ORIGINAL ARTICLE

Comparing the administration of rt-PA among stroke fast track patients who arrived by emergency medical services and non-emergency medical services

Sirinapa Saneemanomai, MD

Division of Neurology, Department of Internal Medicine, Buddhasothorn Hospital, Chachoengsao, Thailand

ABSTRACT

Introduction: Stroke is a leading cause of death and disability worldwide. Prompt treatment with recombinant tissue plasminogen activator (rt-PA) and endovascular therapy improves outcomes in acute ischemic stroke. Although Emergency Medical Services (EMS) facilitate timely treatment. This study compared rt-PA administration rates and clinical outcomes between patients who arrived via EMS and those who did not in Mueang District, Chachoengsao Province.

Materials and Methods: A retrospective descriptive study was conducted from January 2021 to January 2024, including patients presenting within 4.5 hours of onset, without inter-hospital transfer, and completing 90-day follow-up. Data included transport mode, treatment times, and outcomes.

Results: Of 103 patients, 28 (27.2%) arrived by EMS and 75 (72.8%) by non-EMS. Lipid-lowering agent use was less frequent in the EMS group (17.9% vs. 46.7%, p = 0.008). Onset-to-hospital, door-to-needle, and onset-to-needle times showed no significant differences, and rt-PA administration rates were comparable. In univariable analysis, EMS patients had a higher median NIHSS score than non-EMS patients (median difference = 6.00, 95% CI: 0.99–11.01, p = 0.019), but this was not significant in multivariable analysis (median difference = 0.45, 95% CI: –1.99 - 2.84, p = 0.706). rt-PA was administered in 53.6% of EMS patients and 38.7% of non-EMS patients (p = 0.174). Mechanical thrombectomy was performed more often in EMS patients (42.9% vs. 22.7%, p = 0.043). Discharge NIHSS and 90-day mRS did not differ significantly.

Conclusion: EMS use was associated with greater thrombectomy referral but not with higher rt-PA administration rates or improved outcomes.

KEYWORDS:
Emergency medical services; Ischemic stroke; Patient Outcome Assessment; Stroke Fast Track

INTRODUCTION

Stroke stands as a primary cause of global mortality and long-term disability.[1] Thailand faces particularly high rates of stroke-related death and illness, with acute ischemic stroke incidence on the rise. National data (2009–2021) indicate a significant mortality rate (5.94% to 8.33%) among these patients[2], underscoring stroke's critical public health impact. Beyond patient impact, stroke places a substantial burden on caregivers requiring long-term support. Timely treatment is crucial for improving patient outcomes and family quality of life. Intravenous thrombolysis with recombinant tissue plasminogen activator (rt-PA) proves effective within 4.5 hours of symptom onset, with earlier administration significantly boosting survival; each 15-minute delay increases one-year mortality.[3] Endovascular therapy offers another effective intervention, especially for large-vessel occlusions, as per the 2019 AHA guidelines.[4] A Thai study reported high vessel recanalization (92.7%) and favorable outcomes (34.15% at 16 months)[5], supporting its role in stroke care. While Thailand's thrombolytic treatment system has advanced, with rt-PA use increasing from 0.18% to 8.04% (2009–2021)[2], Emergency Medical Services (EMS) utilization remains low (6.6%) 6, despite evidence indicating that EMS transport facilitates faster treatment[7,8]. Consequently, this study aims to compare rt-PA administration rates and treatment outcomes in acute ischemic stroke patients in Mueang District, Chachoengsao Province, between EMS and non-EMS users. The findings will inform strategies to enhance acute stroke care.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of Buddhasothorn Hospital (BSH-IRB No. 009/2567). A retrospective descriptive study was conducted, enrolling patients with symptomatic acute ischemic stroke in Mueang District, Chachoengsao Province, between January 1, 2021, and January 31, 2024.

