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Retrospective analysis of stroke code activation in the emergency department of a large tertiary care center in Saudi Arabia

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Abstract

Background: Stroke, a major cerebrovascular disorder with a high mortality that can lead to permanent disability, is the third leading cause of death in Saudi Arabia. Quick recognition of stroke symptoms and initiation of time-sensitive treatment can significantly change the course of stroke, and stroke code activation in the emergency department (ED) can expedite patient management. This study aimed to analyze the stroke code activation protocol against the set hospital standards in the ED of a tertiary care center in Saudi Arabia.

Methods: The data of patients aged ≥14 years who were admitted to the ED between January 2021 and January 2022, for whom the stroke code was activated in the ED, were retrospectively analyzed, and the time intervals from ED triage to stroke code activation, neurologist review, computed tomography (CT) imaging/reporting, and thrombolysis were determined.

Results: The study included 409 patients with a mean age of 60.12 ± 18.1 years and a mean weight of 73.4 ± 17 kg. Additionally, 61% of the patients were male, 26% of the patients were transported to the ED by ambulance, 63% of the patients were diagnosed with stroke based on CT imaging, and 43% of the patients were managed by mechanical thrombectomy. Furthermore, 91.12% of the patients with stroke had neurologic symptoms whereas 8.89% of the patients with stroke had atypical presentations. The mean time from ED triage to stroke code activation was 44.7 ± 49.6 min, the mean time from code activation to neurologist review was 12.1 ± 28.1 min, and the mean time from code activation to CT imaging was 51.9 ± 38.2 min, respectively.

Conclusions: Implementing the stroke code protocol in the ED can accelerate the diagnosis and treatment of patients with stroke. Delays in various stages in managing patients with stroke can be resolved with training and robust teamwork. Utilizing ambulance services to transport patients with stroke to appropriate centers can play a key role in expediting care.

Background

Stroke, a leading global cause of death and disability, is a major public health concern in Saudi Arabia. The World Health Organization estimates that 15 million people suffer stroke annually and further predict that one-third of the patients with stroke die and that another one-third become permanently disabled. Stroke is a major contributor to severe, long-term neurologic impairment and functional disability [1-4]. Stroke is broadly classified into ischemic and hemorrhagic stroke, which comprise 85% and 15% of the cases, respectively. Risk factors associated with stroke include arterial hypertension, cigarette smoking, diabetes mellitus, hyperlipidemia, older age, human immunodeficiency virus infection, sickle cell disease, and cerebral malaria [1].

Stroke is a time-sensitive clinical presentation; thus, its management requires rapid and accurate diagnosis with prompt treatment. In emergency department (ED) settings, stroke code protocols have been developed to expedite the diagnosis and treatment of patients with stroke. These protocols involve a coordinated effort by various healthcare professionals, including emergency physicians, neurologists, radiologists, and nurses [1].

In many hospitals across Saudi Arabia, stroke code protocols have been implemented to improve the quality of care. These protocols have been shown to reduce the time to diagnosis and treatment, which can improve patient outcomes. However, the implementation of stroke code protocols in Saudi Arabia continues facing challenges, including the lack of trained personnel and the limited availability of stroke and rehabilitation centers [1,4]. At King Faisal Specialist Hospital and Research Center in Riyadh, the key components of the stroke code protocol include the rapid identification of stroke symptoms, timely notification of the stroke team, rapid diagnostic workup, and prompt initiation of appropriate treatment. The stroke team includes emergency

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physicians, neurologists, radiologists, and nurses, all of who are trained in the management of patients with stroke [4].

The present study aimed to analyze the time spent to complete each component of the stroke code protocol in patients with stroke admitted to the ED of King Faisal Specialist Hospital and Research Center.

Methods

Study design, setting, and population

This was a retrospective study including all patients aged ≥14 years for whom the stroke code was activated in the ED of King Faisal Specialist Hospital and Research Center between January 2021 and January 2022. Patients transferred from another hospital and those with stroke symptoms lasting more than 24 h were excluded.

Data collection

The patient data were collected from the hospital's medical records and included data on demographics, mode of transportation, time of presentation at the ED, vital signs, time of stroke code activation, time of neurologist review, time of CT imaging, the National Institutes of Health Stroke Scale (NIHSS) score, hospital length of stay, and mortality.

Statistical analysis

Data were analyzed using SPSS (version 26.0; IBM, Armonk, NY, USA). Categorical variables were presented as numbers with percentages, normally distributed continuous variables were presented as means with standard deviation, and no normally distributed continuous variables were presented as medians with interquartile range (IQR).

