ORIGINAL ARTICLE

Stroke Code Implementation in A Physician-Led District Hospital in Malaysia

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ABSTRACT

Introduction: The past few years have shown a marked improvement in acute ischaemic stroke (AIS) thrombolysis therapy in Malaysia. We analysed our data on stroke code activation performed in a non-neurologist hospital. **Methods:** Data of all stroke code activated patients from September 2019 to September 2020 was collected. Demographic, clinical characteristics and outcomes of these patients were analysed and reviewed with published data in Malaysia. **Results:** Seventy cases were stroke code activated. Majority of the stroke cases (80%) were ischaemic in nature with the highest subgroups of lacunar infarct at 60.7%. Hypertension is the most prevalent risk factor followed by dyslipidaemia and diabetes. The median time for onset-to-door was 95minutes, door-to-CT was 24minutes, door-to-decision was 46.5 minutes and door-to-needle was 80minutes. There was a sequential reduction in median door-to-CT and door-to-needle time to 16.5 and 65.5minutes respectively. Fifteen patients (21.4%) were given thrombolysis therapy. The median NIHSS score was 7.5 on arrival and 6 upon discharge. They had an improvement of mRS from a median of 4 upon discharge to 1 at six months follow-up. There were no haemorrhage incidences post thrombolysis. The outcome of LACI strokes versus non-LACI strokes was similar at 3 and 6-months follow-up despite non-LACI strokes having a more severe presentation upon admission. **Conclusion:** With AIS thrombolysis therapy, non-LACI strokes may have similar functional outcomes as LACI strokes. With backup support from hospitals with neurologists and neurosurgeons, physician-led AIS thrombolysis therapy is implementable in a non-neurologist centre. Strong adherence to protocol is pertinent to ensure success.
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INTRODUCTION

Stroke is characterised by a sudden neurological deficit caused by an acute interruption of blood flow to the brain. Stroke has incapacitated countless victims and remains a leading cause of premature death worldwide (1). In Malaysia, up to two-thirds of stroke cases are due to ischaemia (2). In the last decade, stroke is the third leading cause of mortality in Malaysia with an average of at least one patient dying from stroke every hour (3). In 2016, stroke care accounted for 33,812 admissions in Malaysia at a cost of almost RM180 million (4).

Pathophysiologically, ischaemic stroke consists of a core infarcted area which is surrounded by a penumbra area. The infarcted core area is destined to die while the at-risk infarcted penumbra areas are potentially salvageable (5). For each minute of interrupted blood flow, roughly 1.9 million neurons are damaged with 1.8 days loss of physical function. Hence, the slogan "Time is Brain" is a concept supported by compelling data on early reperfusion therapy (6).

Intravenous recombinant tissue plasminogen activator (rTPA) is an evidence-based treatment (level 1A) available for acute ischaemic stroke aiming to restore blood circulation and salvaging the penumbra area. The landmark study by the National Institute of Neurologic Disorders rtPA Stroke Study, NINDS199 showed the efficacy of rTPA when administered within three hours of symptom onset, with minimal or no disability three months after a single 0.9mg/kg treatment (7). The American Stroke Association (ASA) subsequently recommends this treatment to further benefit those presented within 4.5 hours of symptoms onset (8). Although the benefits outweighed the risks, many clinicians are cautious about the potential risk of bleeding, especially cerebral haemorrhage of around 6% (7). Stringent criteria have been designed to minimise this adverse event. Therefore, a patient is only deemed suitable for thrombolysis treatment after

fullfilling specific requirements.

Hospital Sultan Abdul Halim (HSAH) is one of the new centres embarking on stroke thrombolysis led by non-neurologist physicians since 2019. This centre is equipped with a paperless Environmental Hospital Information System (eHIS), emergency departments, digitalised radiology services for rapid diagnostic imaging, fully computerised laboratory support, intensive care unit with paperless Critical Care Information System (CCIS), and physicians trained in the administration of stroke thrombolysis. There are no in-house neurologists or neurosurgeons. Complex cases were consulted via telemedicine with the nearest tertiary centres at Hospital Seberang Jaya, Hospital Canselor Tuanku Muhriz and Hospital Sultanah Bahiyah (9). Initially, stroke code activation was only available during office hours in the centre. Stroke code is activated if any patients with signs and symptoms of acute stroke that presents to the hospital within 4.5 hours from symptoms onset.

