Original Article :

Door to Needle Time in Acute Ischemic Stroke Patients before and after Initiation of Quality Improvement Project - Single Local Centre Experience

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Received on May 25, 2023, accepted for publication on Sep 27, 2023, dx.doi.org/10.5455/mjhs.2023.04.009

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Abstract

Background and Aims:
Thrombolysis has been shown to improve stroke outcomes by reducing disability, particularly when administered early. Lowering the door-to-needle time (DNT) for administering intravenous thrombolysis (IVT) is an important objective for improving the quality of acute stroke care. This study aims to compare DNT before and after implementing the code stroke pathway protocol.

Methods:
The study evaluated the impact of a quality improvement project, Code Stroke, on acute ischemic stroke patients at King Fahd General Hospital in Jeddah, Saudi Arabia, September 2019 to April 2020, using a retrospective record-based analysis, with data extracted using a standardized format and categorized into pre and post code groups.

Results:
81 stroke patients were reviewed, with 47 in the pre-code group and 34 in the post-code group. The reported tPA DNT time was less than 60 minutes in only 8.5% of patients before the implementation of stroke code activation, compared to 55.9% after implementation (p=.001). Incidence of symptomatic hemorrhagic transformation was 8.6%. Post-code group had a lower median length of hospital stay (8 days) compared to the pre-code (13 days), with a marginal trend towards statistical significance, and

half of the post-code group patients had a modified Rankin Scale of 0-2 compared to one third of the pre-code group at three months of discharge.

Conclusions:
The Code Stroke project resulted in a significant reduction in DNT, improved functional outcomes, and a reduction in hospital length of stay, but the incidence of symptomatic intracranial hemorrhage and in-hospital mortality rates were slightly higher than expected, requiring continued improvement efforts.

Keywords:
Door to needle time DTN, Length of hospital stay LOS, Code stroke, Acute stroke.

Introduction

Around the globe, stroke ranks among the top causes of both mortality and impaired physical function [1]. Early administration of the thrombolysis has been shown to improve stroke outcomes by reducing disability [2]. Early administration of intravenous tissue plasminogen activator (tPA) has been associated with reduced long-term disability and complications such as symptomatic intracranial hemorrhage in patients with acute ischemic stroke [3]. Although tPA has proven benefits, its use remains limited in certain countries, such as Saudi Arabia, due in part to delayed presentation at emergency departments [4].

The time from a patient's presentation with stroke symptoms at the hospital to the start of intravenous thrombolysis (IVT), known as the door-to-needle time (DNT), is considered a key indicator of the quality of acute stroke care provided by hospitals [5]. Reducing the median Door-to-Needle Time (DNT) is a critical quality improvement goal that is employed worldwide as an auditing measure for this specific aim [6], The international guidelines recommend a door-to-needle (DTN) time of ≤60 minutes from the time of patient arrival at the hospital [7]. Although poor experience can contribute to treatment delays, smaller and less experienced stroke centers can still achieve shorter Door-to-Needle (DTN) times by implementing structural and logistical changes in the delivery of stroke care [8,9]. While several hospitals have reported implementing diverse policies to enhance the promptness of tPA administration, the degree of implementation of each pre-specified strategy has varied significantly.

The adoption of the 'Code Stroke' rapid access protocol yielded a decrease in Door-to-Needle (DTN) time and may have contributed to an uptick in the utilization of intravenous tissue plasminogen activator (IV-tPA) [10]. As conjunction with other similar centers pathways, Code stroke at King Fahad General hospital (KFGH),

Jeddah, Saudi Arabia involves rapid emergency triage, physician evaluation, investigation requests, and immediate referral to the stroke team through a linked pager system. This enables the team to quickly activate the code stroke protocol upon arrival at the patient's bedside, including neurological assessment using National Institutes of Health Stroke Scale (NIHSS), imaging review, further investigations, diagnosis review, and assessment of thrombolysis eligibility.

