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Improving multidisciplinary hospital care for acute cerebral circulation disorders in Kazakhstan☆

Gulzhan Adenova [a], Galina Kausova [a], Aigul Tazhiyeva [b,*]

[a] Kazakhstan Medical University "KSPH", Almaty, Kazakhstan
[b] Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan

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ABSTRACT

Background: According to the World Stroke Organization, there was a significant increase in stroke cases, stroke deaths, and the DALY rate in low- and middle-income countries in 2022. The number of stroke cases rose by 70.0%, stroke deaths reached 86.0%, and the DALY rate reached 89.0%. Among cerebrovascular diseases, ischemic stroke accounts for 62.0% of all strokes, with more than 7.6 million cases reported annually.

Kazakhstan, with a population of 19,832,737, is the largest country in Central Asia in terms of territory. In Kazakhstan, the incidence of cerebrovascular disease has risen from 258.4 cases per 100,000 population in 2015 to 433.7 cases per 100,000 population in 2020. Official statistics indicate that the average inpatient mortality rate from stroke in the country is 16.2%, and the average time for patients to be delivered to the hospital after an ambulance call is 40 min (83.2%).

Our study findings reveal that in the regions of Kazakhstan, the main contributors to the high morbidity and mortality rates in stroke are a shortage of doctors, inadequate primary healthcare, insufficient follow-up and treatment, and delayed hospitalization. Consequently, this study has helped fill knowledge gaps regarding the epidemiological situation in these regions and underscores the need for training doctors in managing high-risk patients, establishing multidisciplinary home visit teams, and establishing "Stroke Schools" to enhance public awareness of early stroke signs and the fundamentals of a healthy lifestyle. Future research endeavors should consider these study results as valuable contributions towards addressing the existing problems.

Aim: To study the prevalence and mortality of acute cerebral circulation impairment in the population within multidisciplinary hospitals in the cities of Nur-Sultan and Almaty, Republic of Kazakhstan, for the period of 2018–2020.

This retrospective study was conducted in two stages. In the first stage, an analysis of morbidity, prevalence, and mortality was conducted for the population of Nur-Sultan and Almaty cities, as well as for the overall population of Kazakhstan. This analysis was based on data from the "Electronic Register of Discharged Patients" (IS ERDB) and the annual collection "Health of the Population of the Republic of Kazakhstan and the Activities of Health Organizations in 2015–2020". In the second stage, we examined the care provided to patients with acute impaired cerebral circulation in a multidisciplinary hospital in these two cities. The analysis was based on data regarding the sex and age composition of treated patients in hospitals across the Republic of

☆ MeSH terms: Hospital Units*; Hospitalization*; Outcome Assessment, Health Care; Patient Care Team*; Prognosis; Stroke / mortality; Stroke / therapy*; Stroke Rehabilitation; Treatment Outcome.

* Corresponding author. Asfendiyarov Kazakh National Medical University, Tole-bi str. 94, Almaty, 050020, Kazakhstan.
E-mail addresses: adenovag30@gmail.com (G. Adenova), kausovag50@gmail.com (G. Kausova), a.tazhieva@kaznmu.kz (A. Tazhiyeva).

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Kazakhstan, categorized according to the ICD-10 code "Acute Impaired Cerebral Circulation" (I60–I64). We investigated the methods of patients' delivery to medical organizations, types of hospitalization, and outcomes of treated patients. The sample of patients was selected using data from the "Electronic Register of Dispensary Patients" of the Ministry of Health of the Republic of Kazakhstan, along with the statistical collection "Health of the Population of the Republic of Kazakhstan and the Activities of Healthcare Organizations". Between January 1, 2018, and December 31, 2020, a total of 5965 patients were diagnosed with a cerebrovascular event and admitted to a general hospital in Nur-Sultan city, while 13,498 patients were diagnosed and admitted in Almaty city.

1. Introduction

According to the Global Burden of Disease (GBD), there are more than 12.2 million new strokes each year globally. Globally, one in four people over 25 will have a stroke during their lifetime. High risk is noted in many countries, such as Bulgaria, Latvia, Macedonia, Romania, and Russia. The population of East Asia also has an increased risk of stroke at 38.8%, compared to 31.7% in Central and Eastern Europe. Currently, there are more than 101 million people worldwide who have had a stroke [1].

Stroke is the leading cause of disability in the adult population and is a cerebrovascular disease that has severe consequences if not diagnosed and treated in time [2]. According to the World Health Organization (WHO), stroke ranks second in the frequency of disability and mortality worldwide. According to statistics, the prevalence of stroke averages 6.67 cases per 100 thousand people [3]. By 2030 there may be up to 12 million deaths from stroke, 70 million stroke survivors, and more than 200 million DALYs lost annually from stroke [4].

A study found geographic differences in lifetime stroke risk, with the highest risks in East Asia, Central Europe, and Eastern Europe [5].