Table 1. Basic characteristics of patients for whom the stroke code was activated

Basic characteristics of patients for whom the stroke code was activated			
Age (Year)	Mean (±SD)	60.1 (±18.1)	
	Median (IQR)	63 (23)	
Weight (Kg)	Mean (±SD)	73.4 (±17)	
Length of stay (Day)	Mean (±SD)	16.1 (±175.4)	
	Median (IQR)	5 (2)	
Parameters	**Category**	**Total Count (n=409)**	**Percentage**
Gender	Male	251	61.4
	Female	158	38.6
Transport	Family or relative	115	28.1
	Ambulance	106	25.9
	Wheelchair	105	25.7
	Walking	61	14.9
	Other	22	5.4
Positive for stroke	**Yes**	**259**	**63.3**
Number of positive for stroke in patients with:	Neurological symptoms	236	91.1
	Non-neurological symptoms	23	8.8
Type of management (n= 79)	Mechanical thrombectomy	34	43
	Tissue plasminogen activator	10	12.7
	Both	6	7.6
	Other	29	36.7
Vital signs of the patients:			
Temperature (C°)	Mean (±SD)	36.7 (±1.8)	
	Median (IQR)	36.8 (0.4)	
Heart rate (beats per minute)	Mean (±SD)	87.35 (±21.1)	
	Median (IQR)	84 (25)	
Systolic blood pressure (mm Hg)	Mean (±SD)	133.5 (±27.1)	
Diastolic blood pressure (mm Hg)	Mean (±SD)	75.8 (±14.6)	
	Median (IQR)	76 (17)	
Respiratory rate (breaths per minute)	Mean (±SD)	20.3 (±3.5)	
	Median (IQR)	20 (3)	

Table 2. Time taken in all processes of the stroke code (n=166)

Time taken in all processes of the stroke code (n=166)		
Time from triage to code activation (minute)	Mean (±SD) Median (IQR)	44.7 (±49.6) 30.00 (32)
Time from activation to examination by neurology (minute)	Mean (±SD) Median (IQR)	12.1 (±28.1) 0 (14)
Time from code activation to CT imaging (minute)	Mean (±SD) Median (IQR)	51.9 (±38.2) 40 (47)

The chi-square test was used to determine the association between the demographic variables and study outcomes (mortality rate among stroke patients) terms of meeting our hospital standards for stroke code protocol activation as primary outcome, and EMS utilization among suspected stroke patients and to determine the distribution of categorical variables within groups. The Chi-square test was used when at least 80% of the expected counts are 5 or more. If the counts are below 5, especially in small samples or rare cases, Fisher's exact test should be used instead. A p value of <0.05 were considered to indicate statistical significance. The normality of distribution was evaluated for all continuous variables used Shapiro–Wilk test. Two-group comparisons for no normally distributed continuous variables were performed using the Mann–Whitney test., and two-group comparisons for normally distributed continuous variables were performed using the independent-samples t test.

Results

The study cohort included 409 patients who met the inclusion criteria, including 259 patients (63%) with confirmed stroke based on computed tomography (CT) results. Additionally, 91.2% of the patients with confirmed stroke presented with neurologic symptoms whereas the remaining 8.8% had atypical symptoms.

The mean time from ED triage to stroke code activation was 44.7 ± 49.6 min, the mean times from code activation to neurologist review was 12.1 ± 28.1 min, and the mean time from code activation to CT imaging was 51.9 ± 38.2 min, respectively.

The mean age was 60.1 ± 18.1 years, the mean weight was 73.4 ± 17 kg, and the median length of hospital stay was 5 (2) days. Additionally, 61% of the patients were males and 26% of the patients were transported by ambulance.

The mean temperature was 36.7°C ± 1.8°C, the mean heart rate was 87.4 ± 21.1 beats/min, the mean systolic and blood pressures were 133.5 ± 27.1 and 75.8 ± 14.6 mm Hg, respectively, and the mean respiratory rate was 20.3 ± 3.5 breaths/min (Table 1).

