

# Impact of implementing a stroke code on the door to needle time during Hajj at a tertiary center in Makkah, Saudi Arabia

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## ABSTRACT

**الأهداف:** السكتة الدماغية من أكثر المشاكل الطبية شيوعاً. في هذه الدراسة نسعى لقياس فعالية تطبيق نداء السكتة الدماغية على الوقت اللازم لإعطاء الدواء المخصص لعلاج السكتة الدماغية منذ وصول المريض إلى المستشفى أثناء فترة الحج في مستشفى رعاية ثلاثي بمدينة مكة المكرمة.

**المنهجية:** تم إجراء دراسة استرجاعية على حالات السكتات الدماغية التي وصلت إلى المستشفى أثناء الوقت الذهبي المخصص لإعطاء الدواء في مدينة الملك عبد الله الطبية بمدينة مكة من تاريخ 1 سبتمبر 2015 إلى يوليو 2020.

**النتائج:** في هذه الدراسة، تمت إضافة 69 مريض (28 مريض منهم أثناء فترة الحج و 41 مريض في الفترات المتبقية من العام). أثناء فترة الحج، انخفض الوقت اللازم لإعطاء الدواء المخصص مقارنة بالمجموعة الأخرى، وكان له قيمة إحصائية. كما لوحظ وجود انخفاض في الوقت اللازم لعمل الأشعة المقطعية لنفس المجموعة. أيضاً كان هناك انخفاض في مدة التنويم أثناء فترة الحج. لم يكن هنالك علاقة إحصائية يعتد بها في تحسن الحالة الصحية ونسبة الإعاقة أثناء فترة الحج والفترات الأخرى.

**الخلاصة:** تم ملاحظة انخفاض في الوقت المطلوب لإعطاء الدواء المخصص للسكتة الدماغية بمعدل 44% أثناء فترة الحج. بالرغم من ذلك لم يكن هناك أثر في تحسن الحالة الصحية للمرضى عند الخروج من المستشفى. هذه الدراسة محدودة النتائج لأن حجم العينة صغير بالإضافة لعدم وجود متابعة طبية طويلة المدى.

**Objectives:** To assess the impact of a stroke code on the door to needle time during Hajj at a tertiary center in Makkah, Saudi Arabia. Stroke is one of the most common medical problems globally. Tissue plasminogen activator is an effective treatment in patients with acute ischemic stroke. However, its efficacy is time-dependent.

**Methods:** We conducted a retrospective study on acute ischemic stroke patients who presented within

the study window and were eligible for intravenous thrombolysis therapy at King Abdullah Medical City in Makkah between September 1, 2015 and July 2020.

**Results:** Sixty-nine patients received intravenous tissue plasminogen activator and enrolled in this study, 28 patients of which presented during the Hajj period. We found a statistically significant reduction in both the door to needle time and the door to computed tomography time during the Hajj period. In addition, the length of hospital stay reduced significantly in the same period

**Conclusion:** We observed a 44% reduction in the door to needle time during the implementation of the stroke code. However, we did not observe a significant difference in clinical outcomes. This study is limited by its small sample size and it lacks a long follow-up for clinical conditions.

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Stroke is one of the most common and concerning medical problems globally due to its association with death and multiple disabilities.<sup>1</sup> Almost 16.9 million people suffer a stroke annually, which represents 11.8% of all deaths worldwide.<sup>2,3</sup> Tissue plasminogen activator (tPA) is an effective treatment in patients with acute ischemic stroke.<sup>4,5</sup> However, the efficacy of tPA

is time-dependent.<sup>6</sup> The door to needle (DTN) time defines the shortest target time needed for a stroke patient that presented to the emergency room to have the tPA injection.<sup>7</sup> Islam has 4 main rituals, of which Hajj is one. At this time of the year, millions of Muslims from around the world come to Makkah. The incidence rate of stroke patients among pilgrims is 8.9/100,000.<sup>8</sup>

King Abdullah Medical City (KAMC) is a tertiary center in Makkah providing advanced stroke care. During the Hajj period, KAMC serves thousands of pilgrims and citizens, providing several medical services including the acute stroke service. In that time, it temporarily implements the stroke code protocol and activates a stroke hotline to receive patients from different hospitals in Makkah. Once the patient arrives in the emergency department, there is a fast pathway for registering the patient, performing rapid clinical assessment, shifting the patient to the computed tomography (CT) room immediately and initiating intravenous thrombolysis upon acquisition and review of image by the stroke team.