This study is important as there is still a limited number of district hospitals in the country providing acute stroke thrombolysis services. This study aims to review the data on stroke code implementation in HSAH since its commencement, looking into its clinical outcome and area for future improvement. Analysing these data would enable more hospitals to be set up and provide acute stroke thrombolysis services for the betterment of patients.

MATERIALS AND METHODS

This retrospective study was conducted in HSAH after the approval of the Malaysian Research Ethics Committee. (Study registration number: NMRR-20-2063-56172). Data of all patients who were stroke code activated from the start of stroke thrombolysis services in September 2019 until September 2020 were traced from the hospital record registry. Those with missing data were excluded. The identities of all patients were anonymized and kept confidential.

Socio-demography, comorbidities, types of stroke, timing from symptoms onset to hospital arrival (onset-to-door), duration from hospital arrival to computed tomography (CT) scan (door-to-CT), duration from hospital arrival to decision (door-to-decision) and duration from hospital arrival to thrombolysis (door-to-needle) were recorded. Clinical outcomes such as serial National Institutes of Health Stroke Scale (NIHSS) were recorded upon admission until the day of discharge while the Modified Rankin Scale (mRS) score were recorded up to 6-months follow-up. Complications post thrombolysis or acute stroke were recorded as well. A mRS score of 0–2 was classified as a good clinical outcome, whereas a score of 3–6 was categorised as a poor clinical outcome (10, 11). SPSS version 27 was used for data analysis. For categorical variables, frequencies and percentages were used. For numerical variables, mean and standard deviation were used. However, if data is skewed, medians, and interquartile range (IQR) were reported. Logistic regression analysis was conducted to identify factors associated with poor clinical outcomes. A value of $P<0.05$ is considered statistically significant.

RESULTS

Out of 1392 patients who were admitted for stroke, 70 were acute stroke cases arriving within 4.5 hours from onset during working hours and were stroke code activated. The demography and clinical characteristics of all acute stroke patients are detailed in Table I. The patients showed no significant gender difference with a median age of 58 (IQR, 19). The majority of the stroke cases were ischaemic in nature at 80%, while 15.7% was haemorrhgic. Three cases (4.3%) were stroke mimics due to functional disorder, hypokalemic periodic paralysis and cervical myelopathy respectively. Lacunar infarct (LACI) was the commonest subgroup of ischaemic stroke at 60.7%, followed by partial anterior circulatory infarct (PACI) at 19.6%, total anterior circulatory infarct (TACI) at 16.1% and posterior circulatory infarct (POCI) at 3.6% (Table I).

Scrutiny of the risk factors showed that hypertension is the most prevalent risk (64.3%) followed by dyslipidaemia (38.6%), diabetes (34.3%) and smoking (21.4%). Other risk factors were heart disease, atrial fibrillation, previous stroke or transient ischaemic attack, chronic kidney disease, malignancy, autoimmune disorder, thyroid disease and thalassemia (Table I).

The stroke code activation outcome revealed that the median onset-to-door time was 95 minutes (IQR, 93), door-to-CT scan time was 24 minutes (IQR, 29), door-to-decision time was 46.5 minutes (IQR, 37) and door-to-needle time was 80 minutes (IQR, 42) (Table I). Fifteen patients (21.4%) were given thrombolysis therapy.

For the thrombolysed cohort, an improvement in NIHSS score from a median of 9 (IQR 13) on admission to 6 (IQR, 13) upon discharge was observed (Fig. 1). They also had an improvement of mRS score from a median of 4 (IQR, 3) upon discharge to 1 (IQR, 3) at 6-months follow-up (Fig. 2).