Table 2 showed the timeline of stroke code activation pathway started from triage to activation time which was 44.7 (±49.6) minutes, from activation to examination by neurology 12.1 (±28.1) minutes and from activation to performing CT imagine was 51.9 (±38.2) minutes. The mean NIHSS scores before and after treatment and at discharge were 8.4 ± 7, 6.2 ± 5.6, and 4.8 ± 4, respectively (Table 3). In total, 68.2% of the patients with stroke were discharged with approval, and 9.6% died. (Table 4)

The analysis of the association between demographic factors and mortality rate in patients with stroke revealed that sex, age, weight, and stroke diagnosis were significantly associated with mortality (Table 6). Briefly, the mortality rate was higher in male patients than in female

Table 3. Total Scores of National Institutes of Health Stroke Scale (NIHSS)

Total Scores of National Institutes of Health Stroke Scale (NIHSS)		
Pre-Treatment NIHSS score	Mean (±SD) Median (IQR)	8.4 (±7) 6 (12)
Post Treatment NIHSS score	Mean (±SD) Median (IQR)	6.16 (±5.6) 5 (18)
NIHSS score upon Discharge	Mean (±SD)	4.8 (±4)

Table 4. Outcome of the stroke among patients.

Outcome of the stroke among patients.			
Parameters	**Category**	**Total Count (n=409)**	**Percentage**
Discharge disposition (n=409)	Discharged with approval	279	68.2
	Discharged against advice	15	3.7
	Discharged for other reason	76	18.6
	Deceased	39	9.6
Mortality (n=409)	Yes	39	9.6
	No	370	90.4

Table 5. Effect of demographic factors on mortality rate among stroke patients

Effect of demographic factors on mortality rate among stroke patients						
Factors		**Mortality**				**P-value**
	Categories	Yes		No		
		Count	%	Count	%	
Gender	Male	31	12	221	88	0.038*
	Female	9	5.7	148	94.3	
Transport	Ambulance	14	13.2	92	86.8	0.138
	Private transportation	26	8.5	277	91.7	
Positive for stroke	Yes	7	4.3	156	95.7	0.015*
	No	14	12.1	102	87.8	
Factors		**Mortality**				**P-value**
		Yes		No		
		Median (IQR)		Median (IQR)		
Age (Year)		67 (20)		62 (24)		0.037*
Length of stay (Day)		5 (3)		5 (2)		0.332
Temperature (C°)		36.8 (0.7)		36.8 (0.4)		0.533
Heart rate (beats per minute)		88 (26.8)		84 (24.5)		0.290
Respiratory rate (Breath per minute)		20 (6)		20 (2)		0.978
Diastolic Blood pressure (mm Hg)		72 (19)		76 (17)		0.449
Factors		Mortality				P-value
		Yes		No		
		Mean (±SD)		Mean (±SD)		
Weight (Kg)		81.8 (±18.2)		72.8 (±16.9)		0.034*
Systolic Blood pressure (mm Hg)		132.7 (±34.5)		133.6 (±26.5)		0.880

patients (12% versus 5.7%, p = 0.038) and in those without stroke than in those with stroke (12.1% versus 4.3%, p = 0.015). The mean age was significantly higher in patients who died than in those who survived (67 [IQR, 20] versus 62 years [IQR 24], p = 0.037). In addition, the mean weight was significantly higher in patients who died than in those who survived (81.8 ± 18.2 versus 72.8 ± 16.9 kg, p = 0.034). (Table 5).

The association between demographic factors and mortality rate in stroke patients was calculated. Gender, age, weight, and being positive for stroke were the statistically significant factors. The mortality rate among males (12%) was higher than females (5.7%) (p-value= 0.038). On the other hand, the mortality rate among patients with positive stroke results (4.3%) was lower than those with negative results (12.1%) (p-value= 0.015). The patients who died had a higher median age of 67 years (IQR of 20), while the surviving patients had a median age of 62 years (IQR of 24) (p-value=0.037). In addition, patients who died had a mean weight of 81.8 kg (±18.2), which was significantly higher than the mean weight of patients still alive, which was 72.8 kg (±16.9) (p-value=0.034). All details are in Table 6.

The following table (Table 7) outlines the King Faisal Specialist Hospital and Research Centre's Stroke Code standards, detailing each step in the management of a suspected stroke patient—from Emergency Department triage to the final decision on definitive treatment by the neurology team, whether thrombolysis or mechanical thrombectomy—presented in chronological order.

Discussion

Stroke is one of the leading causes of disability and death worldwide [7]. Timely intervention is crucial in acute stroke management, and prompt treatment is associated with better patient outcomes, including lower rates of symptomatic intracranial hemorrhage, better discharge destinations, and lower in-hospital mortality [7]. In the ED, stroke code protocols are deployed to expedite the diagnosis and treatment of patients with stroke [6] and delays in stroke management can be attributed to several factors, including delays in seeking medical attention, diagnosis, and treatment initiation. In some cases, delays may be due to system-level factors, such as inadequate resources and inefficient processes [7].

