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ORIGINAL

Improving the organization of specialized and high-tech medical care for patients with acute cerebral circulatory disorders on the example of the Almaty region

Mejora de la organización de la atención médica especializada y de alta tecnología para pacientes con trastornos circulatorios cerebrales agudos, siguiendo el ejemplo de la región de Almaty.

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ABSTRACT

Introduction: acute disorders of cerebral circulation are currently one of the main socio-medical problems of clinical neurology.
Objective: to conduct a comprehensive review of relevant literature sources regarding the state of the organisation of medical care for patients with acute cerebral circulatory disorders in the Almaty region, the role of stroke centres in providing high-tech medical services, the results of the application of telemedicine achievements in this area and the search for ways to improve established practices.
Method: analysis, systematisation, induction, bibliographic, generalisation, method of analogy, and synthesis.
Results: examines the features of the organisation of assistance to people with acute cerebral circulatory disorders in the Almaty region and analyses the model of a stratified three-level system of stroke centres in the Republic of Kazakhstan. The prospects of applying modern achievements of telemedicine in the field of emergency neurology and neurosurgery are analysed. The main global trends in the organisation of assistance to people with acute cerebral circulatory disorders are highlighted, and the prospects for further integration of a number of information technologies and mobile stroke centres in Kazakhstan in general and the Almaty region in particular are highlighted.
Conclusions: the result of the study is a comprehensive analysis of modern scientific literature on the topic of optimising the provision of specialised and high-tech care to patients with acute cerebral circulatory disorders in the example of the Almaty region.

Keywords: Stroke; Cerebrovascular Diseases; Telemedicine; Thrombolytic Therapy; Non-Traumatic Intracranial Haemorrhage.

RESUMEN

Introducción: los trastornos agudos de la circulación cerebral constituyen actualmente uno de los principales problemas sociomédicos de la neurología clínica.
Objetivo: realizar una revisión exhaustiva de las fuentes bibliográficas pertinentes en relación con el estado de la organización de la atención médica a los pacientes con trastornos circulatorios cerebrales agudos en la región de Almaty, el papel de los centros de accidentes cerebrovasculares en la prestación de servicios médicos de alta tecnología, los resultados de la aplicación de los logros de la telemedicina en este ámbito y la búsqueda de formas de mejorar las prácticas establecidas.
Método: análisis, sistematización, inducción, bibliográfico, generalización, método de la analogía y síntesis.
Resultados: se examinan las características de la organización de la asistencia a personas con trastornos

circulatorios cerebrales agudos en la región de Almaty y se analiza el modelo de un sistema estratificado de tres niveles de centros de ictus en la República de Kazajstán. Se analizan las perspectivas de aplicación de los modernos logros de la telemedicina en el ámbito de la neurología y la neurocirugía de urgencia. Se ponen de relieve las principales tendencias mundiales en la organización de la asistencia a personas con trastornos circulatorios cerebrales agudos y se destacan las perspectivas de una mayor integración de una serie de tecnologías de la información y centros móviles de ictus en Kazajstán en general y en la región de Almaty en particular.

Conclusiones: el resultado del estudio es un análisis exhaustivo de la literatura científica moderna sobre el tema de la optimización de la prestación de asistencia especializada y de alta tecnología a pacientes con trastornos circulatorios cerebrales agudos en el ejemplo de la región de Almaty.

Palabras clave: Accidente cerebrovascular; Enfermedades cerebrovasculares; Telemedicina; Terapia Trombolítica; Hemorragia Intracraneal no Traumática.

INTRODUCTION

Acute disorders of cerebral circulation are currently one of the main socio-medical problems of clinical neurology. This is the most common and dangerous neurological disease, which is the leading cause of disability not only in the Republic of Kazakhstan but also throughout the world. In addition to substantial medical-social importance, acute cerebral circulatory disorders cause substantial economic damage. The above causes the need to explore ways to optimise measures for the diagnosis, treatment, prevention, and rehabilitation of acute cerebral circulatory disorders.

