


Research Article

Time Disparities in Stroke Access to Care: A Prospective Comparative Study of Patients Transported by Emergency Medical Services Stroke Pathway Versus Private cars in Riyadh, Saudi Arabia

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Abstract

Background: Stroke is an emergency condition that can lead to a long-term disability or death if not recognized early and managed properly. Emergency Medical Services (EMS) providers have a significant role in recognizing, stabilizing, and transporting suspected stroke patients to the nearest appropriate facility. Recently a new stroke pathway has been implemented in Riyadh, Saudi Arabia, in which suspected stroke patients will be transported immediately to King Fahad Medical City (KFMC) and the stroke team will be notified prior to the patient's arrival. This research aims to compare the stroke patients' times of care access for patients transported by EMS using the new stroke pathway with those transported by private cars.

Methods: This was a prospective study conducted in KFMC from 17th of January to 31st of December 2022, focusing on adult patients whose stroke code was activated during that year. Patients' characteristics, times of care access, and their 90 days mortality outcomes were collected. SAS Software Version 9.4 (SAS Institute Inc., Cary, North Carolina, USA) was used for analysis.

Results: A total of 478 patients were included in the study, 173 of them were transported by EMS while the other 305 were brought by private cars. The majority of the EMS group were categorized as moderate, moderate to severe, and severe based on the National Institutes of Health Stroke Scale (NIHSS), compared to the majority of the private car group who were categorized as moderate, minor, and severe. The median time of stroke care access in KFMC was shorter and statistically significant for the EMS group. Additionally, there was no statistical difference in mortality between the EMS group and the private car group (P value = 0.2826).

Conclusion: In conclusion, there was a statistical difference in times of care access between the two groups indicates that patients transported by EMS using the new stroke pathway have received care faster than those who transported by private cars.

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Introduction

Stroke is one of the serious emergency medical conditions which lead to a long-term disability or death if not recognized early and managed properly [1]. It occurs when an artery supplying a part of the brain gets

blocked, which is known as ischemic stroke, or gets ruptured, which is known as hemorrhagic stroke, resulting in lack of nutrients and oxygenated blood required for the brain cells [2]. In addition to Ischemic and hemorrhagic attack, transient ischemic attack (TIA) is the other type of stroke [3]. TIA, which is commonly called "ministroke", differs from the other major types of strokes in that the symptoms usually last no more than 24 hours before resolving [4]. Emergency medical services (EMS) clinicians have a significant role in recognizing, stabilizing, and transporting suspected stroke patients to an appropriate facility. Paramedics and emergency medical technicians recognize stroke patients by using FAST acronym which stands for face, arm, speech, time. Patients who have facial drops, arm drift, or slurred speech are most likely to have reduced or cut of blood supply to a part of their brains. The longer they have these symptoms without medical intervention, the less they get benefit from the medical intervention, since stroke treatment, thrombolysis and mechanical thrombectomy, are effective only if given or done to the patients in appropriate time [5,6]. Recently, in the Kingdom of Saudi Arabia, a new stroke pathway has been implemented by the second health cluster in Riyadh along with Saudi Red Crescent Authority (SRCA), which is the main EMS system in Saudi Arabia, in which a suspected stroke patient will be transported immediately to KFMC and bypass the local emergency departments. What differentiates this new stroke pathway from the regular old practice is that the stroke team in KFMC will be notified before patient arrival, and patients will bypass local non-designated emergency rooms. Once the patient arrives, the stroke team will do a quick assessment and then take the patient to Computed Tomography (CT) immediately, if the patient is stable, to confirm stroke diagnosis. The stroke pathway is a new method implemented to assist stroke patients and improve care. There is no identified local studies to address the effectiveness of such practice. In this study, we will compare the times of care access and the 90-day mortality outcomes of stroke patients who were transported by SRCA ambulance using the new stroke pathway to those who were transported to the exact same hospital via private cars.

Methods and Materials

Study Design:

This was a prospective comparative study conducted to examine the effectiveness of the new stroke pathway that has been implemented in Riyadh, Saudi Arabia by the second health cluster. Data was collected from SRCA then followed up at King Fahad Medical City (KFMC) from 17th of January to 31st of December 2022. Patients were included if they were adults (14 years and above) of both genders and had stroke code activated during the year of 2022.

