УДК 616.831-005.1-005.4-005.6-089.87-052:347.463
https://doi.org/10.20538/1682-0363-2021-4-218-224

Work of a stroke team: experience of transferring ischemic stroke patients from district hospitals to Krasnoyarsk Regional Vascular Center for thrombectomy

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ABSTRACT

Modern high-technology methods for ischemic stroke treatment (systemic thrombolysis, mechanical thrombectomy, thrombaspiration, stenting of cerebral arteries) can improve the rehabilitation potential and survival of patients. Important tasks here are selection for reperfusion and its performance on the greatest possible number of peracute patients. Mechanical thrombectomy combined with systemic thrombolysis is the most effective reperfusion strategy in the therapeutic window, but the availability of endovascular methods is limited to highly specialized centres. One way to solve this problem is to organize effective logistics with stroke patients, which will provide high-tech care for patients living far from large treatment centers due to regulated interaction between institutions at different levels.

The aim of the study was to improve emergency interaction related to transfer of peracute stroke patients from primary vascular units and district hospitals of the Krasnoyarsk region to Krasnoyarsk Regional Vascular Center for thrombectomy.

Key words: ischemic stroke, stroke team, logistics of patients with stroke, mechanical thrombectomy, thrombolysis.

Conflict of interest. The authors declare the absence of obvious or potential conflicts of interest related to the publication of this article.

Source of financing. The authors state that they received no funding for the study.

For citation: Shniakin P.G., Isaeva N.V., Kuznetsov V.Y., Protopopov A.V., Korchagin E.E., Dovbish N.Y., Litvinyuk N.V. Work of a stroke team: experience of transferring ischemic stroke patients from district hospitals to Krasnoyarsk Regional Vascular Center for thrombectomy. *Bulletin of Siberian Medicine.* 2021; 20 (4): 218–224. https://doi.org/10.20538/1682-0363-2021-4-218-224.

Работа Stroke team: опыт перевода пациентов с ишемическим инсультом на тромбэкстракцию из межрайонных больниц в Региональный сосудистый центр г. Красноярска

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РЕЗЮМЕ

Современные высокотехнологичные методы лечения ишемического инсульта (системный тромболизис, механическая тромбэкстракция, тромбаспирация, стентирование церебральных сосудов) позволяют улучшить реабилитационный потенциал и выживаемость пациентов. Важной задачей является отбор и проведение реперфузии в острейшем периоде наибольшему количеству больных. Тромбэкстракция в сочетании с системным тромболизисом является наиболее эффективной стратегией реперфузии в терапевтическом окне, однако доступность эндоваскулярных методов ограничена высокоспециализированными центрами. Одним из путей решения этой задачи является организация эффективной логистики пациентов с острым нарушением мозгового кровообращения (ОНМК), что позволит оказывать высокотехнологичную помощь пациентам, проживающим на удалении от крупных лечебных центров, благодаря отрегулированному взаимодействию между учреждениями разного уровня.

Цель исследования: совершенствование экстренного взаимодействия по вопросам перевода пациентов в острейшем периоде ишемического инсульта из первичных сосудистых отделений и межрайонных больниц Красноярского края в Региональный сосудистый центр г. Красноярска для проведения тромбэкстракции.

Ключевые слова: ишемический инсульт, Stroke team, логистика пациентов с ОНМК, тромбэкстракция, тромболизис.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии финансирования при проведении исследования.

Для цитирования: Шнякин П.Г., Исаева Н.В., Кузнецов В.Ю., Протопопов А.В., Корчагин Е.Е., Довбыш Н.Ю., Литвинюк Н.В. Работа Stroke team: опыт перевода пациентов с ишемическим инсультом на тромбэкстракцию из межрайонных больниц в Региональный сосудистый центр г. Красноярска. *Бюллетень сибирской медицины.* 2021; 20 (4): 218–224. https://doi.org/10.20538/1682-0363-2021-4-218-224.