As for complications, one patient developed post reperfusion seizure and one had atrial fibrillation post thrombolysis. There was one mortality due to massive cerebral infarct and edema despite thrombolysis being given on time (Table II). There was no haemorrhagic complications post thrombolysis from our centre. The median duration of hospital stay was 4 days (IQR, 3.3), whereby those who were thrombolysed stayed slightly longer at a median duration of 6 days (IQR, 8.0) for post thrombolysis monitoring and neurorehabilitation (Table I).

Table I: Presentation of all patients upon stroke code activation

	All (N = 70)	rtPA (N=15)	Non rtPA ischemic stroke (N=41)
	Demography		
Age, year[b]	58 (19)	55 (18)	63 (17)
Gender – Female/ Male[a]	34 (48.6) / 36 (51.4)	7 (46.7)/ 8 (53.3)	22 (53.7) /19 (46.3)
Duration of hospital stay, day[b]	4 (3.3)	6.0 (8.0)	3.0 (2.0)
	Comorbidities		
Hypertension [a]	45 (64.3) / 25 (35.7)	9 (60.0)/ 6 (40.0)	27 (65.9) /14 (34.1)
Dyslipidaemia[a]	27 (38.6) / 43 (61.4)	8 (53.3)/ 7 (46.7)	18 (43.9) /23 (56.1)
Diabetes mellitus[a]	24 (34.3) / 46 (65.7)	5 (33.3)/ 10 (66.7)	16 (39.0) /25 (61.0)
Smoker [a]	15 (21.4) / 55 (78.6)	4 (26.7)/ 11 (73.3)	9 (22.0) /33 (80.5)
Heart disease[a]	12 (17.1) /58 (82.9)	4 (26.7)/ 11 (73.3)	7 (17.1) /34 (82.9)
Atrial fibrillation[a]	7 (10.0) / 63 (90.0)	1 (6.7)/ 14 (93.3)	6 (14.6) /35 (85.4)
Stroke [a]	7 (10.0) / 63 (90.0)	1 (6.7)/ 14 (93.3)	9 (22.0) /32 (78.0)
Transient ischemic attack [a]	4 (5.7) / 66 (94.3)	1 (6.7)/ 14 (93.3)	3 (7.3) /38 (92.7)
Chronic kidney disease[a]	3 (4.3) / 67 (95.7)	0 (0.0)/ 15 (100.0)	3 (7.3) /38 (92.7)
Cancer [a]	2 (2.9) / 68 (97.1)	0 (0.0)/ 15 (100.0)	2 (4.9) /39 (95.1)
Autoimmune [a]	2 (2.9) / 68 (97.1)	0 (0.0)/ 15 (100.0)	2 (4.9) /39 (95.1)
Thyroid disease [a]	2 (2.9) / 68 (97.1)	0 (0.0)/ 15 (100.0)	1 (2.4) /40 (97.6)
Thalassemia Hb constant spring [a]	1 (1.4) / 69 (98.6)	0 (0.0)/ 15 (100.0)	1 (2.4) /40 (97.6)
	Types of strokes		
Ischaemic stroke [a]	56 (80.0)		
LACI [a]	34 (60.7)	7 (46.7)	27 (65.9)
PACI [a]	11 (19.6)	4 (26.7)	7 (17.1)
TACI [a]	9 (16.1)	3 (20.0)	6 (14.6)
POCI [a]	2 (3.6)	1 (6.7)	1 (2.4)
Haemorrhagic stroke [a]	11 (15.7)		
Intracerebral [a]	10 (90.9)	N/A	N/A
Extradural [a]	1 (9.1)	N/A	N/A
Stroke mimic [a]	3 (4.3)	N/A	N/A
	Stroke severity upon admission		
NIHSS on admission [b]	7.5 (14.0); 4	9.0 (13.0)	5.0 (13.0); 4
Minor (NIHSS 1-4) [b]	23 (34.8); 4	0 (0.0)	20 (48.8); 4
Moderate (NIHSS 5-15) [b]	24 (36.4); 4	10 (66.7)	11 (26.8); 4
Moderate-severe (NIHSS 16-20) [b]	12 (18.2); 4	4 (26.7)	6 (14.6); 4
Severe (NIHSS 21-42) [b]	7 (10.6); 4	1 (6.7)	4 (9.8); 4
	Clinical presentation		
Symptoms onset to door time, minute [b]	95.0 (93.0)	75.0 (52.0)	121.5 (104.0)
Door-to-CT time, minute [b]	24.0 (29.0)	27.0 (41.0)	24.0 (24.0)
Door-to-decision time , minute [b]	46.5 (37.0)	53.0 (41.0)	46.5 (38.0)
Door-to-needle time , minute [b]	N/A	80.0 (42.0)	N/A
CT-to-decision time , minute [b]	26.0 (33.0)	26.0 (25.0)	26.0 (33.0)
Decision-to-needle time , minute [b]	N/A	27.0 (27.0)	N/A
Thrombolysed [a]	15 (21.4) / 55 (78.6)	15 (21.4)	55 (78.6)
	Reason for not thrombolyse		
Haemorrhagic stroke/ transformation [a]	12 (21.8)	N/A	N/A
NIHSS <5 [a]	22 (40.0)	N/A	22 (53.7)
NIHSS >23 [a]	3 (5.5)	N/A	3 (7.3)
High risk [a]	4 (7.3)	N/A	4 (9.8)
Stroke mimic [a]	3 (5.5)	N/A	N/A
Rapid neurological recovery [a]	2 (3.6)	N/A	2 (4.9)
rtPA not available [a]	2 (2.9)	N/A	2 (4.9)
Wake up stroke [a]	2 (3.6)	N/A	2 (4.9)
Suspect contagious infection [a]	2 (3.6)	N/A	2 (4.9)
After office hour [a]	1(1.8)	N/A	1(2.4)
Persistent high BP [a]	1(1.8)	N/A	1(2.4)
Established stroke [a]	1(1.8)	N/A	1(2.4)