Our analysis of the specific stroke code times revealed a significant delay in the time from ED triage to code activation compared to the standard time, which might be due to the high number of patients

Table 6. Effect of demographic factors on mortality rate among stroke patients

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	Categories	Yes		No		
		Count	%	Count	%	
Gender	Male	31	12	221	88	0.038*
	Female	9	5.7	148	94.3	
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	Private transportation	26	8.5	277	91.7	
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	No	14	12.1	102	87.8	
Factors		Mortality				P-value
		Yes		No		
		Median (IQR)		Median (IQR)		
Age (Year)		67 (20)		62 (24)		0.037*
Length of stay (Day)		5 (3)		5 (2)		0.332
Temperature (C°)		36.8 (0.7)		36.8 (0.4)		0.533
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Factors		Mortality				P-value
		Yes		No		
		Mean (±SD)		Mean (±SD)		
Weight (Kg)		81.8 (±18.2)		72.8 (±16.9)		0.034*
Systolic Blood pressure (mm Hg)		132.7 (±34.5)		133.6 (±26.5)		0.880

Table 7. KFSHRC Stroke Code Standards by Area and Time Intervals

KFSHRC Stroke Code Standards by Area and Time Intervals	
Area	**Time (Duty)**
ED Triage	0-10 minutes (Notifying ED physician)
ED Acute Care/Resus	10-25 minutes (Notifying Neurologist On-call)
Radiology	25-45 minutes (Perform STAT CT/CTA Brain)
ED (Neurologist Decision)	45-60 minutes (Management: Thrombolytic vs Thrombectomy)
Angio Suite	60-120 minutes (Intervention to perform mechanical thrombectomy)

presenting with no neurologic symptoms, such as body weakness, unwitnessed fall, and syncope. Additional factors which might have contributed to the observed delay include failure to recognize stroke symptoms during triage, language barriers, preexisting neurologic conditions, such as dementia, and other associated symptoms taking priority, such as chest pain. In our hospital, neurologists take priority over ED physicians in activating the stroke code, which might have also contributed to the observed delay. However, we did not observe an association between the time from ED triage to code activation and the mortality rate.

In the present study, 61.4% of the patients were males, consistent with other studies in Saudi Arabia, with one study reporting a male incidence of 66% [4]. Another study by Alhazzani et al. reported that 65% of the patients with stroke were males [10]. This finding might be associated with the higher prevalence of vascular risk factors in male patients. Studies in China reported a higher incidence and mortality rate among males with stroke [7,8], whereas Yim et al. reported a 54% of males have stroke [1]. A Canadian study by Wan et al. reported a sex difference in the rate of hospitalisations and ED visits, with event rates of 292.2 and 281.3 per 100,000 visits for male and female patients, respectively, although they did not observe other significant disparities between the sexes [2]. Another comprehensive province-wide cohort study in Canada revealed no discernible disparities between sexes [3]. In a study from Spain, the incidence rate 55.7% of the patients with stroke were males [4]. Additionally, the average age for the first stroke event was higher in females than in males (79.07 ± 11.96 versus 72.47 ± 12.48 years). Therefore, the current evidence strongly suggests that the sex disparity in the rate of patients presenting to the ED with stroke varies across countries, highlighting the importance of considering regional factors in understanding healthcare patterns related to stroke incidence.

Age is a critical risk factor for stroke [13,14] In the current cohort, the mean age of the patients with confirm stroke was similar to that reported in a previous study (61–70 years) [9] Moreover, a study in China highlighted the critical role of age in stroke incidence [11] Ekker et al. described an exponential increase in stroke incidence with increasing age in patients older than 35 years. [5] another study reported similar findings, indicating highest stroke incidence in individuals aged older than 65 years [6]. Additionally, this study observed a rise in stroke incidence in individuals aged 25–44 years. In contrast to the prior study, however, Alhazani et al., identified an increase in stroke incidence among individuals aged 45–64 years. We also found older age as a significant factor associated with mortality, in agreement with a study by He et al., who reported that older age was associated with a higher risk of in-hospital mortality [10] The observed association of older age with stroke might be attributed to the higher rates of neurologic and non-neurologic complications of stroke in older patients [7,8].