Statistical Analysis:

A power calculation was conducted prior to the study to determine the minimum sample size needed. It was determined that a total of 101 patients would be required to detect a statistically significant difference, with a margin of error of 5% and a confidence level of 95%. Convenience sampling method was used to include the patients. By using a data collection form, several data were collected from the KFMC database including categorical variables such as the patient's method of transportation, gender, nationality, previous medical history, mortality outcome in 90 days, and National Institute of Health Stroke Scale (NIHSS) category at admission. In addition, the patient's age and times of care access, which were already determined by the use of the electronic patient care system, were collected as continuous variables. The time was standardized using the electronic patient care system. The primary outcome of this study was to find the differences in times of care access for stroke patients who were brought to the hospital by EMS through the new stroke pathway with those who arrived by private cars, while the secondary outcome was to investigate the epidemiology of stroke patients in Riyadh, Saudi Arabia, and the 90 days mortality. Data was first entered in MS excel sheet and divided into two groups based on the patients' methods of transportation. Descriptive analysis is used to summarize study variables in terms of frequencies, percentages, and media with quantiles. The comparison between the methods of transportation was conducted using the chi-square test for categorical variables and the Wilcoxon Two-Sample Test for continuous variables. Statistically significant was declared at an alpha level of .05 and SAS Software Version 9.4 (SAS Institute Inc., Cary, North Carolina, USA) was used for analysis.

Ethical Approval:

This study was approved by King Abdullah International Medical Research Center (KAIMRC; Riyadh, Saudi Arabia).

Results

Baseline Characteristics of Patients

In our comprehensive study conducted at King Fahad Medical City (KFMC) for a period of one year, we included a total of 1494 suspected stroke patients for whom the stroke code was activated. From this cohort, we meticulously analyzed a subset of 478 individuals who had documented records of care access times. The characteristics of these two distinct groups, categorized by their mode of transportation (Emergency Medical Services or private car), are summarized in Table 1.

In terms of age, the EMS group had a median age of 60 years, and the private car group had a median age of 61 years. Notably, both groups had a higher proportion of male

Table 1: Baseline characteristics of patients.

Variable	Total (n= 478) N(%)	EMS group (n= 173) N(%)	Private car (n= 305) N(%)	P value
Age, years median (Q1-Q3)	60(50-70)	60(50-68)	61(49-71)	0.3418
Gender	N:478	N= 173	N= 305	
Male	307(64.23)	116 (67.05)	191 (62.62)	0.3316
Female	171(33.77)	57 (32.95)	114 (37.38)	
Nationality (Frequency Missing: 226)	N= 252	N= 89	N= 164	
Saudi	173(68.65)	47 (52.81)	126 (77.30)	<0.0001
Non Saudi	79(31.35)	42 (47.19)	37 (22.70)	
NIHSS (Frequency Missing: 18)	N=460	N=170	N=290	
No stroke symptoms	17(3.70)	3(1.76)	14(4.83)	
Minor	73(15.87)	15(8.82)	58(20.00)	0.0011
Moderate	214(46.52)	79(46.47)	135(46.55)	
Moderate to severe	76(16.52)	38(22.35)	38(13.10)	
Severe	80(17.39)	35(20.59)	45(15.52)	
Symptoms Duration (Frequency Missing: 4)	N=474	N=172	N=302	
Less than 4.5 hours	240(50.63)	114 (66.28)	126 (41.72)	<0.0001
More than 4.5 hours	234(49.37)	58 (33.72)	176 (58.28)	
Stroke except TIA (Frequency Missing: 12)	N=467	N=166	N= 300	
Yes	12(2.57)	29(17.47)	59(19.67)	0.5618
Myocardial Infarction (Frequency Missing: 10)	N=468	N=166	N=302	
Yes	11(2.35)	2(1.20)	9(2.98)	0.2252
Ischemic Heart Disease (Frequency Missing: 10)	N=468	N=166	N=302	
Yes	79(16.88)	30(18.07)	49(16.23)	0.6098
Diabetes Mellitus (Frequency Missing: 10)	N=468	N=166	N=302	
Yes	235(50.21)	81(48.80)	154(50.99)	0.6491
Hypertensive Disease (Frequency Missing: 10)	N=468	N=166	N=302	
Yes	286(61.11)	101(60.84)	185(61.26)	0.9298
Hyperlipidemia (Frequency Missing: 10)	N=468	N=166	N=302	
Yes	62(13.25)	15(9.04)	47(15.56)	0.0463

patients (67.05% and 62.62%, respectively), and a significant representation of Saudi nationality (52.81% in EMS vs. 77.30% in private car). In terms of stroke severity, assessed using the National Institute of Health Stroke Scale (NIHSS) at admission, we observed substantial disparities between the two groups (P-value = 0.0011). The majority of the EMS group presented with moderate, moderate to severe, and severe stroke (46.47%, 22.35%, and 20.59%, respectively). In contrast, the private car group displayed a majority of patients with minor, moderate, and severe stroke (20.00%, 46.55%, and 15.52%, respectively). The time elapsed from symptom onset to hospital arrival was also significantly different between the groups, with a majority of EMS patients arriving within 4.5 hours (66.28%) and most private car patients arriving after 4.5 hours (58.28%). Common comorbidities such as hypertension, diabetes mellitus, ischemic heart disease, and a prior history of stroke were similar in both groups.

