medical care to admission to a specialized hospital was reduced from 102 to 84 minutes [16]. Similar positive results were obtained when evaluating the results of the evacuation of MI patients by helicopter from rural areas of Belgium [15] and Sweden [17].

Eastern Austria has a STEMI healthcare network since 2007 with a population of around 766,000, successfully operating two medical helicopters HEMS [11]. The average duration of an aviation medical transportation by helicopter is 41 (33–55) minutes; the limiting factor is not the use of air ambulance at night time.

Japanese authors published an article on the successful transportation by a medical helicopter HEMS, followed by PCI and revascularization of a patient with occlusion of the left coronary artery trunk in a state of cardiogenic shock; vascular hospital was located 90 km from the scene [12].

A retrospective analysis of the aviation medical transportation of 2258 patients with ACS, including those in a state of cardiogenic shock, in Canada in the period from 2005 to 2007 showed the safety of this method of evacuation in relation to potentially unstable cardiac patients: the incidence of adverse events was low (5.6% cases), only one death was recorded during the flight [18].

HEMS is also widely used for medical evacuation of emergency patients with stroke around the world. S.P. Świeżewski et al. published data from a 5-year retrospective study of hospitalization histories of 3906 stroke patients flown by HEMS helicopters to hospitals in Poland. Maximum duration of transportation from call to patient arrival to hospital did not exceed 108 minutes, the average duration was 60 minutes; more than 87% of patients, according to the temporary hospitalization criteria, had the opportunity to undergo thrombolytic therapy or thromboextraction [19].

In the USA, in the period from 2004 to 2011, emergency medical service helicopters hospitalized 25322 patients with stroke; 96% of patients were admitted to the hospital within 2 hours of the call, while 58% of them were transported from rural and remote rural areas, 79% of patients were admitted to primary stroke centers [20]. Another study conducted in the United States showed comparable treatment outcomes for ground and air transport of patients with acute stroke who received thrombolytic therapy at the prehospital stage; Thus, according to the researchers, the HEMS service should be preferred over the ground service when transporting patients with stroke, planned for emergency endovascular intervention [21].

There are works on medical evacuation by the HEMS service of patients with acute stroke in Japan [22] and Germany. [23]. The German authors found a significantly shorter time of arrival at the scene of a medical helicopter compared to ground ambulance for calls for stroke and heart attack, as well as a shorter duration of transportation of these categories of patients to specialized centers [23].

An analysis of the medical literature on the impact of HEMS on the process and results of transportation of patients with ACVA generally shows mixed results: there is an obvious advantage in the use of medical helicopters in terms of the duration of transportation (compared to ground medical service), but no clear advantages in terms of mortality and outcomes in stroke patients have been demonstrated. The economic efficiency of using HEMS is also ambiguous - only two studies indicate the economic benefit of using transportation by a medical helicopter for patients who underwent thrombolytic therapy for stroke. [24]. The authors conclude that there is a need for targeted use of the HEMS service (rural areas, patients planning for thromboectomy) and additional research on this topic.

THE ROLE OF THE CEMA AIRCRAFT IN THE PROVISION OF EMERGENCY MEDICAL CARE TO PATIENTS WITH INFARCTION AND STROKE IN THE CITY OF MOSCOW

In the clinical practice of CEMA, there is extensive experience in the medical evacuation of patients with ACS and acute stroke using medical helicopters of the Moscow Aviation Center and personnel of aviation medical teams. The aviation medical team has all the necessary equipment to provide medical care to an emergency vascular patient, both at the scene of the accident and during medical evacuation. Since January 2016, 3 medical helicopters have been on duty around the clock, 2 more aircraft, if necessary, can be used additionally [7]. For aviation medical evacuation, light ambulance helicopters EC-145 are used, equipped with modern medical equipment, which allows, if necessary, to carry out resuscitation and anesthetic measures to save the life of clinically severe patients with MI and stroke during their medical evacuation to the hospital. In the process of aviamedical evacuation, the specialists of the CEMA inform the vascular invasive center in advance about the alleged hospitalization of a patient with ACS or acute ischemic stroke, planned for endovascular intervention, in order to minimize the time for its reception and delivery to the X-ray operating room.