Abbreviations: BP, blood pressure; LACI, lacunar cerebral infarct; N/A, not applicable; NIHSS, National Institutes of Health Stroke Scale; PACI, partial anterior circulation infarct; POCI, posterior circulation infarction; rtPA, recombinant human tissue-type plasminogen activator; TACI, total anterior circulation infarct.

[a]Number: yes (%)/ no (%); missing data (if applicable).

[b]Median (IQR); missing data (if applicable).

Patient with PACI, TACI or POCI strokes presented with a significantly more severe form of stroke upon admission as compared to patient with LACI strokes (p = 0.022). Post thrombolysis, the improvement in NIHSS or mRS scores and post rTPA complications were not significantly different among patients with LACI strokes versus patients with PACI, TACI or POCI strokes (Table II).

For those who were not thrombolysed, 40% had NIHSS score <5, 7.3% was due to high risk of bleeding and 5.5% was due to NIHSS >23. Other causes include rapid neurological recovery, wake-up stroke, suspicion of contagious infection (pulmonary tuberculosis and Middle East respiratory syndrome coronavirus infection), rtPA not available, after office hour admissions, persistent high blood pressure >180/110 mmHg and established stroke (Table I).

DISCUSSION

The onset-to-needle time and door-to-needle time of our centre and other published data in Malaysia are shown in Table III.(11-19) Door-to-CT time was within the target of

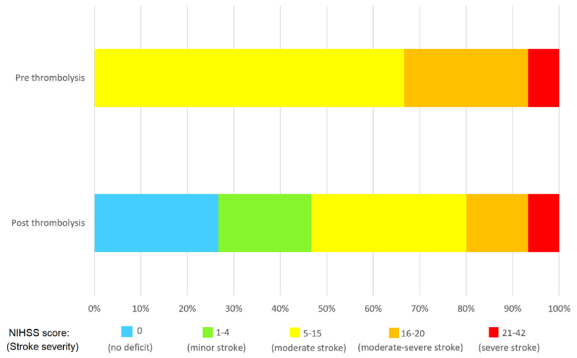

Fig. 1: Categories of National Institutes of Health Stroke Scale (NIHSS) score of post-thrombolysis patients upon discharge