However, during the remainder of the year, the stroke code and stroke hotline are not available. Therefore, in this study, we assessed the impact of the stroke code on the DTN time in acute stroke patients at KAMC in Makkah, Kingdom of Saudi Arabia.

**Methods. Study design and population.** We conducted a retrospective study in KAMC, a tertiary hospital in Makkah, Saudi Arabia. We reviewed all patients who presented to KAMC with a case of acute ischemic stroke from September 2015 to July 2020. We excluded patients who did not receive intravenous thrombolysis. We divided patients into 2 groups: one group included patients who presented during the Hajj period and the other group comprised patients who presented during the rest of the year.

**Sampling technique and sample size.** We used a non-probability consecutive sampling technique to conduct the study. Altogether, 185 patients received intravenous thrombolysis and 69 patients provided the required data.

**Data collection.** We reviewed the electronic medical system and medical records and collected the following data: age, gender, nationality, risk factors, National Institute of Health Stroke Scale (NIHSS) at admission and discharge, time and date of symptom onset before hospital arrival, time of intravenous tPA bolus, other

therapeutic interventions, complications during hospitalization, length of hospital stay and hospital mortality.

**Ethical considerations.** We obtained ethical approval from the institutional review board of KAMC.

**Statistical analysis.** We used SPSS software version 23 for the data analysis. We examined univariable distributions for anomalies and corrected errors. We report discrete variables using counts and percentages and continuous variables using the mean and standard deviation.

**Results.** Sixty-nine patients received intravenous tPA and enrolled in this study, 28 of which presented during the Hajj period. Of all enrolled patients, 43 (62.3%) were men and 26 (37.7%) were women. The most frequently reported risk factors were hypertension (78.2%) and diabetes mellitus (52.1%). Table 1 compares the baseline characteristics during the Hajj and non-Hajj periods. Overall, there was no significant difference between patients admitted in the Hajj and

**Table 1 -** Baseline characteristics.

Variables	Hajj (n=28)	Non-Hajj (n=41)	P-value
	n (%)		
<b>Age</b>			
Mean±SD	64.2±10.5	63.3±15.5	.695
Median (IQR)	64 (55–72.5)	65 (55–75)	
<b>Gender</b>			
Male	19 (67.9)	24 (58.5)	.433
Female	9 (32.1)	17 (41.5)	
<b>Nationality</b>			
Saudi	5 (17.9)	30 (73.2)	.000
Non-Saudi	23 (82.1)	11 (26.8)	
<b>Risk factor</b>			
None	1 (3.6)	0 (0)	.223
Diabetes mellitus	11 (39.3)	25 (61)	.077
Hypertension	19 (67.9)	35 (85.4)	.083
IHD	6 (21.4)	16 (39)	.061
CHF	3 (10.7)	8 (19.5)	.327
Atrial fibrillation	8 (28.6)	5 (12.2)	.088
Previous stroke	12 (42.9)	9 (22)	.064
Hyper-lipidemia	11 (39.3)	10 (24.4)	.187
Previous TIA	1 (3.6)	5 (12.2)	.212
Smoking	1 (3.6)	2 (4.9)	.794
Ex-smoking	0 (0)	2 (4.9)	.236
Prosthetic mitral valve	0 (0)	1 (2.4)	.405
<b>Ischemic etiology</b>			
Cardio-embolic	11 (39.3)	17 (41.5)	.533
Large artery disease	5 (17.9)	11 (26.8)	
Small artery disease	5 (17.9)	3 (7.3)	
lacunar	7 (25)	10 (24.4)	
Unknown			

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**Table 2** - Stroke management parameters.