The aim of this study was to evaluate the impact of implementing code stroke on the door-to-needle time for tPA administration, the percentage of patients receiving treatment within 60 minutes, Length of hospital stay (LOS) and clinical outcomes before and after the intervention.

Methodology

A retrospective record-based study was conducted at King Fahd General Hospital, Jeddah, Saudi Arabia, to evaluate the impact of the quality improvement project (Code Stroke) on patients with who were presented as acute ischemic stroke from September 2019 to April 2020, as the first phase assessment of the project, we excluding other months of the year that were affected by COVID-19 pandemic protocols. Also, Patients with all type of hemorrhagic strokes, cerebral venous thrombosis, and stroke mimics were excluded. The study was approved by the Institutional Review Board (IRB) of King Fahad General Hospital, Jeddah. Data were extracted using a pre-structured standardized format to minimize errors and included demographic information, emergency room processes, IV tPA administration process and timing, acute stroke management, stroke complications, clinical evaluations, length of hospital stay, and discharge outcomes as well as three months Modified Ranken Scale (MRS) either documented in the follow up clinic or through direct contacts with the discharged patients. Data were categorized into two groups: the pre-Code Stroke group, from September 2019 to December 2019, and the post-Code Stroke group, from January 2020 to April 2020.

Data analysis

The extracted data was reviewed, coded, and analyzed using IBM SPSS version 22 (SPSS, Inc. Chicago, IL) as part of the statistical analysis. Two-tailed tests were used for all statistical analyses, and a p-value less than 0.05 was considered statistically significant. Descriptive analyses, including frequency and percentage distributions, were conducted for all variables in both study groups, including demographic and clinical stroke data, tPA door-to-needle time, onset-to-tPA needle

time, and discharge data with clinical outcomes. To compare the data between the two study groups (pre-code stroke patients versus post-code stroke patients), cross-tabulation was used, and relations were assessed using Pearson chi-square test and exact probability test for small frequency distributions. It should be noted that this analysis is specific to the first phase assessment of the Code Stroke project.

Results

After excluding patients with hemorrhagic strokes, cerebral venous thrombosis, and stroke mimics, a total of 81 medical files for stroke cases were thoroughly reviewed for relevant data, with 47 patients in the pre-code group and 34 in the post-code group. The ages of the patients ranged from 42 to 109 years old, with a mean age of 60-63 for both groups, and there was no significant difference in age (P=.281). About one-third of the patients were female, and there was no significant difference between the two stroke patient groups in terms of gender or nationality. Interestingly, less than one-fourth of the patients arrived at the emergency department by emergency medical system (EMS). Code strokes were activated at evening or night shifts in approximately 57% of cases, but this difference was not statistically significant. The incidence of symptomatic hemorrhagic transformation, which is defined as a worsening of more than 4 points on the National Institutes of Health Stroke Scale (NIHSS), was found to be approximately 8.6% overall. Making sense, the incidence was lower in the post-code group, with only two patients experiencing it, compared to five patients in the pre-code group.

Table 1. Bio-demographic and clinical data for stroke patients attended King Fahd General Hospital, Jeddah before and after code stroke activation

Bio-demographic data	Total		Phase				p-value
		Pre code		Post code			
	No	%	No	%	No	%	
Age in years							.281
< 50	14	17.3%	6	12.8%	8	23.5%	
50-59	26	32.1%	14	29.8%	12	35.3%	
60+	41	50.6%	27	57.4%	14	41.2%	
Gender							.935
Male	52	64.2%	30	63.8%	22	64.7%	
Female	29	35.8%	17	36.2%	12	35.3%	