INTRODUCTION

Hyperacute ischemic stroke treatment with implementation of high-tech methods into clinical practice sets new goals in healthcare management and patient routing. An important issue is to improve the availability of a full range of medical services, combining methods of therapeutic (systemic thrombolysis) and surgical (mechanical thrombectomy, thrombaspiration, stenting of cerebral vessels) reperfusion for the largest number of patients [1–5]. In Krasnoyarsk, endovascular methods for ischemic stroke are successfully applied at the premises of three largest clinics: Krasnoyarsk Regional Clinical Hospital (chief physician – Egor E. Korchagin), Karpovich Krasnoyarsk Regional Clinical Emergency Hospital (chief physician – Sergey V. Grebennikov), and Krasnoyarsk Regional Hospital No. 20 (chief physician – Vladimir A. Fokin).

At the same time, healthcare institutions in remote areas of the Krasnoyarsk region have limitations in relation to the use of such methods, and making them available for patients from remote areas is relevant. The solution to this problem may be to improve the logistics for ischemic stroke patients and their emergency transportation to healthcare institutions with necessary resources for high-tech medical care [6, 7].

RESULTS

Currently, the Regional Vascular Disease Center (RVDC) of Krasnoyarsk Regional Clinical Hospital (KRCH) (the head of the RVDC is A.V. Protopopov, Dr. Sci. (Med.), Professor), interacts and cooperates on a round-the-clock basis with primary vascular departments (PVDs) and interdistrict hospitals located within a 100 km radius from the Krasnoyarsk Regional Clinical Hospital: Clinical Hospital No. 51 of the Federal Medical Biological Agency of the Russian Federation (62.4 km) and Divnogorsk Interdistrict Hospital (45 km) (Fig. 1).

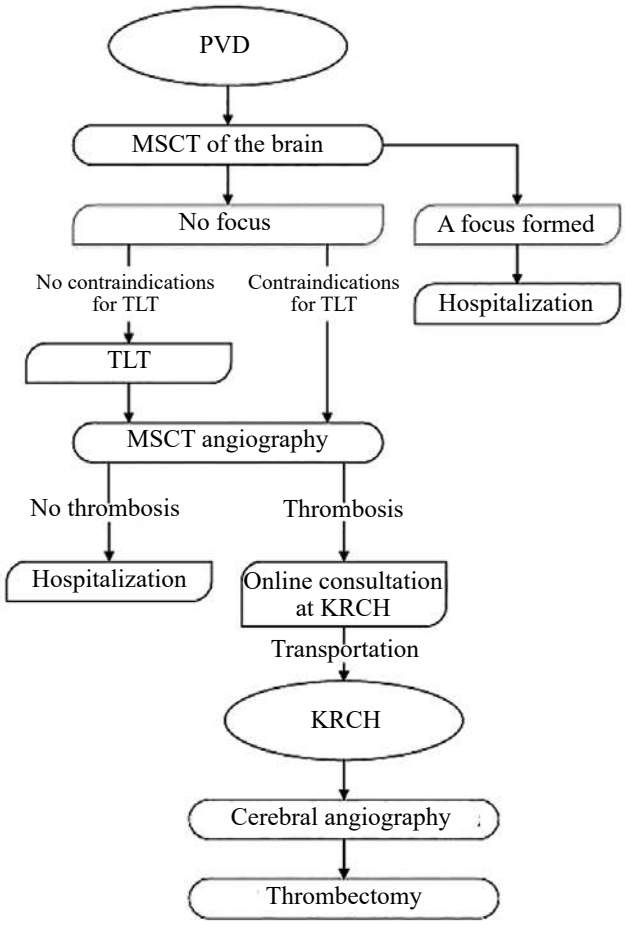

Fig. 1. The current system of interaction between the Krasnoyarsk Regional Vascular Disease Center and other treatment facilities in the region in selecting ischemic stroke patients for emergency thrombectomy