A 2010 comparative analysis of age-standardized stroke prevalence, mortality, and disability-adjusted life years lost (DALYs) showed significant geographic differences in stroke incidence (six times), mortality (15 times), prevalence (four times), and DALYs (20 times) in Eastern Europe, East and South-East Asia, Central Africa, and Oceania. Among the top 15 countries in the global ranking of mortality from stroke (173.2 cases per 100,000 population), Kazakhstan occupies 176th place of all 187 countries. In the age-standardized indicator of incidence of stroke, Kazakhstan occupies 173rd place (342.3 cases per 100,000 population). According to loss of life years from stroke (DALY), it occupies 175th place (3085 cases per 100,000 population) [6]. The results of a study in Kazakhstan on morbidity and mortality of patients with stroke based on hospitalization and discharge status of predominant stroke subtypes from 2014 to 2019 showed that the annual morbidity rate did not increase during the observed period, and the all-cause mortality rate among stroke patients approximately doubled during the observed period [7].

The current study identifies several reasons for the underrepresentation of national stroke clinical registries in certain regions, which include a lack of monitoring of the quality of stroke care provided in hospitals, resource-intensive community-based stroke incidence studies within a geographic region, criteria for stroke registry review should be 'national' and flexible to cover regional registries within the country [8].

In 2009, the American Heart Association and the American Stroke Association believed that the care of patients with acute ischemic stroke at all stages of hospitalization should include current best practices relevant to the nursing and interprofessional care of ischemic stroke patients and their families [9].

Canadian best practice in stroke management states that pre-hospital care, emergency department, and inpatient acute stroke care should be a single integrated unit [10]. Improved outcomes at the end of planned follow-up, with no reduction in length of hospital stay (WMD -2.19, 95% CI -5.19 to −0.82), were found in patients regardless of patient gender and age, type, and severity of stroke in the stroke unit organized inpatient care compared with the general department in the alternative service [11].

Effective modes of care in stroke units need to be investigated in resource-limited healthcare settings as well as in higher-income countries. The inpatient stroke unit, first introduced in the 1960s, is now the standard model in most developed countries. However, since its introduction, there have been dramatic changes in stroke care services, especially in acute care [12].

Organizational factors influence treatment outcomes, including mortality, length of stay, and functional independence, where the timing of stroke care (24 h a day, 7 days a week, 24/7) plays an important role [13]. The cost of inpatient stroke care varies greatly depending on stroke type and diagnosis status. Linear regression analysis showed that the length of hospital stay was significantly correlated with cost (beta coefficient = 232, 95% CI = 220–243, $p < 0.001$) [14]. A comparative analysis of the outcomes of stroke patients in urban and rural hospitals in Australia found that patients admitted to rural hospitals were less likely to receive thrombolysis compared to urban hospitals (7.5% in rural hospitals vs. 12.7% in urban hospitals, $p < 0.001$), while it was also noted that fewer patients were discharged with a planned care appointment (61.3% in urban areas compared to 44.7% in rural areas, $p < 0.001$) [15]. Besides, in the current research, it has been established that the raised level of bed occupancy in the first hour of hospitalization of patients with a stroke is closely connected with a reduction in the chances of receiving reperfusion therapy [16].

A major component of inpatient stroke care is the prompt detection of stroke in hospitalized patients. Delays in recognizing stroke symptoms and initiating in-hospital stroke treatment can hurt patient outcomes. This quality improvement intervention used simulation along with a traditional lecture to instruct nurses at a university hospital about a new stroke protocol being implemented to improve the rate of stroke recognition and meet the quality criteria for inpatients at the National Hospital Joint Commission. This

quality improvement intervention provides a feasible model for developing new care protocols in the inpatient setting [17].

Results show that every 10% increase in competition (a 0.1-unit decrease in HHI value) is associated with an average 2.38% decrease in total inpatient stroke care costs. A study examining the relationship between competition and inpatient stroke care costs across subgroups found that hospitals facing more competition incurred lower costs for treatment, drugs, and supplies. Further analysis shows that for-profit, private, and small hospitals are more sensitive to changes in the level of market competition and results show that every 10% increase in competition is associated with an average 2.38% decrease in total inpatient stroke care costs [18].

There were no differences in the quality of care based on the day and time of admission during the week in terms of stroke nursing assessment, and in three-day mortality or disability at hospital discharge (all values $p > 0.05$) [19]. Stroke patients admitted to the hospital after hours, on weekends or holidays were less likely to be treated according to current guidelines and had worse outcomes than those hospitalized during normal business hours [20]. A positive impact on patient management and efficiency of care has been found by the introduction of the standardized application of time-dependent protocols and the introduction of multi-disciplinary/integrated care, which has improved all phases of acute ischemic stroke care [21].

2. Materials and methods

2.1. Study design and setting

This retrospective study included all patients who had a diagnosis of acute disorders of cerebral circulation (ADCC) aged 18 years or older, treated and followed up at multidisciplinary hospitals in Kazakhstan during the years 2018–2020.

2.2. Population and sample

Nur-Sultan is the capital of Kazakhstan with a population of 1.2 million people. There are four stroke centers in the city that provide care for adult patients in acute cases of stroke. The stroke centers were organized based on the multidisciplinary clinical hospitals of Nur-Sultan. The distribution of beds in the stroke centers in Nur-Sultan is based on the density of the population served and is as follows: The Central City Multiprofile Hospital No. 1 has 30 stroke beds, the Central City Multiprofile Hospital No. 2 has 30 beds, the Central Road Hospital has 30 beds, and the Multiprofile Medical Center has 30 stroke beds. The stroke centers form a database of patients' health status, the number of admissions, and discharges for all hospitalizations.