Bio-demographic data	Total		Phase				p-value
			Pre code		Post code		
	No	%	No	%	No	%	
Nationality							.753
Saudi	35	43.2%	21	44.7%	14	41.2%	
Non-Saudi	46	56.8%	26	55.3%	20	58.8%	
Code stroke activation time							.059
Morning	35	43.2%	16	34.0%	19	55.9%	
Evening/ night	46	56.8%	31	66.0%	15	44.1%	
Arriving at hospital							.186
By EMS	18	22.2%	8	17.0%	10	29.4%	
Others	63	77.8%	39	83.0%	24	70.6%	
Asymptomatic haemorrhagic transformation	13	16.0%	5	10.6%	8	23.5%	0.119
Symptomatic haemorrhagic transformation	7	8.6%	5	10.6%	2	5.9%	.452#

P: Pearson X2 test , * P < 0.05 (significant), #: Exact probability test

Table 2. presents the results of DTN time, LOS, and in-hospital mortality before and after stroke code activation.

tPA duration	Total		Phase				p-value
			Pre code		Post code		
	No	%	No	%	No	%	
tPA Door to needle time							
< 60 minutes	23	28.4%	4	8.5%	19	55.9%	.001*
> 60 minutes	58	71.6%	43	91.5%	15	44.1%	
Median (range) in minutes	87 (0-254)		105 (0-254)		60 (30-180)		.001*$
Median onset to tpa time (range) in minutes	220 (90-345)		230 (95-345)		200 (90-260)		.039*$
Median Length of hospital stay (days)			13		8		.068$
in-hospital all-cause mortality	13	16.0%	8	17.02%	5	14.7%	.721

P: Pearson X2 test #: Exact probability test $: Mann-Whitney test

* P < 0.05 (significant)

Table 2 presents the results of DTN time, LOS, and in-hospital mortality before and after stroke code activation. Prior to the implementation of stroke code activation, the reported tPA Door to needle time was less than 60 minutes in only 8.5% of stroke patients, while after applying the stroke code, this percentage increased to 55.9%, with an average time of 105 versus 60 minutes, respectively, which is a statis-

tically significant difference (P=.001). The median onset to tPA needle time was 220 minutes for both groups combined. Additionally, the post code group had a lower median length of hospital stay (8 days) compared to the pre-code group (13 days), with a marginal trend towards statistical significance (Figure 1).

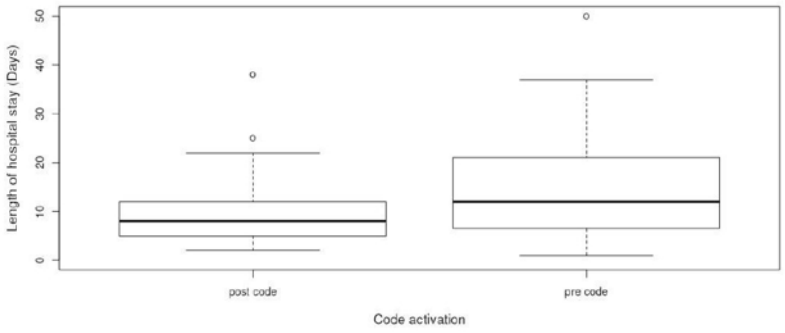


Figure 1. Length of Hospital Stay of stroke patients attended King Fahd General Hospital, Jeddah before and after code stroke activation