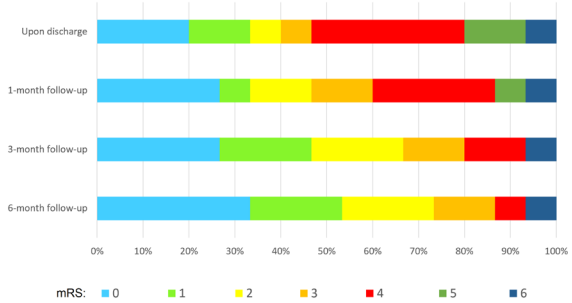

Fig. 2: Modified Rankin scale (mRS) of post thrombolysis patients up to 6-month follow-up

the American Stroke Association (ASA) recommendation of less than 25 minutes even at the first year of stroke code implementation. (20) Strong support from the Malaysian Stroke Council and nearby tertiary centres in terms of teleconsultation and intensive training had contributed to this positive outcome. (9) This was also partly due to the paperless hospital information system which enables speedy radio imaging interpretation as well as optimising telemedicine for rapid stroke code activation and consultation.(21) Furthermore, several physicians have previously been trained in a tertiary stroke centre. Moreover, this service was only available during office hours in our centre during the study period. Interestingly, the outcome of LACI strokes versus non-LACI strokes (PACI, TACI or POCI) is similar at 3-months and 6-months follow-up despite non-LACI strokes having a more severe presentation upon admission. This suggest that even a bigger stroke may eventually have a good outcome if patients are thrombolysed on time. Other possible factors for this outcome may also be due to the strict selection criteria of patients for rTPA and the small sample size in our study.

Using univariable logistic regression, there were no significant factors associated with poor clinical outcomes for patients post thrombolysis (Table IV). This

Table II: Clinical outcome of all acute stroke patients that was thrombolysed.

Clinical outcome	rtPA (N=15)
NIHSS on admission [a]	9.0 (13.0)
NIHSS 2-hour post rTPA [a]	10.0 (17.0)
NIHSS 24 hours post rTPA [a]	7.0 (14.0)
NIHSS upon discharge [a]	6.0 (13.0)
mRS upon discharge [a]	4.0 (3.0)
mRS at 1-month follow-up [a]	3.0 (4.0)
mRS at 3-months follow-up [a]	2.0 (3.0)
mRS at 6-months follow-up [a]	1.0 (3.0)
Post rtPA specific complications [b]	2 (13.3)
Reperfusion seizure [b]	1 (6.7)
Atrial fibrillation [b]	1 (6.7)
Other complications [b]	3 (20.0)
Pneumonia [b]	1 (6.7)
Urinary tract infection [b]	1 (6.7)
Evolving MCA infarct [b]	1 (6.7)
Functional outcome at 3-month follow-up:	
Good (mRS 0-2) [b]	10 (66.7)
Poor (mRS 3-6) [b]	5 (33.3)

Clinical outcome base on subtypes of ischaemic stroke

Clinical outcome	LACI (N=7)	Non-LACI (N=8)	*P*
Stroke severity upon arrival [c]			0.022
No (NHISS 0)	0	0	
Minor (NHISS 1-5)	7	3	
Moderate (NHISS 6-15)	0	4	
Moderate-Severe (NHISS 16- 20)	0	1	
Severe (NHISS 21- 42)	0	0	
Stroke severity upon discharge [c]			0.121
No (NHISS 0)	3	1	
Minor (NHISS 1-5)	1	2	
Moderate (NHISS 6-15)	3	2	
Moderate-Severe (NHISS 16- 20)	0	2	
Severe (NHISS 21- 42)	0	1	
Functional outcome at 3-month follow-up [c]			0.573
Good (mRS 0-2)	5	5	
Poor (mRS 3-6)	2	3	
Functional outcome at 6-month follow-up [c]			0.338
Good (mRS 0-2)	6	5	
Poor (mRS 3-6)	1	3	
Post rTPA complications [c]	0	2	0.267
Improvement in NIHSS score post rTPA upon discharge [d]	4.14 ± 2.67	2.87 ± 12.29	0.794
Improvement in mRS score post rTPA at 6-month follow-up [d]	0.86 ± 0.90	1.50 ± 1.20	0.258

Abbreviations: LACI, lacunar cerebral infarct; MCA, middle cerebral artery; mRS, Modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; rtPA, recombinant human tissue-type plasminogen activator.