Variable	Hajj (n=28)	Non-Hajj (n=41)	P-value
<i>Stroke onset to hospital arrival time (hours)</i>			
Mean±SD	2.2±.9	1.9±.9	.218
Median (IQR)	2 (2–3)	2 (1–3)	
<i>Door to CT time (minutes)</i>			
Mean±SD	8.6±3.1	13.7±13	.017
Median (IQR)	8 (7–10)	10 (8–14.5)	
<i>DTN time (minutes)</i>			
Mean±SD	27.5±13.7	57.8±32.5	.000
Median (IQR)	26.5 (15–35.7)	60 (23.5–79.5)	
Endovascular therapy performed	10 (35.7%)	8 (19.5%)	.132
<i>NIHSS at admission</i>			
Mean±SD	13.1±5.3	12.9±6.1	.736
Median (IQR)	14 (8.2–17)	12 (8.5–17.5)	

HT - Hemorrhagic Transformation, TPA - Tissue plasminogen activator, NIHSS - National Institutes of Health Stroke Scale, IQR - Interquartile Range

**Table 3** - Patients' complications and outcomes.

Variables	Hajj (n=28)	Non-Hajj (n=41)	P-value
	n (%)		
Hemorrhagic transformation (HT)	7 (25)	14 (34.1)	.417
<i>Time of HT post TPA (hours)</i>			
Mean±SD	19.8±9.9	31.6±20	.204
Median (IQR)	16 (12–30)	28 (15.5–40.5)	
Clinical worsening after HT	2 (7.1)	5 (12.2)	.306
Drop in NIHSS 4 points and more after HT	2 (7.1)	3 (7.3)	.717
<i>HT Type</i>			
Hemorrhagic infarction	2 (7.1)	7 (17.1)	.481
Parenchymal hematoma	5 (17.9)	7 (17.1)	
Systemic hemorrhage post TPA	0 (0)	1 (2.4)	.405
Recurrent stroke	0 (0)	5 (12.2)	.055
Developed brain herniation	5 (17.9)	6 (14.6)	.720
Decompressive craniectomy	1 (3.6)	2 (4.9)	.794
<i>NIHSS at discharge</i>			
Mean±SD	7.3±5.2	6.6±6.7	.303
Median (IQR)	5 (3–12)	5 (1–8.2)	
<i>Length of stay in hospital</i>			
Mean±SD	7.7±7.4	17±20	.007
Median (IQR)	5 (3–10.2)	10 (5–23)	

HT - Hemorrhagic Transformation, TPA - Tissue plasminogen activator, NIHSS - National Institutes of Health Stroke Scale, IQR - Interquartile Range

non-Hajj periods related to the baseline characteristics (for example, age, gender, risk factors and ischemic etiology). However, the number of non-Saudis who received tPA during Hajj was significantly greater than that during the non-Hajj period.

Table 2 shows some of the parameters related to the management of stroke patients. The median time

from symptom onset to hospital arrival was 2 hours during Hajj, which was similar to the time from onset to presentation in the non-Hajj period ( $p=0.218$ ). The median door to CT time was 8 minutes in Hajj, which was significantly shorter than that in the non-Hajj period ( $p<.001$ ). The median DTN times in the Hajj and non-Hajj periods were 26.5 and 60 minutes. This

difference was also statistically significant ( $p < .001$ ). The frequency of patients undergoing endovascular therapy was similar in both periods ( $p = 0.736$ ).