The problem of organizing emergency interaction between medical and prevention institutions in Krasnoyarsk and the Krasnoyarsk region is solved with various tools. Along with the traditional method of inter-hospital interaction using telephone communication, modern technologies have been introduced in the Krasnoyarsk region. Telemedicine consultations are performed through the RCH Center of X-ray Consultations with the possibility to upload neuro-visualization images (multi-slice computed tomography (MSCT), magnetic resonance imaging (MRI)) to the unified database for their immediate evaluation by radiologists of the center from any remote station. Another important tool for assessing the patient's condition and determining further management strategy is the neuromonitoring program [8], with which a consulting neurologist can establish a two-way communication with doctors of all hospitals in the Krasnoyarsk region, receiving full information on the patient with the ability to make timely decisions on treatment correction or transfer the patient to the RVDC. Taking into consideration wide capabilities of telemedicine, it is now possible to apply high-tech methods of treating hyperacute ischemic stroke in patients living outside the city of Krasnoyarsk.

In 2019, 10 patients with stroke received treatment in the Neurology Department of RVDC after transfer from PVDs with subsequent endovascular surgery (mechanical thrombectomy, stenting of cerebral vessels).

CLINICAL CASE 1

Patient B, 63 years old. Transferred from PVD of Zheleznogorsk Clinical Hospital No. 51 of FMBA of the Russian Federation with the clinical presentation of right-sided hemiparesis, motor aphasia; the patient was alert (Modified Rankin scale score: 3, NIHSS: 5). On the emergence of symptoms, the patient was admitted to a local PVD with a suspected stroke. A standard neurological examination involving scaling, laboratory data evaluation, as well as native brain MSCT was performed. The diagnosis of ischemic stroke was confirmed. Taking into consideration admission within the therapeutic window and lack of contraindications, systemic thrombolytic therapy (TLT) was immediately started in the MSCT room in the PVD [9–11]. According to MSCT angiography of cerebral and brachiocephalic vessels, symptomatic thrombosis was revealed: a left-sided occlusion of the internal carotid artery (ICA).

The Regional Clinical Hospital has developed a standard regulating the selection of patients admitted with the diagnosis of stroke for transfer to the RVDC for mechanical reperfusion [3]. The prerequisites are admission within the therapeutic window, the consciousness level of over 9 according to the Glasgow Coma Scale, ASPECTS scale score of no less than 6 (MSCT of the brain), the Modified Rankin Scale score for the degree of disability before stroke of no more than 2. Patient B. met all the listed criteria.

Considering the presence of symptomatic ICA occlusion, required transportation time (approximately one hour), and the evacuable state of the patient (the level of consciousness no lower than obtundation, unassisted breathing, stable hemodynamics), the neurologist at the PVD informed the neurologist at the RVDC by phone about the anamnesis data, neurological status, and MSCT results, indicating the time of TLT onset. The neurologist and radiologist at the RVDC assessed the MSCT scans of the patient's brain

and cerebral vessels, which were presented to the Center of X-ray Consultions.

This clinical examination complied with all the conditions for a possible thrombectomy [12–15], and a decision was made to urgently transfer the patient to the RVDC. Meanwhile, the RCH neurologist informed the interventional radiologist and the anesthesiology team about the forthcoming arrival of the patient who was a candidate for thrombectomy. The endovascular surgeon began preparing the X-ray-equipped operating room for emergency intervention.

The patient was delivered to the Krasnoyarsk RVDC by the ambulance team. In the admission unit at the RCH, the patient was examined at runtime by the attending neurologist, MSCT of the brain was performed (the ASPECTS score of 8) to exclude major irreversible ischemia and intracranial hemorrhage (Fig. 2).

Fig. 2. Computed tomography of the brain of patient B., 63 years old, after thrombolysis before thrombectomy

Since the therapeutic window period was about to end, cerebral perfusion MSCT was performed in order to assess the core – penumbra area ratio. The core was within 1/3 of the left middle cerebral artery (MCA) circulation.

Indications for emergency thrombectomy were evaluated in the admission unit by a multidisciplinary team including a neurologist, an interventional radiologist, and a radiologist. All parameters met the criteria for thrombectomy. The patient was admitted to the X-ray-equipped operating room, where selective cerebral angiography was performed to resolve the issue of further treatment strategy. Mechanical thrombectomy was carried out on the left ICA circulation, and the blood flow was restored according to grade 3 of the mTICI scale. According to the data of MSCT of the brain at runtime, a small ischemic area formed in the left temporoparietal zone after 24 hours without decrement in the neurological status (Fig. 3).