[a] Median (IQR)

[b] Number (%)

[c] Fisher's exact test

[d] Mean ± standard deviation, independent T test

Table III: Published data on timing of acute stroke thrombolysis treatment in Malaysia

Studies	Period	Operation hours	Neurologist center	Onset-to-Door Time (minute)	Door-to-imaging Time (minute)	Thrombolysis	Door-to-Needle Time (minute)	Onset-to-reperfusion Time (minute)
Hashim et al (22)	2010 - 2011	24 hours	Yes	90 (83.8)[b]	85 (96.8)[b]	n = 8 * Includes thrombectomy	225 (144.3)[b]	290.5 (143.7)[b]
Asyraf et al (15)	2009 - 2015	24 hours	Yes	-	-	Pre-stroke unit (n=90) With stroke unit (n=32)	167.11 ± 55.8 [a] 112.6 ± 46.9 [a]	-
Aziz et al (12)	2009 - 2016	Mixed	Yes	-	-	n = 138	132 ± 78[a]	-
Asyraf et al (16)	2013 - 2015	24 hours	Yes	-	-	After hours (n=38) Office hour (n=31)	130.5 ± 45.8 [a] 92.8 ± 40.3 [a]	-
Tai et al (14)	2012 - 2016	24 hours	Yes	-	-	n = 36	-	211 ± 39.00 [a] 210 (150) [b]
Chew et al (11)	2012 - 2019	24 hours	Mixed	-	-	with neurologist (n = 37) without neurologist (n = 26)	112.1 ± 45.4 [a] 130.6 ± 52.6 [a]	203.1 ± 53.9 [a] 201.2 ± 59.5 [a]
Schee et al (18)	2013 - 2020	Mixed	Mixed	-	-	with neurologist (n=225) without neurologist (n=74)	91.6 ± 45.6 [a] 96.8 ± 40.7 [a]	-
Schee et al (17)	2018 - 2020	Mixed	No	-	-	n = 29	75 (50-115) [b]	210 (55)[b]
Neoh et al (19)	2019	Office hour	Yes	-	20 (29.8) [b] 80 (45.0) [b]	CT (n=8) hMRI (n=4)	75 (36.5) [b] 105 (5.0) [b]	-
Loh et al (13)	2019 - 2020	24 hours	Yes	27 (33.8) [b] 30 (34.1) [b]	24.5 (15.0) [b] 12 (12.0) [b]	Pre-COVID-19 period (n=11) COVID-19 period (n=37) * Includes thrombectomy	93.5 (29.0) [b] 60 (42.0) [b]	186.7 ± 45.7[a] 194.1 ± 52.3[a]
ASA recommendation (8)	**-**	**-**	**-**	**<180**	**<25**	**ASA recommendation**	**<60**	**<270**
Current study	2019 - 2020	Office hour	No	95 (93) [b]	24 (29) [b]	n = 15	80 (42)[b]	170 (51)[b]

Abbreviations: ASA, American Stroke Association; CT, Computed tomography; hMRI, hyperacute stroke magnetic resonance imaging.
[a] Mean ± SD
[b] Median (IQR)

Table IV: Univariable logistic regression on factors associated with poor clinical outcome for patients post thrombolysis (n=15)