Since 2015, the hospitalization of emergency patients with a vascular accident by the aeromedical teams of the Center for Emergency Medicine has been carried out in close cooperation with the visiting medical personnel of the Ambulance Station named after A.S. Puchkov of the Moscow Department of Healthcare (SMP), according to the principle of "calling a helicopter ambulance on himself"; identified indications for emergency medical evacuation of patients with acute stroke and ACS to invasive vascular centers in Moscow. The clear interaction of the two services makes it possible to urgently transport a severe vascular patient located in areas remote from the vascular hospital or requiring emergency evacuation in case of difficult road conditions.

The NIHSS Stroke Severity Scale has been introduced into the practice of the aeromedical teams of the CEMP to qualitatively and quantitatively determine the severity of stroke when the patient is admitted to the emergency room team, after prehospital therapy and during his hospitalization in the department of the vascular center. The developed algorithm of interaction between the employees of the aeromedical teams of the Center for Emergency Medicine and the field personnel of the SMP helps to reduce the period from the appearance of the first symptoms of a vascular accident to the provision of qualified medical care on the spot and high-tech care in a specialized hospital, which positively affects the results of treatment.

INTERACTION OF DZM STRUCTURES IN PROVIDING MEDICAL CARE TO PATIENTS WITH STROKE

An important aspect of providing medical care to patients with acute cerebrovascular accidents is the creation in Moscow of a project for a system of interaction between medical organizations of all levels - from primary care and hospitalization to gradual rehabilitation of the patient. The project involves medical organizations of the Moscow Department of Health: GBUZ "NPTs EMP DZM", GBUZ "City Hospital No. 15 named after O. M. Filatov DZM", GAUZ MNPTs MRVSM DZM, GBUZ" KDP No. 121 DZM", GBUZ "GP No. 180 DZM". The interaction between the above medical organizations is based on the effective use of the resources of the Moscow healthcare system, the continuity and proximity of rehabilitation measures to the patient's place of residence, patient orientation with an increase in the availability and quality of medical care, a unified electronic document flow. Rehabilitation of patients with acute cerebrovascular accidents within the framework of the project is based on the principles of staging, socialization, active involvement in rehabilitation activities of the patient and his family members, the use of psychological support and the active use of telemedicine technologies. All this will maximize the patient's quality of life after a stroke, even in the presence of a neurological deficit.

STATISTICS OF PROVIDING EMERGENCY MEDICAL CARE TO ACUTE VASCULAR PATIENTS BY AIR MEDICAL TEAMS

Over the past few years, the share of patients with acute somatic pathology in the structure of calls of the aviation medical teams of the CEMA has been steadily growing. If in 2018 the ratio of cases of medical evacuation of patients with trauma and burns and somatic pathology was approximately equal - 49.3% and 51.7%, respectively, then in 2019 the share of somatic patients increased to 71.7%, in the first half of 2020 it amounted to 56%. Among the cases of aviation medical transportation of patients with somatic pathology, the absolute majority is the evacuation of patients with ACS and acute stroke. So, in 2018, a total of 236 aeromedical evacuations of patients with ACS and acute cerebrovascular accidents were carried out, which amounted to 90.4% among the transportation of somatic patients and 45.8% of the total number of helicopter calls. In 2019, the number of calls of aviation medical helicopter teams in the event of vascular "catastrophes" increased: 373 emergency patients were transported to hospitals in the city of Moscow with the possibility of endovascular intervention, 54.2% - with a stroke, 45.8% - with ACS (unstable angina and MI). This accounted for 79.5% of all somatic nosologies hospitalized by the medical air brigades of the CEMA, and 57% of all departures of the center's specialists.