Diagnostic Methods

In our study, we assessed the methods employed for diagnosing stroke patients. This involved examining the utilization of clinical symptoms, CT scans, and MRI as diagnostic tools. Refer to Table 2 for detailed diagnostic data.

We found that both groups predominantly relied on clinical symptoms and CT as a diagnostic criterion, with a higher percentage of EMS patients (93.64%) using this method compared to private car patients (88.49%).

Stroke Types

We investigated the distribution of stroke types in our patient population, which provides valuable insights into the nature of the cases encountered. These findings are detailed in Table 3. Ischemic strokes were the most common type observed in both groups, constituting 76.83% of cases in the EMS group and 80.54% in the private car group.

Revascularization Approach

Understanding the revascularization approach is vital for assessing treatment strategies. This section presents the data on the utilization of thrombolytic therapy (TPA), mechanical thrombectomy, and the combination of TPA and mechanical thrombectomy, as well as cases where no revascularization

approach was employed. Detailed findings are available in Table 4. A significant difference was observed in the revascularization approach between the two groups (P-value <0.001). Interestingly, a higher percentage of private car patients receiving no revascularization approach (67.87%) compared to the EMS group (48.55%).

Table 2: Diagnostic Methods

Variable	Total (n=478)	EMS Group (n=173)	Private Car (n=305)
Clinical symptoms alone	8 (1.68%)	4 (2.31%)	4 (1.32%)
Clinical + CT	431 (90.36%)	162 (93.64%)	269 (88.49%)
Clinical + MRI	38 (7.97%)	7 (4.05%)	31 (10.20%)

Table 3: Stroke Types

Variable	Total (n=478)	EMS Group (n=173)	Private Car (n=305)
Ischemic stroke (IS)	333 (79.10%)	126 (76.83%)	207 (80.54%)
Intracerebral hemorrhage (ICH)	69 (16.39%)	34 (20.73%)	35 (13.62%)
Transient ischemic attack (TIA)	19 (4.51%)	4 (2.44%)	15 (5.84%)

Table 4: Revascularization Approach

Variable	Total (n=478)	EMS Group (n=173)	Private Car (n=305)
TPA	68 (14.23%)	31 (17.92%)	37 (12.13%)
Mechanical Thrombectomy	74 (15.48%)	28 (16.18%)	46 (15.08%)
TPA + Mechanical Thrombectomy	45 (9.41%)	30 (17.34%)	15 (4.92%)
No Revascularization Approach	291 (60.88%)	84 (48.55%)	207 (67.87%)

Table 5: Differences in times of care access between EMS group and private car group in minutes.

Variable	Total (n=478)	EMS group (n=173)	Private car group (n=305)	P value
Last seen normal to triage (Frequency Missing: 4) median (Q1-Q3)	N=474 190.50(92-485)	N=172 139(80-326)	N=302	0.0002
Door to neurologist (Frequency Missing: 17) median (Q1-Q3)	N=461 5(1-9)	N=158 1(0-5)	N=303 6(3-12)	<0.0001
Triage to code time (Frequency Missing: 36) median (Q1-Q3)	N=442 3(0-10)	N=140 0(0-2)	N=302 7(1-14)	<0.0001
Code to ASU nurse response (Frequency Missing: 8) median (Q1-Q3)	N=470 5(3-7)	N=169 5(0-6)	N=301 6(4-7)	<0.0001
Door to CT (Frequency Missing: 17) median (Q1-Q3)	N=461 18(12-26)	N=159 13(9-18)	N=302 20(15-30)	<0.0001
Door to CT interpretation (Frequency Missing: 25) median (Q1-Q3)	N=453 21(15-31)	N=154 16(11-21)	N=299 24(18-34)	<0.0001
Door to Drug (Frequency Missing: 364) median (Q1-Q3)	N=114 31.50(20-47)	N=63 24(19-37)	N=51 41(27-53)	0.0001
Door to PunctureDoor to Puncture (Frequency Missing: 374) median (Q1-Q3)	N=104 95(78.50-117)	N=49 95(78-110)	N=55 95(79-127)	0.6912

Primary Outcome: Comparison of Time to Care Access

Our results unequivocally demonstrate that the EMS group received care more expeditiously. The median time for various aspects of stroke pathway, such as "last seen normal to triage," "door to neurologist," "triage to stroke code activation," "acute stroke unit nurse response," "door-to-CT," "door-to-CT interpretation," and "door to drug," was significantly shorter in the EMS group (P-value = 0.0002, <0.0001, <0.0001, <0.0001, <0.0001, 0.0001, respectively). However, there was no statistically significant difference in the median time from "door to puncture" between the EMS and private car groups (95 minutes vs. 95 minutes, P-value = 0.6912). Table 5 summarizes times of care access between EMS group and private car group.