A.F. Shamsutdinova et al.[1] considered acute cerebral circulatory disorders as a critical medical and social problem in their study. The researchers stressed that more than 40 thousand cases of stroke are registered annually in the Republic of Kazakhstan, of which about 80 % are ischemic strokes. Therewith, among all cases of acute cerebral circulatory disorders, 5 thousand die during the acute period, which covers 1-7 days from the moment of pathology development. The relatively high mortality rate, disability, and the need for long-term hospital and post-hospital care make the treatment of such patients' resource-intensive for the healthcare system. The researchers also stressed that the cost of one minute of delayed treatment for stroke is enormous, so treatment should be conducted according to the concept of "time-brain" and the recommendations of international clinical protocols. The authors examined in detail a number of aspects of the organization of care for people with acute cerebral circulatory disorders; nevertheless, they were missing a number of essential elements outlined in this study, such as the use of telemedicine and mobile stroke units.

R.M. Kastey et al.[2] considered the issue of epidemiology and prevention of acute cerebral circulatory disorders, in this case, not only on the example of ischemic stroke. The researchers emphasized the decrease in the average mortality rate due to this problem from 65,7 to 61 per 100 thousand people. Mortality rates and prevalence rates identified during this study are unevenly distributed relative to different regions of the Republic of Kazakhstan, which was also true for trends regarding changes in these indicators over time. This study also overlooked some aspects of medical and emergency care organization in this area. Moving from the general to the specific, N.A. Abdikaliyev et al.[3] considered the issue of prevalence, mortality, and disability from acute cerebral circulatory disorders in the territory of the Almaty region. The study revealed a persistent trend towards a decrease in mortality and an increase in the disability rate, especially among the male population. This trend may be associated with the optimization of the pathology treatment process in the region in combination with the insufficient development of rehabilitation programs.

In the territory of the Almaty region, four stroke centers use both therapeutic and surgical methods for the treatment of haemorrhagic stroke, the features of which have become the object of the study by M.G. Talasbaev et al.[4] The researchers stressed that the decision on surgical treatment remains controversial: early surgery can limit brain damage, but with continued bleeding, the risks may outweigh the benefits. Surgical studies of intracranial hematomas (SSIH) have not determined substantial advantages of surgical treatment of intracerebral hematomas compared with the use of conservative methods. Therewith, in some cases, on the contrary, surgical interventions have demonstrated greater effectiveness. Although the presented study demonstrated a comparison of the effectiveness of various methods of treating acute cerebral circulatory disorders, the issue of rehabilitation of patients with these disorders was ignored. B. Khusainova[5] considered the process of digitalising medical services and the economic benefits of integrating telemedicine achievements, including in clinical neurology. The author drew attention to the use of telemedicine in preventive and rehabilitative practice to combat acute disorders of cerebral circulation, however, omitting the most modern methods of application in the field of emergency neurology.

The available papers on this subject are characterized by fragmentation and do not cover the problem in its

entirety. This is due to the complexity and multidimensional nature of the research object. This study aims to overcome these limitations through a comprehensive analysis that considers different aspects of the problem. The purpose of this study is to conduct a comprehensive review of modern literature sources concerning the current state of the organization of medical care for patients with acute cerebral circulatory disorders in the example of the Almaty region.

METHOD

While working on this scientific material, a comprehensive search for modern scientific literature related to the organisation of high-tech specialised care for people with acute cerebral circulatory disorders was conducted using the bibliographic method. The search for scientific sources was conducted on a number of medical, social, and scientific-practical resources, such as Google Scholar, PubMed, Ovid, Web of Science, EMBASE, and Science Direct. A number of keywords and phrases were used to achieve greater accuracy of search queries in the above scientometric databases, such as: "stroke", "organisation of medical care", "stroke centre", "telemedicine", "stroke prevention", "regionalisation of medical care", "integrated model of medical care", "telemedicine and stroke", "Acute cerebral circulation disorders". A number of inclusion and exclusion criteria were used to narrow the range of scientific literature received: sources had to meet the time frame 2019-2024, priority was given to practically oriented papers on the organisation of medical care and the integration of innovative technologies into clinical practice, many strictly theoretical scientific-biological studies were also eliminated.