Fig. 3. Computed tomography of the brain of patient B., 63 years old, after thrombectomy of the internal carotid artery on the left

The patient received standard baseline and neurometabolic therapy and underwent early rehabilitation. Positive changes in the patient's condition were observed, hemiparesis regressed, moderate speech disorders persisted, manifested through efferent motor and dynamic aphasia. The motor component of the speech improved (Modified Rankin Scale: 2, NIHSS: 1). The patient was discharged in a satisfactory condition for follow-up rehabilitation of speech disorders.

The choice of stroke treatment methods and organization of transportation should be made as quickly as possible. The feature of the following clinical case is that a stroke patient was transported twice between healthcare institutions before admission to the RVDC. In the meantime, the patient was delivered within the therapeutic window.

CLINICAL CASE 2

Patient R., 57 years old, was urgently taken to the Divnogorsk Interdistrict Hospital due to acute

development of focal neurologic deficit with suspected stroke. Considering the absence of CT equipment in the interdistrict hospital, according to the routing, the patient was initially transferred to the private healthcare institution "Clinical hospital "RZD-Medicine", Krasnoyarsk, where MSCT of brain structures and MSCT angiography of cerebral arteries were performed, M1 segment occlusion of the left MCA was diagnosed, and systemic thrombolysis was initiated (Fig. 4). Taking into account the duration of the therapeutic window, the patient was transported for the next stage to the RVDC. Upn admission, the patient was fully alert, with focal neurologic deficit in the form of right-sided hemiparesis, hemihypesthesia, and motor aphasia. Modified Rankin Scale score was 4, NIHSS score was 13.

Fig. 4. Computed tomography of patient R., 57 years old, after TLT, before the start of thrombectomy

At the RVDC, thrombectomy was performed on the M1 segment of the left MCA with full perfusion restoration, the mTICI scale score was 3. A small ischemic area in the left MCA circulation was revealed using dynamic MSCT of the brain (Fig. 5). During the inpatient treatment, the patient's condition showed positive changes: muscle strength and sensitivity in the right limbs were restored, overall mental activity and physical performance increased. Voluntary attention and memory enhanced, self-service ability improved. Upon discharge, speech disorders corresponded to dynamic aphasia in the form of systemic perseverations.

Fig. 5. Computed tomography of the brain of patient R., 57 years old, after thrombectomy of the M1 segment of the left middle cerebral artery. Formation of a small ischemic area without neurological status deterioration

Upon discharge, the score on the Modified Rankin Scale was, on NIHSS – 1. The patient was referred to follow-up treatment: stage 3 of speech rehabilitation.

This article presents clinical cases of a small sample of patients to show the possibility of increasing the availability of endovascular methods for treating hyperacute ischemic stroke patients who live outside large cities with specialized vascular centers.

The analysis of time intervals in 10 clinical cases of patients from the initial ischemic stroke symptoms in the area of residence to thrombectomy at the Krasnoyarsk RVDC in 2019 showed that the duration of each period largely depended on the promptness of the stroke team actions. The key elements of medical aid provision at each stage are as follows: reaction to the call for an ambulance team, stroke diagnosis at the PVD where the patient was initially transported to and where the decision to transfer the patient to the RCH was made, and promptness of actions of the RVDC team. It was determined that the average time between the stroke onset and admission to the RCH was 245 [198.25; 257.25] minutes, while thrombolysis started after 155 [140; 180] minutes, beginning at the PVD and continuing in the ambulance during transportation to the RCH. The time between entering the

hospital and starting the operation was 37.5 [28.25; 47.5] minutes. Thrombectomy was initiated after an average of 247 minutes [237.5; 293.5] from the first stroke symptoms. Recanalization had been completed by 388 [300.5; 408.25] minutes from the stroke onset (Fig. 6).