The statistics of the first half of 2020 is not indicative of the activity of aeromedical evacuations by the CEMA teams of patients with acute coronary and cerebral pathology. For objective reasons - due to the COVID-19 pandemic, the need to participate in anti-epidemic measures, the transportation of clinically serious patients with a new coronavirus infection to specialized hospitals and computed tomography centers, the delivery of samples for SARS-CoV-2 to the laboratory, a number of aviation medical evacuation specialists worked in ground transport brigades, therefore, the activity of the aviation medical service in the first months of the pandemic was limited [26]. However, even in a difficult epidemiological situation, in the first half of 2020, the helicopter medical teams of the CEMA carried out 38 evacuations of patients with ACS and stroke, which amounted to 47% of the total number of flights.

Clinical observation

04 December 2019 at 09.30 - a call from the SMP of the aviation medical brigade of the CEMA to the village of Kievsky (the territory of the Troitsky administrative district of the city of Moscow, 63rd kilometer of the Kiev highway). The helicopter took off from the base at 09.41. At 10.05 the team arrived at the scene.

Patient K., 77 years old, about 1 hour ago she noted the appearance of intense pain in the precordial region of a pressing and compressive character at rest. Previously, such pain did not arise. History of arterial hypertension for 5 years, up to high numbers, without regular antihypertensive therapy.

On examination: the general condition is severe. Consciousness is clear. The skin is of normal color and moisture, no edema. During auscultation, vesicular breathing is heard over the lungs, no wheezing. The respiratory rate is 18 per minute. The rhythm of the heart is correct, the tones are muffled. Heart rate - 60 bpm.

Blood pressure is 90/60 mm Hg. No focal neurological symptoms.

Electrocardiogram: sinus rhythm, correct. The heart rate is 60 per minute. The horizontal position of the electrical axis of the heart. Elevation of the ST segment up to 2 mm in leads I, aVL, V2 – V4. Depression of the ST segment up to 2 mm in leads II, III, aVF. The changes corresponded to the acute stage of myocardial infarction with ST segment elevation of antero-septal localization with involvement of the apex of the heart, reciprocal changes.

Glucometry: 7.6 mmol / L. Pulse oximetry: 89%.

Diagnosis: "Acute myocardial infarction of the antero-septal region with extension to the apex of the heart, with elevation of the ST segment" from 04.12.2019. Killip I.

Comorbidities: Arterial hypertension of the 3rd degree, 3rd stage, the risk of cardiovascular complications 4 (very high).

SMP therapy: Clopidogrel 600 mg, Acetylsalicylic acid 250 mg, Morphine 10 mg IV.

Takeoff from a place at 10.25. During transportation - repeated episode of chest pain, psychomotor agitation. Therapy was carried out: fentanyl 50 mcg intravenously; diazepam 10 mg intravenously; isotonic sodium chloride solution, 250 ml intravenously; low-flow oxygen therapy, 4 l / min. Against the background of therapy, the anginal attack was arrested.

At 10.53 - the patient was delivered to the N.V. N.V. Sklifosovsky Research Institute for Emergency Medicine, hemodynamically stable, condition without negative dynamics. At 13.00 - the helicopter returned to the base.

Time from receiving the call to arrival at the place - 35 minutes.

Duration of patient transportation - 28 minutes.

The time from the onset of clinical symptoms to admission to the hospital is 108 minutes.

Transportation distance - 62 kilometers.

In the hospital, the patient underwent stenting of the infarction-associated coronary artery (anterior descending branch) with positive clinical dynamics and satisfactory LV contractility according to the examination results. Discharged for outpatient treatment under the supervision of a cardiologist at the place of residence.

CONCLUSION

Thus, in the light of the modern organization of care for acute coronary and cerebrovascular patients, the ever-increasing role of the aeromedical helicopter teams of the Center for Emergency Medicine is obvious, which can provide the most important factor for the provision of emergency invasive care for patients with heart attack and stroke - the speed of patient delivery to a specialized hospital in combination with safety and a high level of medical support during transportation.

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