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Performance of door-to-CT time of code stroke in Indonesian tertiary referral center hospital

Al Rasyid*![ORCID], Mohammad Kurniawan, Taufik Mesiano, Rakhmad Hidayat, Beny Rilianto and Salim Harris

Abstract

Background: This study was aimed to analyze the performance of door-to-CT scan (DTC) time of code stroke at the central referral hospital in Indonesia. Data from 310 patients were obtained in this cross-sectional study. Inclusion criteria were: notified with code stroke within the period between November 2016 and April 2019. Bivariate and multivariate analyses were carried out to find which factors affecting DTC time.

Results: A tendency of decreasing DTC time was reported from November 2016 until April 2019. The median DTC time at study endpoint was 19.5 (1–210) minutes. Chi-square analysis showed that CT scan location was the factor associated with DTC (OR: 12.6, 95% CI 6.8–23.35, $p < 0.001$). Logistic regressions analysis also showed significant relationship of CT scan location and DTC (OR: 24.27, 95% CI 17.71–30.81, $p < 0.05$).

Conclusions: Refinement of the code stroke implementation and CT scan placement in the Emergency Department (ED) are effective in reduction of DTC time, and as a result, improving acute stroke management.

Keywords: Stroke, Ischemic stroke, Emergency treatment, Computed tomography

Introduction

Stroke remains as a health burden in Indonesia and the world as it is associated with high disability and death [1]. Indonesian Stroke Registry data from 2012 to 2014 pointed out that the prevalence of ischemic stroke (67%) were higher than hemorrhagic stroke (33%) [2]. Every minute of acute ischemic stroke might result in the loss of 1.9 million [3]. Diagnostic neuroimaging is of the utmost vital component in acute stroke management. According to current guideline by American Heart Association (AHA) [4], CT scan of patients presented with acute stroke suspicion should be performed in less than 25 min since their arrival while the results should be interpreted within 45 min.

Acute ischemic stroke management consists of several stages covering the whole time from patient arrival at triage until thrombolytic therapy administration [5]. Time of DTC and door-to-needle (DTN) is influenced by collaborated medical team in which roles of members during those stages are varied. The DTC and DTN process require integrated communication and performance involving the emergency doctors, radiologists, neurologists, nurses, pharmacies, patients, and families.

The delay factors in DTC might be found even since the beginning of patient arrival. However, there were limited studies focusing on the door-to-CT scan (DTC) time, especially information regarding factors affecting DTC delays. This study was aimed to evaluate the performance of DTC as acute stroke patient management in the Emergency Department of Rumah Sakit Cipto Mangunkusumo (RSCM) Jakarta as the main referral hospital in Indonesia.

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Rasyid *et al. Egypt J Neurol Psychiatry Neurosurg*   (2022) 58:144

Page 2 of 5

Methods

We collected data from Code Stroke Registry of RSCM with submission period of November 2016 until April 2019. Participants in this study were acute ischemic stroke patients aged 18 years or older and presented to ED of RSCM within 6 h since onset (thus the code stroke ought to be activated). We excluded patients who required resuscitation (including intubation), arrived with no code stroke activation, and had uncompleted documentation of DTC time. The protocols number 19-04-0362 have been accepted by the Ethics Committee of the Faculty of Medicine. The research was performed with the knowledge and informed written consent of each participant and in compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) [6].

Statistical analysis was performed using Statistical Package for Social Sciences/SPSS version 20 (IBM Corp, Armonk, NY, USA). We dichotomized patients based on DTC time (≤ 25 min and > 25 min). Factors assumed to be associated with DTC time were also dichotomized except age. These factors included sex (male and female), symptoms onset (≤ 3 h and > 3 h), NIHSS score at admission (< 10 and ≥ 10) with the range from 5 to 42, location where CT scan was performed (non-emergency room and emergency room), and time admission (working hours and outside working hours).