Almaty city is a former capital city of Kazakhstan with a population of 1.9 million. The stroke centers were organized based on multidisciplinary clinical hospitals such as Almaty City Hospital No. 7 with 115 beds, Almaty City Hospital No. 4 with 30 beds, Almaty Central City Hospital with 20 beds, and City Emergency Hospital with 30 beds. Patients with newly diagnosed acute disorders of cerebral circulation (ADCC) aged 18 years or older were included in the study. ADCC was coded as I60–I64 according to the 10th revision of the International Classification of Diseases. Patients under 18 years of age and those who are not residents of Nur-Sultan and Almaty were excluded from the analysis. During the period from January 01, 2018, to December 31, 2020, 5965 patients were admitted to a general hospital and diagnosed as suffering from a cerebrovascular event in Nur-Sultan city, and 13498 patients in Almaty city.

a. Data collection

A retrospective study was conducted using data on the primary population registration of acute cerebral circulation disorders in the cities of Nur-Sultan and Almaty, Republic of Kazakhstan, during the period from January 1, 2018, to December 31, 2020. The data were obtained from the information system "Electronic Register of Dispensary Patients" (IS ERDB). Age indicators and territorial characteristics of registered cases were determined. The information system is designed to form an information database of patients on the dispensary registration and view the registration of patients on the dispensary in medical organizations, as well as the formation of the register of patients on the dispensary, processing, and provision of statistical and analytical data. The type of automated activity is the formation of the register of the dispensary population groups. Data on the population of Kazakhstan is taken from the statistical collection "Health of the population of the Republic of Kazakhstan and the activities of healthcare organizations," Committee on Statistics: Astana, Kazakhstan, 2018–2020. During the period from January 1, 2018, to December 31, 2020, 5965 patients admitted to a general hospital were diagnosed as suffering from a cerebrovascular event in Nur-Sultan city, and 13,498 patients in Almaty city.

b. Statistical analysis

Statistical analysis of the results was carried out using SPSS ver. 25.0 (IBM, Armonk, NY, USA). A p-value <0.05 was considered statistically significant. We also received information from the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan. In this study, acute disorders of cerebral circulation were described as a percentage along with their 95% confidence interval (CI). Pearson's chi-squared test was used to compare gender distributions and attrition between delivery and hospitalization. A significant difference between treatments ($p \leq 0.05$) was observed. The statistical significance of differences in mean values between the morbidity rates in the population of Nur-Sultan city and Almaty city was assessed using Student's t-test ($p \leq 0.05$).

3. Results

Incidence of cerebrovascular diseases in the Republic of Kazakhstan for the years 2015–2020 and the forecast for 2025 are shown in Figs. 1 and 2. The incidence of cerebrovascular diseases in the population of the Republic of Kazakhstan aged 18 years and older increased from 258.4 cases (95% CI 256.0–260.8) per 100,000 people in 2015 to 433.7 cases (95% CI) in 2020. According to the calculated 5-year forecast, the growth of incidence is expected to reach 591.0 cases (95% CI 573.0–609.0) per 100,000 people in 2025.

In 2020, the greatest number of cases of cerebrovascular disease was registered in the East Kazakhstan region - 624.6 cases (95% CI 611.4–637.8), Kostanai region - 493.9 cases (95% CI 479.2–508.6), and Karaganda region - 490.0 cases (95% CI 478.3–501.7) per 100,000 people, respectively. The regions of Kazakhstan with the lowest number of cases were identified, which include: Mangistau oblast - 299.9 cases (95% CI 287.1–312.7), Almaty oblast - 279.0 cases (95% CI 271.8–286.2), and Atyrau oblast - 220.8 cases (95% CI 209.3–232.3) per 100,000 population, respectively.

In Nur-Sultan city, the incidence of cerebrovascular disease from 2015 to 2020 tended to increase from 307.1 cases (95% CI 295.2–319.0) to 469.8 cases (95% CI 457.2–482.4). In the city of Almaty, the incidence also increased from 236.6 cases (95% CI 229.1–244.1) in 2015 to 460.0 cases (95% CI 450.4–469.6) in 2020 per 100,000 population, respectively.

The incidence of cerebrovascular diseases, including acute disorders of cerebral circulation for 2015–2020 is shown in Fig. 3. The incidence of cerebrovascular disease, including acute cerebrovascular events (ACEs), increased from 11.7% (n = 1881, 95% CI 10.2–13.1) in 2015 to 22.6% (n = 3636, 95% CI 21.2–24.0) in 2020 (2-fold) for 2015–2020. In addition, the following increased: hemorrhagic stroke from 2.1% (n = 23, 95% CI -3.8-8.0) in 2015 to 49.4% (n = 538, 95% CI 45.1–53.6) in 2020, cerebral infarction, cerebral artery blockage from 2.5% (n = 74, 95% CI -1.1-6.0) in 2015 to 42.7% (n = 1279, 95% CI 40.0–45.4), unspecified stroke from 10.4% (n = 25, 95% CI -1.6-22.3) in 2015 to 22.8% (n = 55, 95% CI 11.7–33.9) in 2020.