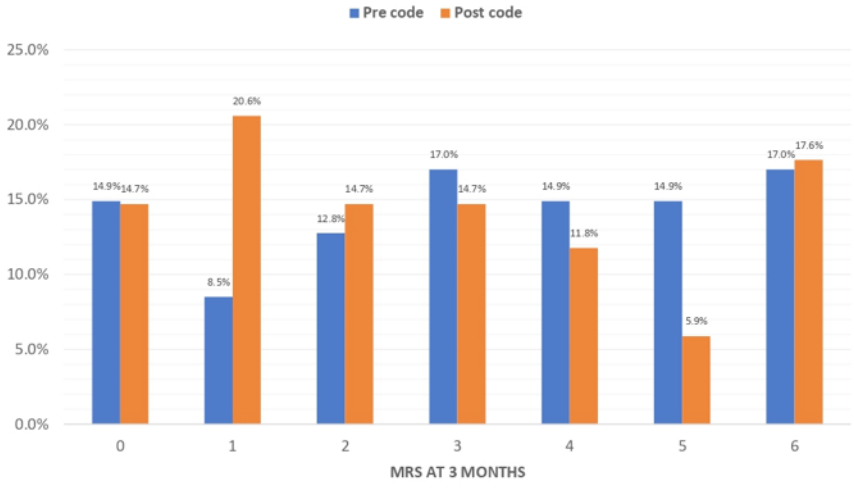


Figure 2. MRS 3 months post discharge of stroke patients attended King Fahd General Hospital, Jeddah before and after code stroke activation

There were 13 patients in hospital death from all causes in both groups. For the Modified Ranken Scale (MRS) at three months of the discharge, half of the post code group patients had the MRS of (0-2) in comparison to one third of the pre code group (Figure 2). A significant improvement was observed in the post-code group who received tPA within 60 minutes, when analyzing DTN time in relation to mRS and LOS (Table 3,4).

Table 3. Relation between MRS score and tPA door to needle time among study patients pre and post code application

MRS		tPA door to needle time	Phase				p-value
			Pre code		Post code		
			No	%	No	%	
MRS at 3 months	0-1	< 60 minutes	1	9.1%	8	66.7%	.005*
		> 60 minutes	10	90.9%	4	33.3%	
	2-3	< 60 minutes	1	7.1%	6	60.0%	.005*
		> 60 minutes	13	92.9%	4	40.0%	
	4-5	< 60 minutes	1	7.1%	5	83.3%	.001*
		> 60 minutes	13	92.9%	1	16.7%	
	Died	< 60 minutes	1	12.5%	0	0.0%	.396
		> 60 minutes	7	87.5%	6	100.0%	

P: Exact probability test

* P < 0.05 (significant)

Table 4. Relation between patient Length of hospital stay and tPA door to needle time among study patients pre and post code application

LOS	tPA door to needle time	Phase				p-value
		Pre code		Post code		
		No	%	No	%	
< 1 week	< 60 minutes	1	8.3%	7	50.0%	.022*
	> 60 minutes	11	91.7%	7	50.0%	
1-2 weeks	< 60 minutes	2	11.1%	8	61.5%	.003*
	> 60 minutes	16	88.9%	5	38.5%	
> 2 weeks	< 60 minutes	1	5.9%	4	57.1%	.005*
	> 60 minutes	16	94.1%	3	42.9%	

P: Exact probability test

* P < 0.05 (significant)

Discussion

Administering timely reperfusion therapy to stroke patients is of paramount importance, as the effectiveness of tPA is heavily dependent on time. Rapid treatment is essential for mitigating the risk of mortality and symptomatic intracranial hemorrhage, while also improving functional outcomes [11,12]. This study evaluated the effectiveness of a quality improvement project (Code

Stroke) in improving clinical outcomes for stroke patients. It assessed the relationship between tPA administration time, proportion of patients treated within 60 minutes, and clinical outcomes before and after implementation of the project.

After the implementation of the stroke code, approximately two-thirds of the patients received tPA within 60 minutes of presentation, indicating a significant reduction in time from 105 minutes before implementation to 60 minutes after implementation, This DTN time achieved is within the 60-minute period recommended by the American Heart Association/ American Stroke Association (AHA/ASA) guidelines, which has been a longstanding recommendation. However, it is worth noting that the latest update of the guidelines recommends even lower door-to-needle targets [13]. When comparing our result to other small little local results, the median door-to-needle (DTN) time was 70 minutes in the large tertiary center in Riyadh city, and 82 minutes in other study [14,15]. The mean DTN times reported in the study from Dubai was 64.1 minutes, and more of the have received tpa in less than an hour in Bahrein study whereas that reported in the (Safe Implementation of Treatment in Stroke Middle-East and North African) SITS-MENA registry was 54 minutes, and 62.5 in in an Indonesian Tertiary Center based on recent publication [16,17,18,19]. On the other hand, other health centers, achieved door-to-needle times in a varying degree between 30–60 minute, and interestingly 20 minutes in Helsinki, Finland. These achievements open a room for more improvement and work in other phases of our improvement projects [20,21,22].