Bivariate analysis was carried out using Chi-square or Fisher's exact test to seek whether the difference between two groups were significant. Factors affecting DTC were analyzed in bivariate model using Chi-square and multivariate model using logistic regression. The Chi-square analysis with *p* value of < 0.05 was later used to choose which factors would be analyzed using logistic regression. The association would be significant if *p* value is less than 0.05 and the 95% confidence interval of the odds ratio (OR) did not include value of 0.

Results

Data of 310 acute stroke patients with full documentation of DTC during November 2016 to April 2019 were obtained. The participants were predominantly male (57.74%), had DTC beyond 25 min (56.77%), presented within 3 h since onset (66.13%), owned NIHSS score equal to or greater than 10 (55.16%), had CT scan performed in emergency room (60.32%), and admitted outside the working hours (75.48%). The mean age of study participants was 55.75 ± 12.21 years old. Table 1 displays the demographic and clinical characteristics of study participants.

Between period of November 2016 and April 2019 DTC had decreased significantly with a difference of

Table 1 Demographic and clinical characteristics

Characteristics	Overall ($n = 310$)
Age (years old; mean $\pm$ SD)	55.75 ± 12.21
Gender (*n*; %)	
Male	179 (57.74)
Female	131 (42.26)
DTC time (*n*; %)	
≤ 25 min	134 (43.23)
> 25 min	176 (56.77)
Symptoms onset (*n*; %)	
≤ 3 h	205 (66.13)
> 3 h	105 (33.87)
NIHSS score (*n*; %)	
< 10	139 (44.84)
≥ 10	171 (55.16)
Location of CT scan performed (*n*; %)	
(Non-emergency room	123 (39.68)
Emergency room	187 (60.32)
Admission time (*n*; %)	
Working hours	76 (24.52)
Outside working hours	234 (75.48)

CT computed tomography; *DTC* door-to-CT; *NIHSS* National Institutes of Health Stroke Scale; *SD* standard deviation

DTC was measured by minutes

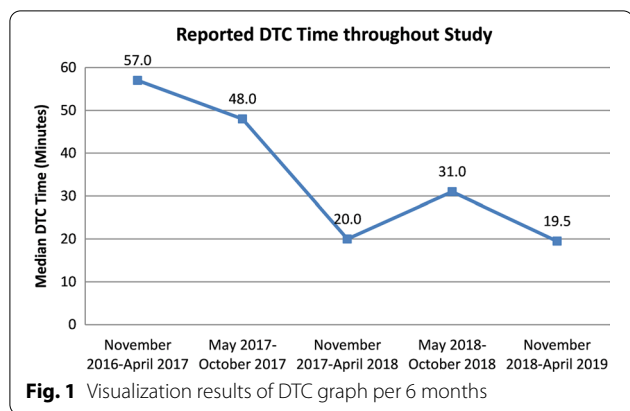**Table 2** Patients number and DTC time throughout study

Period	Patients (*n*)	DTC time [min; median (IQR)]
November 2016-April 2017	41	57 (18–132)
May 2017-October 2017	59	48 (21–123)
November 2017-April 2018	81	20 (3–167)
May 2018-October 2018	57	31 (3–160)
November 2018-April 2019	72	19.5 (1–210)

DTC was measured by minutes

DTC door-to-CT; *IQR* interquartile range

about 37.5 min (Table 2). From period of May and October 2018 the DTC time was increasing before decreased again until April 2019. The graph presenting the visualization data based on time series per semester or 6 months from 2016 to 2019 is available in Fig. 1. The median DTC time at the study endpoint was 19.5 (1–210) minutes.

Bivariate analysis using Chi-square showed that location of CT scan was factor associated with DTC (OR: 12.6, 95% CI 6.8–23.35, p < 0.05), as seen in Table 3. This association was validated further through logistic regressions analysis showing significant relationship of CT scan location and DTC (OR: 24.27, 95% CI 17.71–30.81,

Rasyid *et al. Egypt J Neurol Psychiatry Neurosurg*   (2022) 58:144

Page 3 of 5

Fig. 1 Visualization results of DTC graph per 6 months

$p < 0.05$). Age, sex, symptoms > 3 h, initial NIHSS score ≥ 10, and admission outside working hours were not associated with DTC time as shown by both bivariate and multivariate analyses.