Table 3 summarizes the complications and outcomes. This study, generally, did not observe significant variations in clinical complications during the Hajj and non-Hajj periods. The frequency of hemorrhagic transformation was similar in both groups ( $p = 0.417$ ). There was no difference in stroke severity score at the time of discharge in either group. We found that patients who presented during the non-Hajj period required a longer hospital stay than patients admitted during Hajj ( $p = 0.007$ ).

**Discussion.** The implementation of a stroke code and activation of a stroke hotline in our center are needed to serve pilgrims. During the Hajj period, the government provides huge support to ensure competent health services for pilgrims by providing more healthcare workers (specialized neurologists, neuro-interventionists, neuro-radiologists and technicians) and establishing a hotline with easy and fast accessibility to our center. These factors facilitate establishing a stroke code protocol in that time.

A study in Canada in 2017 carried out on 106 patients compared the effectiveness of implementing reduction strategies for the DTN time and showed a reduction of the median DTN time from 75 to 46 minutes compared with pre-modification ( $p < 0.0001$ ). The implementation of reduction strategies included stroke team activation, immediate CT transfer and tPA injection on the CT table.<sup>9</sup> In another study in India carried out in 2018 that compared pre- and post-stroke code implementation, 109 patients received thrombolysis in both groups and the researchers found a reduction in the mean DTN from 104.95 to 67.28 minutes ( $p < 0.001$ ) and a reduction in the mean door to CT time from 58.88 to 26.44 minutes ( $p < 0.001$ ).<sup>10</sup> A study carried out in Spain in 2018 that included 461 patients compared stroke care before and after the implementation of a stroke protocol and showed that the median DTN time reduced from 52 to 27 minutes ( $p < 0.001$ ). The total time required to treat stroke patients from the beginning of the symptom onset was 90 minutes.<sup>11</sup>

Our study compared acute stroke care during the Hajj period (28 patients) with that during the remainder of the year (41 patients) and the findings were similar to those of other studies. We found that the median door to CT time and DTN significantly reduced during the Hajj period, ( $p < 0.017$ ) and ( $p < .000$ ). These

resulted from pre-hospital stroke notification and code activation; the presence of a neurologist in the emergency department before patient arrival; frequent education provided to emergency department nurses, physicians and CT technicians; fast patient registration in the emergency department with rapid assessment, triaging and immediate shifting to CT scan; and the initiation of intravenous thrombolysis on the CT table before CT angiography.

Given the abundant availability of ambulances, Medivac and other governmental divisions to facilitate the transportation of patients to hospitals, we expected this to decrease the stroke onset to door time during Hajj. However, there was no difference in hospital arrival time (median time 2 hours). This could be explained by a delay in seeking medical attention.

Regarding complications, there was no difference between both groups with the most frequent complication brain herniation, which occurred in 5 patients (17.9%) during the Hajj period and 6 patients (14.6%) during the non-Hajj period, followed by symptomatic intracerebral hemorrhage, seen in 2 patients during the Hajj period (7.1%) and 3 patients in the non-Hajj group (7.3%).

A study from the United States assessed the door to groin puncture (DTG) time before and after the implementation of a stroke protocol. They found average DTG times from 2015, 2016 and 2017 of 263, 136 and 165 minutes. After they implemented the stroke code, the DTG time reduced to 104 minutes.<sup>12</sup> In our study, we did not investigate this point. The most common stroke etiology was cardio-embolic in both groups followed by large vessel disease and small vessel disease. The DTN time during the Hajj period was significantly shorter than that in the other group; however, the median NIHSS score was similar in both groups. This observation is limited by a lack of clinical follow-up.

Interestingly, the length of hospital stay reduced significantly during the Hajj period, with a median of 5 days compared with 10 days in the other group ( $p < 0.007$ ). We can explain this result by the availability of more healthcare workers, longer working hours and fast access to all stroke work –even during nighttime and on weekends.

This study is limited by its small sample size, as we conducted it in a single center, and it lacks a long follow-up to observe the clinical conditions due to the inability to follow Hajj patients, especially those from overseas.

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