With the help of categorisation methods, greater representativeness was achieved, and possible bias regarding both practical recommendations and the identified literature was eliminated. The application of the analysis method allowed considering in detail the implementation on the territory of the Republic of Kazakhstan in general and the Almaty region in particular of the model of a stratified three-level system of stroke centres within the framework of the concept of regionalisation of healthcare, the current state of the stroke service of the Almaty region, the features of its functioning in the conditions of the coronavirus pandemic, the current state, and further prospects for integrating telemedicine achievements into the process of helping people with acute disorders of cerebral circulation. The experience of foreign colleagues in this field was also analysed, especially the recommendations of the American stroke association (ASA) and the practice of developing and implementing mobile stroke centres. With the help of synthesis, further directions for research in this area were formulated in the form of examining the features of the application of telemedicine achievements in the practice of providing assistance to people with acute cerebral circulatory disorders and integrating the system of mobile stroke centres into the organisation of the stroke service of the Republic of Kazakhstan.

Using the analogy method helped to compare the organisation of stroke services in the territory of the Almaty region with those in other countries to consider its various aspects, from primary and secondary prevention to emergency care and rehabilitation in large cities and remote settlements. The methods of abstraction and induction were applied to identify current trends in the provision of specialised care to patients with acute cerebral circulatory disorders. Thus, current trends are to redistribute the attention of stroke services to the areas of primary and secondary prevention and rehabilitation and integration into the broad medical practice of mobile stroke centres.

RESULTS

Given the substantial medical, social, and economic role of acute cerebral circulatory disorders, optimising the ways of prevention, treatment, and rehabilitation of patients with this problem is an essential priority of the health care system of the Republic of Kazakhstan. Currently, the implementation of medical interventions in the field of acute cerebral circulatory disorders is conducted within the framework of the "Roadmap for the implementation of an integrated acute stroke management model in the Republic of Kazakhstan"[6], approved by the Ministry of Health of the Republic of Kazakhstan in 2015. The implementation of this programme is actively conducted with the participation of the Coordinating council for the Introduction of an integrated model of medical care for strokes through the "Republican coordination centre for stroke problems" (RCCSP). The creation of such integrated systems in this area has been conducted on the territory of many other states, which has positively impacted the quality of medical care and optimised its effectiveness.[7,8] Some similar centres were focused not only on clinical activities but also on research work.[9,10]

The changes made to the Order of the Minister of Health and Social Development of the Republic of Kazakhstan No. 809 "On Approval of the Standard of Organisation of Neurological Care in the Republic of Kazakhstan"[11], regulating the provision of medical care to patients with the suspected acute cerebral circulatory disorder in the Republic of Kazakhstan, concerned the paragraph 21 of this order. In Order of the Minister of Health of the Republic of Kazakhstan No. 110 "On Amendments to Order of the Minister of Health and Social Development of the Republic of Kazakhstan No. 809 "On Approval of the Standard of Organisation of Neurological Care in the Republic of Kazakhstan"[11], it is noted that to provide assistance to patients with acute cerebral circulatory disorders (including transient cerebral ischemic attacks, intracerebral and subarachnoid haemorrhage,

cerebral infarction, and other non-traumatic intracerebral haemorrhages and cerebral vascular syndromes in cerebrovascular pathologies), it is necessary to create primary and regional stroke centres based on republican and multidisciplinary healthcare organisations of the regions and cities of Astana, Almaty. These centres should provide inpatient care, considering the recommendations for providing 30 beds per 250 thousand people. The dynamics of the implementation of this programme is shown in figure 1.

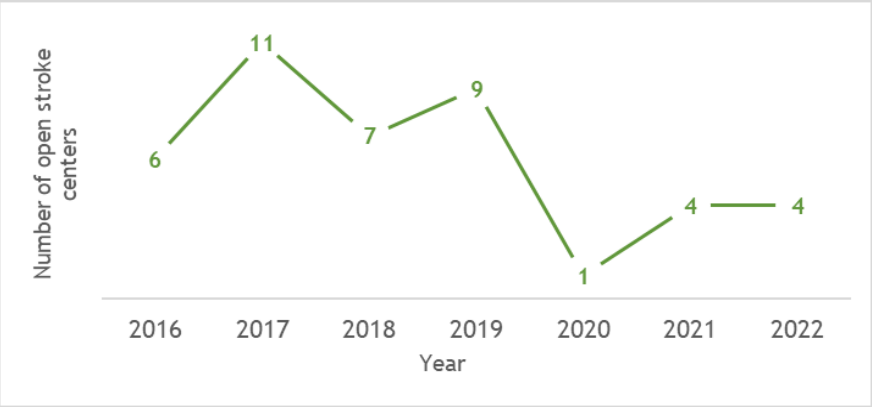

Figure 1. Dynamics of the Roadmap implementation

Stroke centres are focused on the implementation of medical interventions for patients with acute cerebral circulatory disorders, and these interventions are implemented in accordance with international standards. Their main task is to restore lost functions to patients as quickly and effectively as possible after suffering cerebral circulation disruptions and prevent repeated episodes. The placement of stroke centres of 2-3 levels in the territory of the Almaty region and Almaty city is shown in table 1.