The frequency of symptomatic intracranial hemorrhage (sICH) may fluctuate based on the patient demographic and the criteria used to define sICH, although it usually falls between 2% to 7% [23]. Our study found that the incidence of symptomatic intracranial hemorrhage (sICH) was higher than the typical range of 2% to 7%, ranging from 6-8% based on the definition of NIHSS worsening by more than 4 points. In contrast, the Ismail A. Khatri et al. study in Riyadh reported a sICH rate of 8.1%, while the SITS-MENA registry reported <1.4% and the Dubai cohort reported 6.9% [14,16,18]. Additionally, the in-hospital mortality rate in our cohort was around 15%, which is higher than the Riyadh mortality rate of 9%, the Dubai cohort's rate of 6.8%, and the SITS-MENA registry's rate of 2.3%. The National Institute of Neurological Disorders and Stroke (NINDS) rtPA trial reported a considerably higher mortality rate of 17% at three months, and recent studies from Saudi Arabia have reported in-hospital stroke mortality rates of

9.7% and 11.1% and 16.4 from one study from Oman [14,16,18,24,25,26].

The modified Rankin Scale (mRS) is a frequently utilized clinician-reported instrument for evaluating global disability and tracking stroke rehabilitation. Additionally, it has been integrated as a primary endpoint in randomized clinical trials assessing new acute stroke therapies [27]. Half of the post code group patients had the MRS of (0-2) in comparison to one third of the pre code group, when comparing to other studies in the region, approximately one-third of the patients in the Riyadh cohort were discharged with functional independence, while another one-third were partly or fully dependent. In contrast, the Dubai cohort had more than two-thirds of patients discharged with an mRS of 2 or lower. The SITS-MENA registry reported an mRS of 0-2 in 53% of patients, while a study in Oman showed that around 41% of stroke survivors remained physically dependent (mRS>2) [14,15,16,18,26].

Hospital Length of Stay (LOS) is a widely adopted metric for evaluating hospital efficiency and quality of care. Lengthier stays can stem from comorbidities or hospital-acquired infections, and certain patient populations may be more prone to extended stays. [28]. The post code group had a lower median length of hospital stay (8 days) compared to the pre-code group (13 days), with a marginal trend towards statistical significance. Compared to local literature, a study of acute stroke patients with hemorrhagic transformation showed that two-thirds of them stayed in the hospital for more than two weeks, while another study found a median hospital stay of 5 days for patients admitted to the stroke unit versus 8 days for those admitted to a regular ward [29,30]. It is surprising to note that two decades ago, the median hospital stay for stroke patients was 60 days [31]. recent studies conducted in Oman and Egypt cohorts have reported the median hospital stays, with 7 days and 5 days respectively [26,32]. Another study with a similar quality improvement project achieved a reduction in hospital stay to five days, compared to double the length before the project [33].

Conclusion

In conclusion, the implementation of the Code Stroke project resulted in a significant reduction in the time to administer tPA, with two-thirds of patients receiving treatment within the recommended window as well as functional outcome. However, the incidence of symptomatic intracranial hemorrhage and in-hospital mortality rates were slightly higher than expected, highlighting the need for continued improvement efforts. Lastly, the project demonstrated a reduction in hospital

length of stay, indicating improved hospital efficiency and care quality. The study limitations include a small sample size and being conducted in a single center, making generalization to other populations and settings difficult. Future studies should address these limitations and investigate the project's improvement targets.

Conflict of interest

Nil

Financial support

Nil

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