Inpatient mortality from stroke in 2020, by regions of the Republic of Kazakhstan, is shown in Fig. 4. The highest rates are registered in Aktobe region, with 24.2 cases. The increase in mortality is due to the high daily mortality of comorbid patients admitted in an extremely serious condition (neglected patients with hypertension and diabetes without adherence to therapy). This is an indicator of primary health care (PHC) and healthy lifestyle work with the population on prevention, screening, adherence to therapy by health management program (HMP), and training in timely recognition of life-threatening symptoms. There are 22.3 cases in the Kostanay region. The southern region, with a population of about 70 thousand people and a distance of more than 460 km, does not receive qualified care for stroke. The question of the necessity of opening the Stroke centers on 10 beds in the city of Arkalyk was raised before Kostanay region authorities repeatedly. The poor work at the level of primary care therapists and general practitioners (GPs) on clinical examination of patients, primary and secondary prevention of stroke, is the cause of high mortality at home. It is known that 100% of all people who have had a stroke, after discharge from the hospital, are subject to dispensary registration. However, this index in the region is only 51.6%, which indicates a misunderstanding and lack of control of the management of outpatient-polyclinic organizations over this index. In the North Kazakhstan region, there are 21.6 cases. The increase in mortality is due to the high daily mortality of comorbid patients admitted in an extremely serious condition (neglected patients with hypertension and diabetes without adherence to therapy). This is an indicator of primary health care (PHC) and healthy lifestyle (HLS) work with the population on prevention, screening, adherence to therapy by health management program, and training in timely recognition of life-threatening symptoms.

There is an acute shortage of neurologists, a poor material and technical base of equipment. Computer tomographs work with regular breakdowns, the location of which does not correspond to the algorithm of stroke patient movement. Due to this, there is a low percentage of thrombolysis and neurosurgical operations. Inpatient mortality from stroke in the East Kazakhstan region was 19.2 cases.

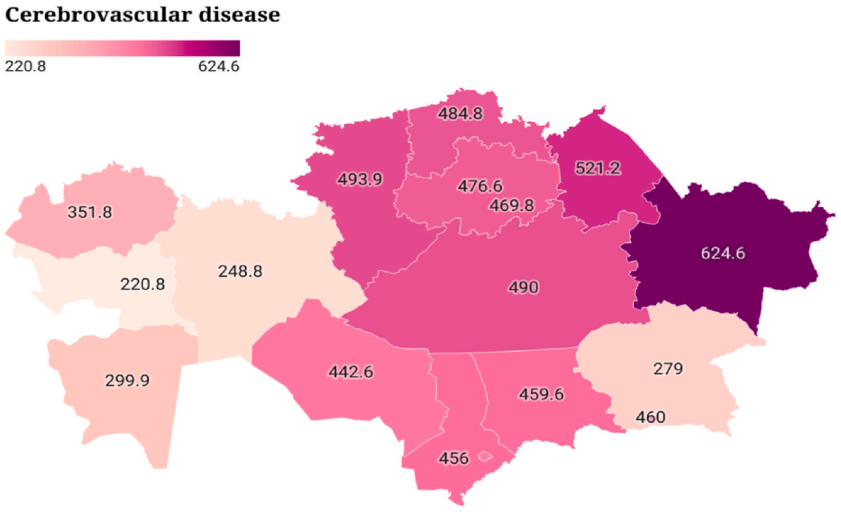

Fig. 1. The incidence of cerebrovascular diseases in adults (18 years and older) in Kazakhstan in 2020 (per 100,000 population).

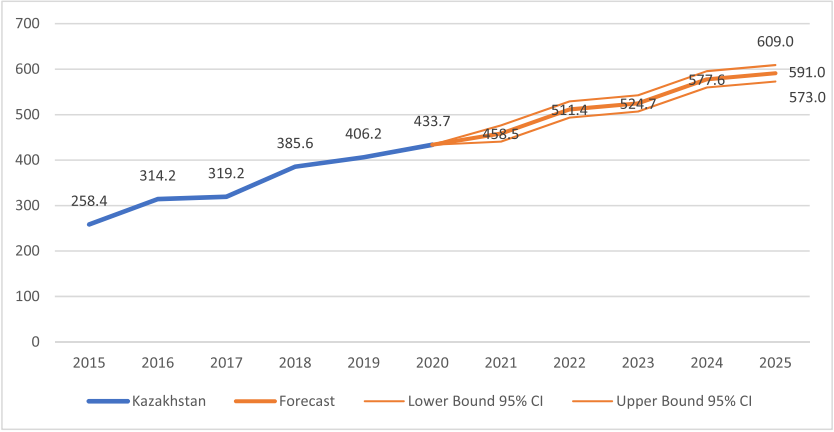

Fig. 2. Cerebrovascular disease morbidity in the Republic of Kazakhstan and the forecast for 2025 year.

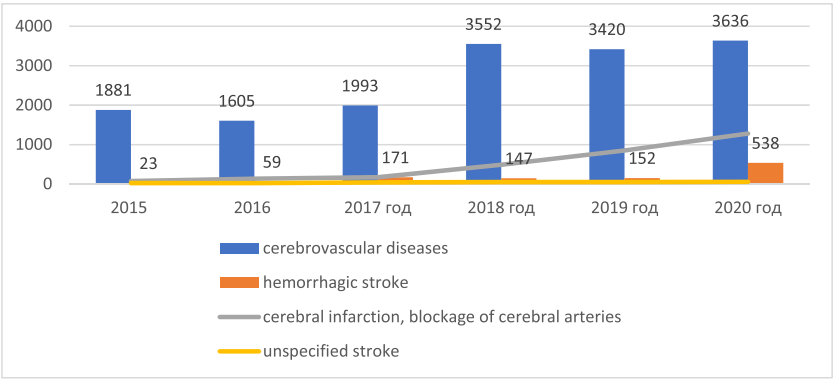

Fig. 3. Incidence of cerebrovascular diseases, including acute disorders of cerebral circulation, from 2015 to 2020.