Table 1. Location of stroke centres on the territory of Almaty region and Almaty city

Location	Name of the healthcare institution	The level of assistance
Almaty region	Almaty Multidisciplinary Clinical Hospital (Almaty city)	3
	State municipal enterprise on the right of economic management "Karasay Central District Hospital" (Kaskelen city)	2
	State municipal enterprise on the right of economic management "Enbekshikazakh Central District Hospital" (Issyk city)	2
	State municipal enterprise on the right of economic management "Talgar Central District Hospital" (Talgar city)	2
Almaty city	Central City Clinical Hospital	2
	Emergency Medical Hospital	3
	City Clinical Hospital No. 4	3
	Emergency Vascular Department No. 2 of the City Clinical Hospital No. 7	3
	Emergency Vascular Department No. 1 of the City Clinical Hospital No. 7	3

Source: compiled by the author based on [11].

The tertiary level is represented by regional stroke centres, which are formed based on large institutions that are key in the emergency care system in a particular region. They work closely with lower-level medical institutions: rural and district hospitals, the ambulance system, and primary stroke centres. Regional stroke centres provide specialised and high-tech therapy and early rehabilitation. They are equipped with angiographs and surgical microscopes for endovascular neurosurgical interventions. Thus, four second-level institutions are located on the territory of the Almaty region (one of them in Almaty city) and five third-level institutions (four of them in Almaty city). In the territory of the Almaty region, according to the principles of regionalisation, neurosurgical interventions in the case of acute cerebral circulatory disorders are conducted based on institutions of the second and third levels, while the volume and complexity of the interventions vary. Second-level stroke centres specialise in open-ended neurosurgical interventions, including the removal of intracranial hematomas, decompression cranial interventions, and external drainage. The third-level stroke centres are focused on using the most innovative neurosurgical interventions. The range of interventions performed there includes stenting of intra- and extra-cranial vessels of different calibres, extra- and intra-cranial anastomoses, including microvascular ones, obliteration of aneurysms and malformations, their embolization and clipping.

The implementation of the Roadmap in the long term contributed to the structuring of medical care in

the event of acute cerebral circulatory disorders, stimulated the use of high-tech treatment methods and positively influenced mortality and disability rates.[24] Therewith, attention should be paid to the problem of unsatisfactory material equipment of centres not only of the first but also of higher levels, which negatively affects the effectiveness of medical interventions.[25] Similar obstacles in assisting people with acute cerebral circulatory disorders have been recorded in other countries. Optimisation of financing and more efficient redistribution of material resources can contribute to optimising the activities of stroke centres, which will positively affect the quality and frequency of high-tech interventions. The provision of medical services in the field of emergency neurology, similar to a number of other medical areas, can be optimised by introducing telemedicine achievements into clinical practice. The effectiveness of the introduction of telemedicine technologies in the organisation of medical care in remote areas has been confirmed in various studies. In this case, given the disproportionality between the population density and the vast area of the territories of Kazakhstan, telemedicine has found its application as a means of optimising the provision of emergency specialised care in cases where the use of air ambulance and operational transportation is difficult.

Thus, optimisation and further improvement of the organisation of emergency neurological care occur mainly within the framework of the implementation of the Roadmap. The structuring of the stroke service conducted in recent years through the creation of stroke centres with their division into groups depending on the volume of medical services provided has had a positive effect on mortality rates and disability from acute cerebral circulatory disorders, including in the territory of the Almaty region. The effectiveness of this approach has proved itself, despite some difficulties with logistical support. The COVID-19 pandemic is a substantial problem which has caused an overload of the healthcare system and the introduction of many restrictive measures, which has led to an increase in the mortality rate from strokes and a decrease in the level of hospitalisation. Promising areas that can contribute to improving the provision of high-tech care in stroke centres are the integration of multidisciplinary teams of specialists and the achievements of telemedicine. The creation of unified advisory telemedicine centres, with a staff of doctors working around the clock in various specialities, will allow quickly making decisions in complex diagnostic cases and coordinating therapeutic measures.