Stroke Patient Outcomes

Our secondary outcome measure focused on 90-day mortality. Within this timeframe, we observed mortality rates of 8.09% for EMS patients and 5.57% for individuals arriving by private car. Notably, the two groups had no statistically significant difference (P-value = 0.2826).

Discussion

Our research revealed that 173 patients who were suspected of having a stroke were brought to KFMC emergency department by ambulance using the new stroke pathway, while 305 suspected stroke patients arrived at the hospital using private method of transportation. Both groups predominantly consisted of adult, male, and Saudi patient. Furthermore, stroke severity at admission has been assessed between the two groups using the National Institute of Health Stroke Scale (NIHSS) and found a statistically significant difference. Most patients in EMS group exhibited moderate, moderate to severe, and severe strokes, while the majority of the private car group presented with moderate, minor, and severe strokes. These findings shed light on the demographic characteristics of stroke patients transported to KFMC by EMS and private car, which can guide the development of targeted interventions and approaches to enhance stroke care delivery and outcomes. Furthermore, the majority of EMS group received revascularization treatments when compared to private car group. This could be a result of the advanced notification of stroke team and the fact that the majority of EMS group presented to the hospital in less than 4.5 hours from symptoms onset. Additionally, our results indicated that the median time for the EMS group to access care was shorter compared to the private car group. There were statistically significant differences in the median time for various aspects of stroke care, such as last seen normal to triage, door to neurologist, triage to stroke code activation, acute stroke unit nurse response, door to CT, door to CT interpretation, and door to drug. The median time of door to stroke code

activation for EMS group is 0 [0-2] minutes, while it is 7 [1-14] minutes in private car group, and the median time for door to needle is 24 [19-37] VS 41 [27-53] minutes respectively. In one prospective cohort study that compared the time of stroke team activation, time to CT, and the time to drug between patients transported by EMS using the regular stroke pathway and patients transported by private car to a tertiary hospital in Riyadh Saudi Arabia, they found that the only statically significant difference was for stroke team activation time, as it was shorter for EMS group [1]. However, in our study, we found that the new stroke pathway implemented in Riyadh is beneficial for stroke patients in regard to time of care access in KFMC. This could be a result of notifying the stroke team before the patient's arrival at the hospital, so the stroke team will be standing by for the patient. And this has been already confirmed by several studies stating that using EMS reduces prehospital delay time. Using EMS without first notifying the hospital, on the other hand, does not reduce in-hospital processing time [8,9]. Despite receiving prompt medical attention, EMS group had a higher mortality rate than the private car group after 90 days of stroke, however the difference is not statistically significant, and the exact time and cause of mortality were not assessed in this study. This suggests that there might be other factors contributing to the poorer outcomes in EMS group, which warrant further investigation, including stroke types, severity, and other pertinent factors. A prospective study in Uganda examined the predictors of 30-day and 90-day mortality among hemorrhagic and ischemic stroke patients concluded that Low levels of consciousness at admission, stroke severity, and hemorrhagic stroke were associated with increased higher mortality [10]. Their findings are associated with our study and might explain the higher mortality rate in EMS group. In our study, 8.82% of EMS patients were having minor stroke compared to 20% of private car groups. Additionally, 20.59% of EMS groups were categorized as having severe strokes, while 15.52% of private care groups were categorized as having severe stroke. As for the prevalence of stroke types in our study, 20.73% of EMS patients had hemorrhagic stroke compared to 13.62% of private car patients.

Limitation

This study exhibits two important limitations, the first is the presence of missing data. There is a number of patients with missing data regarding some variables. Another limitation is the risk of unmeasured confounding factors. Which might have interfered with mortality rate for both EMS and private car groups.

Conclusions

In conclusion, the new stroke pathway implemented in Riyadh, Saudi Arabia, was found to be effective and beneficial when it comes to times of care access. Patients presented to

KFMC by EMS with pre-notification of stroke team received care faster than those how arrived by private mode of transportation in all aspects of stroke care delivery except for door to puncture as there was no difference between the two groups. Further studies investigating neurological outcomes for stroke patients are needed.

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