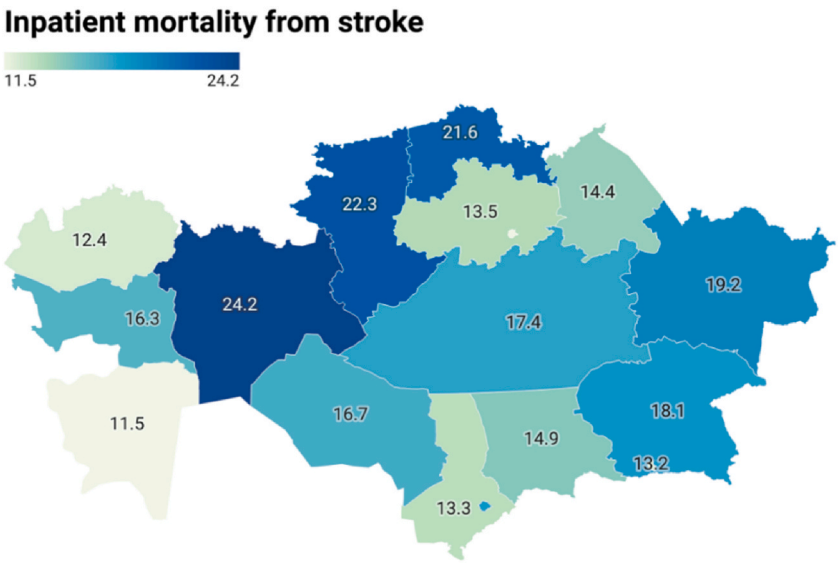

Fig. 4. Inpatient mortality from stroke in 2020 in the Republic of Kazakhstan.

A high morbidity of diseases of the circulatory system (infarction + stroke) is noted in the region, which testifies to the insufficient realization of measures of primary prevention on the PHC level. This is confirmed by the absence of preventive work with the attached population on the theme "Schools of stroke" in half of the outpatient-polyclinic organizations in the region. The level of dispensary examination of stroke patients is only 58.6%, while at the outpatient level, 100% of all persons who have had a stroke after discharge from the hospital within 3 working days are subject to dispensary examination. This proves the lack of understanding and control of medical organizations' management over this indicator. The inpatient mortality rate from stroke in the Almaty region was 18.1 cases. Seven stroke centers are functioning in the region, but the northern part of the region is deprived of the III level of medical aid due to the absence of an angiograph on the basis of level II stroke center in Taldykorgan regional hospital. The lowest level of thrombolysis and neurosurgical operations in the Republic of Kazakhstan is observed. There are no "stroke schools" in the outpatient clinics of the region. In the city of Almaty, the inpatient mortality from stroke was 13.2 cases, which also belongs to the disadvantaged regions of Kazakhstan. The city of Nur-Sultan belongs to relatively safe regions in terms of inpatient mortality with 11.5 cases. The average indicator for the Republic of Kazakhstan was 16.2 cases.

3.1. Patient characteristics

In the period from 2018 to 2020, 5965 cases acute disorders of cerebral circulation were initially detected in Nur-Sultan city. In the population, acute cerebral circulation disorders were detected in 58.0% (n = 1010) of men and in 42.0% (n = 731) of women. It was found that the age group 56–65 years - 30.0% (n = 522), 66–75 years - 24.9% (n = 434) and 46–55 years - 19.9% (346) recorded the highest number of cases of acute cerebral circulation disorders. The results obtained for the morbidity of the population are presented in Table 1.

According to the official data 78.3% (n = 1363) of patients with acute stroke were delivered by ambulance, 13.6% (n = 237) of patients applied independently for medical help to the hospital. 4.8% (n = 83) were delivered to primary care. Among the patients, 95.1% (n = 1655) were hospitalized as an emergency and 4.9% (n = 86) as planned. The outcome of patients with improvement was 86.4% (n = 1504), with recovery was 0.2% (n = 3), and no change in health status was 1.9% (n = 33). A mortality rate of 11.5% (n = 201) of patients with acute cerebral circulation disorder was established. There was no difference between sex and hospitalization of patients ($\chi2 = 30{,}000a$, df = 6, $p > 0.05$) and how the patients were delivered ($\chi2 = 90{,}000a$, df = 15, $p > 0.05$).

In the period from 2018 to 2020 the number of all treated patients with acute stroke decreased from 2166 to 1742 in Nur-Sultan city. In 2020 the frequency of hospitalized patients was 150.0 per 100 thousand population Inpatient mortality of patients with acute impaired cerebral circulation amounted to 201. In the city of Almaty only 4197 patients were treated in 2020. Frequency of hospitalization was 2016.0 on 100 thousand population. Inpatient mortality increased from 462 in 2018 to 568 in 2020 (Table 3).