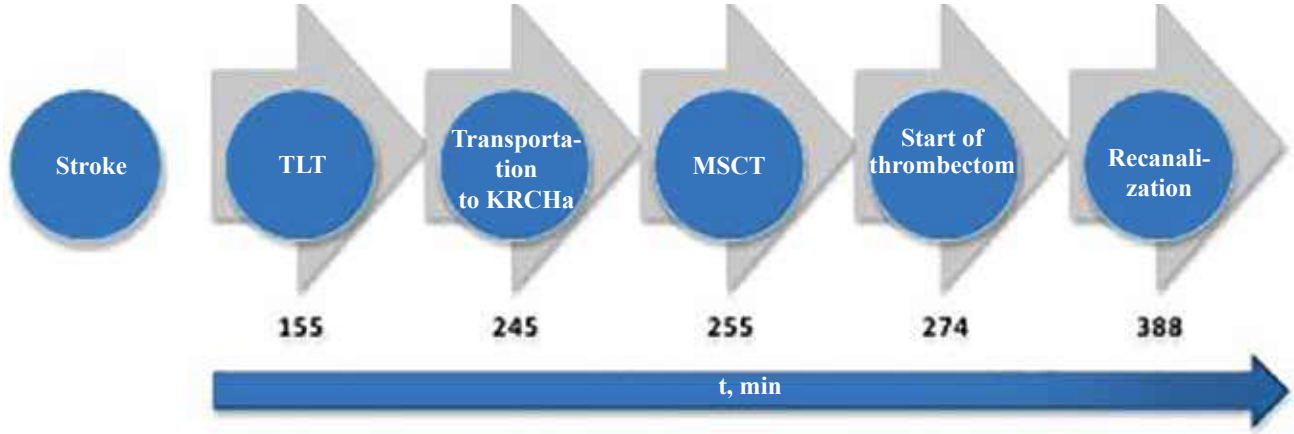

Fig. 6. Time values of working with hyperacute ischemic stroke patients ($n = 10$) transferred from interdistrict hospitals of the region to the Regional Vascular Disease Center for emergency thrombectomy (*Me* [p_{25}; p_{75}])

It is obvious that each region may develop its own system of emergency logistics for stroke patients taking into account its territorial and administrative peculiarities. In the Krasnoyarsk region, a system of interaction between interdistrict hospitals, PVDs, and the RVDC allows to make timely decisions on transfer of patients for thrombectomy, which increases availability of high-quality care for hyperacute ischemic stroke patients. Coordinated teamwork of specialists from healthcare institutions at different levels allows to start thrombectomy within the therapeutic window. Therefore, mechanical thrombectomy in all patients was started within 4.5 hours, and successful recanalization was performed within 6.5 hours from the stroke onset. There were no lethal cases in the group of patients observed after thrombectomy. Good recovery of the neurologic deficit was observed in all the patients.

CONCLUSION

Maximum efficacy of treatment for hyperacute ischemic stroke patients requires:

– a well-developed system for interaction between emergency room specialists, neurologists, radiologists, and intervention radiologists within healthcare institutions providing high-tech medical care for ischemic stroke patients;

– improving the quality of interaction between the RVDC and healthcare institutions at primary and secondary levels by introducing modern technology, such as continuous X-ray consultation and neuromonitoring;

– well-managed work of the ambulance and its interaction with PVDs and the RVDC.

Therefore, well-coordinated teamwork of stroke team specialists at different levels of care for hyperacute ischemic stroke patients contributes to an increase in the availability of high-tech methods for treating patients who live outside the regional center, which makes it possible to preserve the maximum possible amount of nervous tissue, reduce mortality, increase the rehabilitation potential, and improve functional outcomes.

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Authors contribution

Isaeva N.V. – conception and design. Kuznetsov V.Y., Dovbysh N.Yu., Litvinyuk N.V. – analysis and interpretation of data. Shnyakin P.G. – substantiation of the manuscript and critical revision for important intellectual content. Protopopov A.V., Korchagin E.E. – final approval of the manuscript for publication.

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Received 04.06.2020
Accepted 28.12.2020