DISCUSSION

The recommendations of the ASA regarding primary, secondary, and tertiary prevention of acute cerebral circulatory disorders were considered in detail by F. Herpich and F. Rincon.[12] American experts recommend actively supporting initiatives by communities and healthcare providers aimed at implementing primary and secondary prevention programmes among both the general population and at-risk groups. Therewith, great importance is given to educating medical professionals about modern prevention strategies developed based on evidence-based resources and ensuring long-term compliance by patients with the developed schemes, which should be conducted with the active support of medical organisations.

The recommendations of the ASA for stroke in the field of emergency and delayed care were considered by O. Adeoye et al.[13] According to the results of the study, the main emphasis is on early diagnosis using validated scales at the pre-hospital stage, standardisation of protocols for dispatchers, provision of advance notification to the hospital, and minimising the time of transportation of patients with suspected occlusion of the main vessels. As for the provision of care in hospitals, in this case, the importance of certification of stroke centres for compliance with their national standards, the introduction of performance monitoring systems at all stages of the provision of medical services, the development of patient routing within institutions, the integration of innovative imaging, and surgical treatment methods are emphasised.

A number of researchers, including S. Mathur et al.[14], investigated the use of mobile stroke centres (MSC). ICS represent an innovative model of providing care to patients with acute cerebral circulatory disorders at the prehospital stage, allowing specialised high-tech care to be brought closer to the accident scene. The MSC is a fully equipped field ambulance team based on specialised vehicles. In addition to a specialised staff group, the MSC includes equipment for conducting telemedicine consultations and diagnostic examinations, including a portable CT scanner. The main functions of the MSC are the emergency diagnosis of stroke using CT and laboratory rapid tests, determination of optimal therapeutic tactics, including thrombolysis, based on telemedicine consultations of neurosurgeons, transport sorting of patients to specialised vascular centres or departments of neurosurgery, depending on the type of stroke, ensuring timely initiation of therapy during the "golden hour".[15] MSCs play a key role in bringing high-tech care closer to rural and remote areas, optimising patient routing, and reducing the time before treatment begins.[16,17]

The problem of providing highly specialised care to people with acute cerebral circulatory disorders in remote settlements was investigated by R.A. Harrington et al.[18] The researchers emphasised that distance and time are crucial factors for the success of interventions in emergency neurology and neurosurgery. It was determined that delays in the provision of highly specialised care can reach 5-30 hours, which contributes to the low frequency of highly specialised interventions (1-6 %) and, as a result, high mortality and disability rates. Australian researchers represented by S.J. Prior et al.[19] also touched upon this subject, identifying a

substantial gap in the quality of emergency highly specialised care for people with acute cerebral circulatory disorders between urban and rural populations. It was determined that the urban population received access to these medical interventions in 77 % of cases, unlike rural ones, when timely access was provided only in 3 % of cases. A number of specialists, including S. Walter[20], demonstrated the effectiveness of the integration of the MSC system in overcoming the above problems. The researchers emphasised the prospects for optimising the provision of emergency highly specialised care based on the MSC, including Air-MSU, both on the basis of positive dynamics of mortality and disability rates and based on the economic benefits of the introduction of this practice.

Thus, modern trends in the development of stroke services in different countries demonstrate common trends: a substantial redistribution of specialists' attention towards primary, secondary, and tertiary prevention of acute cerebral circulatory disorders, restructuring of stroke services with the introduction of MSC into practice, integration of telemedicine achievements into the practice of emergency neurology and neurosurgery.

CONCLUSIONS

This study provides a comprehensive analysis of modern scientific literature on specialized and high-tech medical care for acute cerebral circulatory disorders in the Almaty region and Kazakhstan. The implementation of a three-level stroke center model and the Roadmap for integrated stroke management have significantly reduced mortality and disability rates. Challenges include insufficient technical resources and pandemic-related disruptions, prompting recommendations for telemedicine expansion and mobile stroke centers. Future priorities should focus on prevention strategies, standardized prehospital emergency care, integrated patient management protocols, and enhanced rehabilitation and secondary prevention efforts. Further research avenues include exploring telemedicine applications in emergency neurology and neurosurgery, as well as integrating foreign models of mobile stroke centers.

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