From 2018 to 2020 in the city of Nur-Sultan, the number of all treated patients with acute stroke decreased from 2166 to 1742. In 2020 the rate of hospitalized patients was 150.0 per 100 thousand population. Inpatient mortality of patients with acute impairment of cerebral circulation was 201. In the city of Almaty in 2020 only 4197 patients were treated. The frequency of hospitalization was 2016,0 per 100 thousand population.

Table 1
Demographic characteristics of confirmed cases acute disorders of cerebral circulation (ADCC) (I60–I64) in Nur-Sultan city (*p < 0,05).

Feature		2018	2019	2020	SD	P
Gender	Male	1132 (58.3)	1303 (57.1)	1010 (58.0)	85.0	p > 0,05
	Female	809 (41.7)	980 (42.9)	731 (42.0)	73.5	p > 0,05
Age	0–17	41 (2.1)	38 (1.7)	13 (0.7)	8.9	p > 0,05
	18–24	6 (0.3)	10 (0.4)	7 (0.4)	1.20	p > 0,05
	25–35	47 (2.4)	46 (2.0)	53 (3.0)	2.19	p > 0,05
	36–45	130 (6.7)	140 (6.1)	108 (6.2)	9.45	p > 0,05
	46–55	415 (21.4)	444 (19.4)	346 (19.9)	29.07	p > 0,05
	56–65	635 (32.7)	780 (34.2)	522 (30.0)	74.67	p > 0,05
	66–75	422 (21.7)	521 (22.8)	434 (24.9)	31.19	p > 0,05
	76 and older	245 (12.6)	304 (13.3)	258 (14.8)	17.9	p > 0,05
Delivered	Primary Health Care	574 (29.6)	524 (23.0)	83 (4.8)	156.0	p < 0,001
	Advisory diagnostic help	7 (0.4)	4 (0.2)	5 (0.3)	0.88	p > 0,05
	Self-reversal	153 (7.9)	247 (10.8)	237 (13.6)	29.81	p < 0,01
	Emergency	1128 (58.1)	1433 (62.8)	1363 (78.3)	92.24	p < 0,01
	Other	79 (4.1)	75 (3.3)	53 (3.0)	8.08	p > 0,05
Type of hospitalization	Planned	571 (29.4)	538 (23.6)	86 (4.9)	156.5	p < 0,001
	Extra	1370 (70.6)	1745 (76.4)	1655 (95.1)	113.0	p < 0,001
Outcome	Recovery	2 (0.1)	3 (0.1)	3 (0.2)	0.33	p > 0,05
	Improvement	1771 (91.2)	2093 (91.7)	1504 (86.4)	170.28	p > 0,05
	No change	8 (0.4)	4 (0.2)	33 (1.9)	9.07	p > 0,05
	Deterioration	3 (0.2)	2 (0.1)	–	0.5	p > 0,05
	Death	157 (8.1)	181 (7.9)	201 (11.5)	12.72	p > 0,05

A total of 4197 patients with acute circulatory disorders in 2020 in the city of Almaty were identified. Among the age group of patients the greatest number of cases was established at the age of 56–65 years 28.6% (n = 1202), at the age of 66–75 years 28.3% (n = 1187) and at the age of 76 years and older 21.7% (n = 912). Most patients with acute cerebral circulation disorder were delivered by ambulance, 87.7% (n = 3674), and 8.5% (n = 356) self-referred. The results are presented in Table 2.

Table 2
Demographic characteristics of confirmed cases acute disorders of cerebral circulation (ADCC) (I60–I64) in Almaty (*p < 0,05).

Feature		2018	2019	2020	SD	P
Gender	Male	2285 (50.5)	2476 (51.8)	2174 (51.8)	88.2	p > 0,05
	Female	2240 (49.5)	2300 (48.2)	2023 (48.2)	84.1	p > 0,05
Age groups	0–17	25 (0.6)	16 (0.3)	29 (0.7)	3.84	p > 0,05
	18–24	18 (0.4)	17 (0.4)	12 (0.3)	1.86	p > 0,05
	25–35	51 (1.1)	92 (1.9)	42 (1.0)	15.4	p > 0,05
	36–45	219 (4.8)	230 (4.8)	214 (5.1)	4.73	p > 0,05
	46–55	611 (13.5)	713 (14.9)	599 (14.3)	36.2	p > 0,05
	56–65	1292 (28.6)	1358 (28.4)	1202 (28.6)	45.2	p > 0,05
	66–75	1150 (25.4)	1269 (26.6)	1187 (28.3)	35.2	p < 0,01
	76 and older	1159 (25.6)	1081 (22.6)	912 (21.7)	72.9	p < 0,001
Delivered	Primary Health Care	64 (1.4)	32 (0.7)	48 (1.1)	9.24	p > 0,05
	Advisory diagnostic help	9 (0.2)	20 (0.4)	37 (0.9)	8.14	p < 0,001
	Self-reversal	429 (9.5)	369 (7.7)	356 (8.5)	22.5	p > 0,05
	Emergency	3831 (84.7)	4099 (85.8)	3674 (87.7)	124.1	p < 0,001
	Other	192 (4.2)	256 (5.4)	75 (1.8)	53.0	p < 0,001
Type of hospitalization	Planned	214 (4.7)	216 (4.5)	110 (2.6)	35.0	p < 0,001
	Extra	4311 (95.3)	4560 (95.5)	4087 (97.4)	136.6	p < 0,001
Outcome	Recovery	4 (0.1)	4 (0.1)	5 (0.1)	0.33	p > 0,05
	Improvement	3925 (86.7)	4051 (84.8)	3463 (82.5)	178.7	p < 0,001
	No change	134 (3.0)	186 (3.9)	157 (3.7)	15.0	p < 0,05
	Deterioration	–	3 (0.1)	4 (0.1)	0.5	
	Death	462 (10.2)	532 (11.1)	568 (13.5)	31.1	p < 0,001

Table 3
Clinical Factors acute disorders of cerebral circulation and Mortality Follow-Up by Hospital Disposition among the regions of Kazakhstan.