Increased body mass index (BMI) is associated with a higher all-cause mortality in the general population [13]. In the present study, weight was significantly associated with mortality in patients with stroke. This has been specifically attributed to the increase in stroke incidence in the younger population, as reported in a case-control study of stroke incidence and mortality among patients under 45 years of age with central obesity across 32 countries [9]. Jo et al. also reported obesity as a significant risk factor in this age group, which had an obesity prevalence of 44.8% [10]. Conversely, recent studies have reported improved mortality in patients with a higher BMI, illustrating the "obesity paradox." The National Institutes of Health FAST-MAG (Field Administration of Stroke Therapy–Magnesium) acute stroke trial revealed that a high BMI was associated with a consistent increase in survival rates, showing that the relationship of BMI with disability and stroke-related quality of life followed a U- or J-shaped pattern, indicating decreased survival with low or very high BMIs [11]. Aparicio et al. reported similar findings; they found that 10-year survival rates after stroke were better in patients classified as mildly obese or overweight than in those with normal weight [15]. However, other studies disagree with these conclusions, attributing the results to potential confounders, such as age, sex, smoking, and obesity phenotypes [12,13].

Several studies have reported that the use of ambulance services was associated with earlier arrival for care [13,14]. In the present study, only 25.9% of the patients arrived via ambulance, highlighting the underutilization of emergency medical services (EMS) for the transportation of patients with stroke in Saudi Arabia. Indeed, one study reported that only 34.1% of the Saudi population utilized EMS [5] whereas another study found that 18.5% of the patients with stroke used ambulance services after the onset of symptoms [13]. Prenotification by EMS has also been associated with decreased in-hospital mortality in patients with stroke [14]. It is evident that the majority of patients with stroke remain dependent on private transportation, consistent with the general population practices regarding stroke in North Africa and the Middle East [13]. Several studies found that the failure of family members in recognizing stroke symptoms led to delays in ED presentation and subsequent diagnosis [13,14,17].

Stroke can lead to serious adverse outcomes; therefore, patients with stroke should be prioritized, particularly in emergency settings where stroke management yields the best outcomes [13]. In the present study, mechanical thrombectomy was the prevalent type of management used in 43% of the patients whereas tissue plasminogen activator was used in 12.7% of the patients [16]. Due to the retrospective study design and the presence of incomplete data, we could not determine whether stroke management was effective in improving the NIHSS score. We acknowledge the limitations of our study. The retrospective study design introduced the risk of incomplete or missing information. Additionally, the study was conducted in a single center, limiting its generalizability to other healthcare settings. A multicenter study is warranted to more comprehensively and reliably evaluate the impact of the stroke code activation protocol on patient outcomes and to determine factors contributing to delays in its activation. We acknowledge that the data presented in the current study, which covers the period 2021–2022, may not fully reflect the present-day efficiency and responsiveness of stroke code activation protocols, considering the advancements and system improvements implemented since then. To address this limitation, we plan to conduct a follow-up study covering the 2025–2026 period. This will allow for a more accurate evaluation of contemporary stroke code activation performance and its alignment with current standards of care.

Conclusion

Implementing stroke code activation protocols in the ED can accelerate the diagnosis and treatment of patients with stroke. Delays encountered due to the lack of symptom recognition in patients with stroke presenting to the ED highlight areas that can benefit from training of the frontline triage staff. Activation of the stroke code by the ED physicians instead of the neurologists may improve patient outcomes. The underutilization of ambulance services in transporting patients with stroke in Saudi Arabia should be addressed by increasing public awareness.

Conflicts of interest

No financial support or funding was received from private entities or international parties.

Author's contributions

Abdulaziz Omar AlSebiheen: Conceptualization, methodology, ethical approval writing-original draft, supervision, manuscript writing.Muhammad Nauman Qureshi: Methodology & discussion writing, writing - reviewing and editing of the manuscript.Asma Waqit AlGhamdi: Software – Data curation, Data review and editing, manuscript writin Ahmed Gamal Syed: Data collection, supervision of co-authors progress, manuscript writing Raghad Mohammed Hijazi: Data collection, manuscript writingJibran Ahmed Khan: Data collection, manuscript writingOhoud Turki Alsudairi: Data collectionAya Arwadi: Data collectionMohammed Bassel AlSarraj: Co- Conceptualization, manuscript reviewing.Hani Hariri: Co-conceptualization, manuscript writing

List of abbreviations

AA	Abolyazid AY
BMI	Body mass index
CT	Computed tomography
ED	Emergency department
EMS	Emergency medical services
HJ	Himali JJ
NIHSS	National Institutes of Health Stroke Scale

Declarations

Ethics approval and consent to participate

Informed consent was obtained and ethically approved from King Faisal hospital and research center #RAC: 2221151

Consent for publication

The paper have been approved by an appropriate King Faisal hospital and research center ethics committee.

Availability of data and materials

The raw data supporting the conclusions of this article will be made available by the authors on request

Competing interests

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