Covariate	OR (95% CI; P Value)[a]
Demography	
Age, year[b]	1.116 (0.975-1.278; 0.111)
Gender [a]	0.333 (0.035-3.205; 0.341)
Duration of hospital admission, day[b]	0.969 (0.799-1.175; 0.747)
Hypertension [a]	5.250 (0.485-56.801; 0.172)
Dyslipidaemia[a]	0.125 (0.009-1.671; 0.116)
Diabetes mellitus[a]	3.200 (0.248-41.208; 0.372)
Smoker [a]	2.000 (0.150-26.734; 0.600)
Heart disease[a]	1.143 (0.077-16.947; 0.923)
NIHSS on admission [b]	1.164 (0.956-1.418; 0.131)
Symptoms onset to door time, minute [b]	1.000[c] (0.966-1.034; 0.988)
Door to CT time, minute [b]	1.020 (0.984-1.058; 0.280)
Door to decision time , minute [b]	1.016 (0.983-1.051; 0.341)
Door to needle time , minute [b]	1.017 (0.984-1.051; 0.323)
CT to decision time , minute [b]	0.983 (0.908-1.064; 0.672)
Decision to needle time , minute [b]	0.998 (0.929-1.073; 0.960)
NIHSS 2 hour post rTPA [b]	1.173 (0.982-1.401; 0.078)
NIHSS 24 hours post rTPA [b]	1.098 (0.956-1.261; 0.187)
NIHSS upon discharge [b]	1.107 (0.950-1.290; 0.193)
mRS upon discharge [b]	3.965 (0.730-21.544; 0.111)
Post rtPA specific complication[a]	0.500 (0.024-10.251; 0.653)

Abbreviations: mRS, Modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; rtPA, recombinant human tissue-type plasminogen activator.
[a]Calculated using logistic regression.
[b]OR for a 1-unit increase.
[c]OR value below 1.000 but close to 1.000

is probably due to the small sample size of our study since stroke code activation at our centre is still in its early phase.

Patients with independent recovery with a mRS score between 0 to 2 at 3-months follow-up were comparable to neurologist centres as well (11, 14). Among the fifteen cases that received rTPA, no haemorrhagic complications were encountered. Stringent patient selection may have contributed to this clinical outcome. However proper training of staff and patient selection plays an important role as well. Post stroke rehabilitation is also equally important to ensure the best functional outcome for patients.

According to a study by Wan Asyraf et al, there are more patients being thrombolysed after office hours (16). Thus, there is a need to extend thrombolysis services to 24 hours. With promising outcome from this early phase, we hope to run after-hours thrombolysis services as well to enable more patients to benefit from acute stroke thrombolysis treatment.

Looking at the performance trend, HSAH showed an improvement of door-to-imaging time & door-to-needle time over the study period. (Fig. 3) This trend is similar to other studies which showed improvement in door-to-needle time year by year. (Table III) For this centre, constant improvement in efficiency of stroke thrombolysis was done by constant auditing, trouble shooting and retraining to build a strong stroke team.
It should be noted that when interpreting Table III, comparative discrepancy should be taken into account. There are some centres that also included intra-arterial

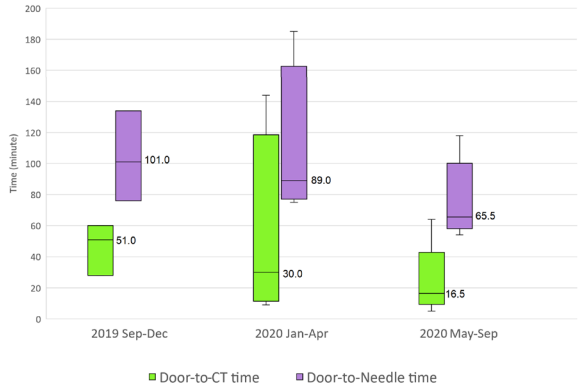

Fig. 3: Serial box plot showed a reducing trend in the median door-to-CT and door-to-needle time over 1 year period

thrombolysis and thrombectomy into their data which may take a longer time to prepare and perform.(13, 22) Thus, we need to take into consideration this mixture of cases on their clinical outcome discrepancy when comparing it with centres administering only intravenous rTPA usage.

The limitation of this study include that as this is a retrospective observational study, some cases had to be excluded due to missing or incomplete data. The sample size was small and may be underpowered to detect any significant differences in terms of functional outcomes and post thrombolysis complication.

CONCLUSION

With AIS thrombolysis therapy, non-LACI strokes may have similar functional outcomes as LACI strokes. With backup support from hospitals with neurologists and neurosurgeons, physician-led thrombolysis therapy for acute ischaemic stroke is implementable in a non-neurologist centre. However, adherence to protocol is pertinent to ensure success.

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