Region	Years	Total treated	Frequency of hospitalization (per 100,000 people)	Death (inpatient mortality)
Nur-Sultan	2018	2166	120.5	180
	2019	2287	207.0	183
	2020	1742	150.0	201
Almaty	2018	4525	244.4	462
	2019	4776	254.0	532
	2020	4197	216.0	568

Inpatient mortality increased from 462 in 2018 to 568 in 2020, due to low follow-up of patients with stroke after discharge from hospitals, lack of neurology specialists in primary health care organizations. The reasons of high mortality at stroke in Nur-Sultan and Almaty cities is insufficient work of primary health care (PHC), because stroke is a complication of such diseases as arterial hypertension, atherosclerosis, heart diseases, diabetes mellitus, etc. In many cases, patients were not regularly monitored and treated, especially where there were no specialist physicians.

4. Discussion

“This retrospective study firstly demonstrates the epidemiological situation on the incidence of cerebrovascular diseases, including hemorrhagic stroke, brain infarction, and unspecified stroke, in the Republic of Kazakhstan over the past five years (2015–2020) and presents an analysis of inpatient mortality from stroke in the regions of the country. Secondly, the study, based on knowledge of the situation in the regions according to the information system ‘Electronic Register of Dispensary Patients’ (ERDB), presents the current state of organization and provision of medical care for patients with cerebrovascular disease in Nur-Sultan City (the capital of Kazakhstan) and Almaty city for 2018–2020.

Our results show that the incidence of cerebrovascular disease in the Republic of Kazakhstan has increased by 1.6 times and is expected to further increase by 1.3 times by 2025. In the cities of Nur-Sultan and Almaty, morbidity and cerebrovascular diseases are significantly higher in men. The high morbidity is established at the age of 56–65 years in the population of Nur-Sultan (30.0%) and Almaty (28.6%). Previous research has confirmed our conclusions [22–24]; it has been established that the morbidity of stroke for the last five years is the highest in Pavlodar, Karaganda, Kostanay, and East Kazakhstan regions.

The advantage of our study is that our results add to the gap in knowledge about the morbidity and mortality of the population with cerebrovascular diseases in the regions of Kazakhstan. The study also provides socio-demographic characteristics of patients, methods of delivery to medical organizations, types of hospitalization, and treatment results, showing the outcomes of patients admitted with cerebrovascular diseases to the multidisciplinary hospitals in Nur-Sultan and Almaty. This study also emphasizes the importance of studying medical care in multidisciplinary hospitals and highlights the problem of interaction between hospitals and primary care. The proper organization of medical care management for patients with acute cerebral circulation disorders is of paramount importance. The current situation shows that there are some shortcomings in patient care in the regions of Kazakhstan. The strengthening of the role of inter-sectoral interaction between medical organizations and other branches of the economy and non-governmental

organizations will help work out measures for decreasing the incidence of strokes and preventing economic losses. Cultural and subcultural differences, ethnicity, beliefs, geographical differences, and lifetime risk of stroke should be taken into account [25,26].

In Kazakhstan, in 2015, the Roadmap for the implementation of an integrated model of acute stroke treatment was approved. For the efficiency of implementation and monitoring of the Roadmap measures, the republican indicators of stroke service in the Republic of Kazakhstan were developed and approved. One of the important indicators of stroke service in the RK is the availability of stroke centers in regions, which is expressed in the performance indicator "Percentage of medical organizations providing stroke care of II and III levels", calculated by the Order of the Ministry of Health and Social Development of the Republic of Kazakhstan №̲ 809 of 19.10.2015 "On the approval of a standard of the organization of neurological care in the Republic of Kazakhstan". For the implementation of secondary prevention measures concerning the implementation of stroke surveillance, the creation of registries involving different health sectors in high- and low-income countries will allow them to make the most effective decisions [27].

Limitations of the study are that we could not calculate standardized indicators for the cities of Nur-Sultan and Almaty due to a lack of data on morbidity for each age group (0–17, 18–24, etc.). We could not use the numbers as a WHO standard (0–4, 5–9, 10–14, 15–19) [28] due to different age grouping. The request to the Republican Center for E-Health was not fulfilled because it takes a long time to receive the data, about 1–2 months.

Primary stroke prevention is aimed at the interaction of medical specialists, medical organizations with patients, and also includes the participation of politicians and financial organizations responsible for providing affordable medical care to the population. The study notes that the implementation of primary stroke prevention requires government involvement and necessary strategies among the population, including task reallocation and segregation, as well as the reorganization of the healthcare system [29,30].