Discussion

Time is the key in acute stroke management as dictated in "*time is brain lost*", either in hemorrhagic or ischemic type. Rapid response in treating acute stroke patients is associated with better patient outcomes and lower mortality rates in the hospital [7, 8]. However, as observed in emergency settings significant delays are often seen in

the treatment of patients with acute stroke, especially in limited-resource settings [9].

Given the potentially serious detrimental effects of stroke, it is important to give high priority to stroke patients in emergency settings [7]. Creating and implementing a fast response system is one useful approach to reduce the time delay from patients' arrival to initial treatment. Current global guidelines have recommended that DTC and DTN time ought to be 25 and 60 min or less of at least 80% thrombolysis candidates [4, 10]. Low DTC and DTN time are considered as important indicators of the good of stroke care.

We reported generally decreasing trend of DTC time since November 2016 in our institution. The median DTC time at study endpoint was 19.5 (1–210) minutes which was also the fewest median time recorded. The final and lowest DTC time reported have reached less than 25 min as recommended. This number was comparable to other DTC time reported in several developing countries, which is Iran, India, and Taiwan [11–13]. Delays in hospital treatment can be minimized with a systematic approach [14, 15]. We have made efforts to continue to reduce the time delay. Several steps our institution has taken including: (1) implementation and improvement of code stroke workflow; (2) training of stroke team members and other health personnel; (3) specialized stroke code hotline; (4) high

Table 3 Bivariate analysis

Variables	DTC time		P value	OR	CI 95%	
	≤ 25 Min	> 25 Min			Lower	Upper
Age	134	176	0.433[a]			
Sex						
Male	76	103	0.75[b]	0.929	0.589	1.463
Female	58	73				
Symptoms onset						
≤ 3 hours	91	114	0.563[b]	1.151	0.715	1.854
> 3 hours	43	62				
Initial NIHSS						
< 10	56	83	0.346[b]	0.804	0.511	1.266
≥ 10	78	93				
CT location						
Non-emergency room	15	108	**0.00[b]**	12.6	6.8	23.348
Emergency room	119	68				
Admission time						
Working hours	37	39	0.269[b]	1.34	0.797	2.253
Outside working hours	97	137				

DTC was measured by minutes

CT computed tomography; *DTC* door-to-CT; *OR*: odds ratio

[a] T-tests, [b] Chi-square. Significant value was remarked by bold

Rasyid *et al. Egypt J Neurol Psychiatry Neurosurg*   (2022) 58:144

Page 4 of 5

priority applications to patients presenting with stroke in ER; (5) procurement of stroke kit in ER and radiology installation; and (6) relocation of CT scan to ER.

The later seems to be important effort in reducing DTC at our institution. A multivariate analysis showed that CT scan location was the only factor associated with DTC time. A study of Bonadio and colleagues [16] revealed that CT scan relocation to within ER had increased patients with DTC time under 20 min by 29%. Another study from Dang and colleagues [17] showed that closer proximity of CT scan which was located 300 m from ER would reduce CT scan interpretation and patients' disposition.

The research has potential limitations, because it is observational, there are several variables that cannot be identified, which affect the DTC time, such as the ability to assess an acute stroke in triage.

Conclusion

There was a trend of declining time needed for stroke patients to reach CT scan examination since arrival throughout November 2016 and April 2019. CT scan location was a factor related to DTC time. To overcome the delay when handling the patient at the hospital, we suggested that it is necessary to optimize code stroke through several steps, including making CT scan easy for stroke patients to access. These improvement strategies should be implemented in 24 h a day for the whole week without being influenced by other factors.

Declarations

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