It is important to have guidelines on the diagnosis, treatment, and prevention of ischemic cerebrovascular diseases, which provide multidisciplinary management of patients in hospitals [31]. Reducing the informal use of inpatient care may improve the efficiency of healthcare resource allocation and prevent further increases in inpatient care costs in the future [32]. While several studies have tracked care pathways for patients in the early stages of stroke recovery, there are no studies on the transition from inpatient to outpatient rehabilitation [33]. Stroke therapy has a different meaning in different hospitals; measuring therapy time is problematic because of different interpretations of 'what matters' and differences in reporting methods [34]. A large-scale study found that the average inflation-adjusted hospitalization cost was $82,514 (standard deviation ± $54,983). Compared with patients younger than 40 years of age, the increase in cost for patients aged 40–59 years was $3829 (±$914; $p < 0.001$) and $4573 (±$1033; $p < 0.001$) for patients aged 60–79 years. However, for patients ≥80 years of age, the cost decreased by $8812 (±$1722; $p < 0.001$) [35].

A current study showed that in-hospital mortality was higher in patients with intracerebral hemorrhage (ICH) hospitalized on weekends, but this association has been lost since the beginning of the use of comprehensive stroke centers [36].

Pre-stroke disability, rather than stroke severity, is the strongest predictor of discharge assignment. However, when combined with other routinely collected data, both can be used by the multidisciplinary team as a supplement to predict discharge assignment in patients with acute stroke [37]. Current studies have identified an association between hospital factors, transient ischemic attack (TIA) process scores, and 90-day ischemic stroke incidence, with hospitals admitting a higher percentage of TIA patients and having a higher staff of emergency physicians, resulting in higher rates on selected guideline-agreed TIA process parameters. Higher emergency physician staffing has been associated with improved outcomes 90 days after TIA [38].

Evidence suggests that survivors of intracerebral hemorrhage have earlier recovery than survivors of ischemic stroke, potentially affecting access to intensive post-resuscitation rehabilitation as a result of changes in healthcare policy [25]. A study of in-hospital mortality in patients with intracerebral hemorrhage (ICH) in rural hospitals and urban hospitals in the United States found significant differences in mortality, with rural hospitals being twice as likely as urban hospitals to experience patient deaths [39].

Currently, there is no evidence-based geriatric rehabilitation program for elderly stroke patients that combines inpatient rehabilitation with adequate postoperative care aimed at reducing the impact of persistent problems after discharge from the geriatric rehabilitation unit [40]. A better description of stroke rehabilitation protocols is needed to better understand current practice, improve internal validity, and generalize the results of clinical trials. The purpose of this study is to describe an intensive rehabilitation program for stroke patients in an inpatient rehabilitation facility, measuring the amount and type of therapy provided (physical, occupational, and speech therapy), and reporting functional outcomes [41].

The study analyzed the relationship between hospital competition and inpatient stroke costs and found that the development of a provincial network to promote ongoing collaboration and structured information sharing, the creation of a stroke coordinator and the role of the stroke physician, and the implementation of a registry to collect information on adults hospitalized for stroke or transient ischemic attack have improved the quality of care [42].

Rehabilitation is an important measure in improving the health status of patients, and in this regard, the WHO pays special attention and has developed the program "Rehabilitation 2030″ to assess the effectiveness of measures for the recovery of patients after a stroke. Given the fact that there are not enough rehabilitation centers for stroke care in the country, it is necessary to develop strategic measures with a focus on preventive measures, lifestyle, and the income of the population. Develop community-based programs aimed at reducing stroke risk in lifestyle and effectively improving stroke outcomes. A study of the relationship between stroke coordinators and evidence-based care and patient outcomes in hospitals with acute stroke units found that stroke inpatients with a stroke coordinator were more likely to receive clinical practice, including rehabilitative therapy, within 48 h. No differences in complications, discharge independence, or mortality were observed [43,44].

It is also necessary to emphasize the importance of providing physicians, including neurologists and cardiologists [45,46], as well as diagnostic imaging modalities such as CT scans and MRIs, in stroke centers and stroke units in hospitals. This will allow for the detection of asymptomatic strokes and signs of acute infarction without neurological manifestations during conventional bedside examinations [47,48]. In Kazakhstan, the issue of the availability of physicians and necessary equipment requires a separate detailed

study by regions of the country. All patients should be admitted directly to the stroke emergency department for close monitoring of early neurological deterioration and the prevention of secondary complications [49]. An organized approach to emergency care, including the implementation of stroke care pathways and collaboration with specialized stroke teams in the emergency department, improves the ability to effectively identify and treat stroke patients. This approach has the potential to improve outcomes on a large scale [50].

5. Conclusion

Due to the growing incidence of cerebrovascular disease in the regions and Kazakhstan as a whole, as well as the increasing inpatient mortality after admission of patients to multidisciplinary hospitals, it is necessary to improve primary health care (PHC). This improvement should involve the development of guidelines or an algorithm for strengthening the integration and coordination of emergency care and primary healthcare, as well as the adequate allocation of healthcare resources.

Author contribution statement

Gulzhan Adenova: Conceived and designed the experiments; Performed the experiments; Wrote the paper.
Galina Kausova: Analyzed and interpreted the data: Contributed reagents, materials, analysis tools or data.
Aigul Tazhiyeva: Analyzed and interpreted the data; Wrote the paper.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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