Inclusion criteria were: direct admission to Buddhasothorn Hospital within 4.5 hours of symptom onset, no transfer from another hospital, no symptom onset during hospitalization, and completion of follow-up within 90 days after discharge. Data collected included basic demographics, history of cardiovascular and cerebrovascular diseases, history of drug use, smoking and alcohol consumption, history of antiplatelet or anticoagulant use, vital signs, use of EMS or non-EMS transport, symptoms at hospital admission, time from symptom onset to rt-PA administration, time to laboratory referral, time to brain CT scan, time from hospital arrival to rt-PA administration, referral for mechanical

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Corresponding Author: Sirinapa Saneemanomai
Email: Sirinapa.smd@gmail.com

Table I: Demographic and clinical characteristics of stroke fast track patients who arrived by emergency medical services and non-emergency medical services. (n = 103)

Characteristics	All patients (n = 103)	EMS (n = 28)	Non-EMS (n = 75)	p-value
Sex				
Female	45 (43.7)	9 (32.1)	36 (48.0)	0.149
Male	58 (56.3)	19 (67.9)	39 (52.0)	
Age (years)	66.15 ± 13.84	65.93 ± 14.27	66.23 ± 13.77	0.923a
Smoking	31 (30.1)	7 (25.0)	24 (32.0)	0.491c
Alcohol drinking	26 (25.2)	5 (17.9)	21 (28.0)	0.292c
Drug abuse	6 (5.8)	2 (7.1)	4 (5.3)	0.662d
Underlying disease				
Hypertension	92 (89.3)	26 (92.9)	66 (88.0)	0.723d
Dyslipidemia	79 (76.7)	20 (71.4)	59 (78.7)	0.439c
Diabetes mellitus	42 (40.8)	9 (32.1)	33 (44.0)	0.276c
Old CVA	10 (9.7)	2 (7.1)	8 (10.7)	0.724d
Ischemic heart disease	11 (10.7)	4 (14.3)	7 (9.3)	0.485d
Atrial fibrillation	13 (12.6)	2 (7.1)	11 (14.7)	0.506d
Old atrial fibrillation	1 (1.0)	0 (0.0)	1 (1.3)	1.000d
Others	18 (17.5)	5 (17.9)	13 (17.3)	1.000d
Medications				
Antihypertensive	63 (61.2)	15 (53.6)	48 (64.0)	0.334c
Lipid-lowering agent	40 (38.8)	5 (17.9)	35 (46.7)	0.008c
Antidiabetic	25 (24.3)	3 (10.7)	22 (29.3)	0.050c
Antiplatelet	14 (13.6)	4 (14.3)	10 (13.3)	1.000d
Anticoagulant	1 (1.0)	0 (0.0)	1 (1.3)	1.000d
Vital sign				
Systolic blood pressure (mmHg)	170.04 ± 30.01	172.36 ± 34.90	169.17 ± 28.18	0.634a
Diastolic blood pressure (mmHg)	94.17 ± 17.32	92.71 ± 20.15	94.72 ± 16.26	0.604a
Pulse rate (bpm)	83.48 ± 14.67	78.89 ± 12.13	85.19 ± 15.24	0.052a
Respiratory rate (rpm)	19.36 ± 1.92	18.79 ± 1.48	19.57 ± 2.04	0.064a
Body temperature (˚C)	36.73 ± 0.43	36.61 ± 0.36	36.78 ± 0.44	0.076a
NIHSS	7 (3 - 16)	12 (3.5 - 17.5)	5 (3 - 16)	0.112b
NIHSS >15 (severe)	28 (27.2)	8 (28.6)	20 (26.7)	0.847c
Glasgow coma scale	15 (11 - 15)	13.5 (11 - 15)	15 (11 - 15)	0.190b
Initial symptoms				
Weakness	64 (62.1)	18 (64.3)	46 (61.3)	0.783c
Dysarthria	6 (5.8)	2 (7.1)	4 (5.3)	0.662d
Ataxia	3 (2.9)	1 (3.6)	2 (2.7)	1.000d
Aphasia	10 (9.7)	2 (7.1)	8 (10.7)	0.724d
Seizure	2 (1.9)	1 (3.6)	1 (1.3)	0.472d
Facial palsy	4 (3.9)	2 (7.1)	2 (2.7)	0.297d
Numbness	10 (9.7)	0 (0.0)	10 (13.3)	0.058d
Coma	4 (3.9)	2 (7.1)	2 (2.7)	0.297d

Data are presented as number (%), mean ± standard deviation or median (interquartile range).
P-value corresponds to aIndependent samples t-test, bMann-Whitney U test, cChi-square test or dFisher's exact test.

Table II: Comparison of duration of treatment between stroke fast track patients who arrived by emergency medical services and non-emergency medical services. (n = 103)

Variables	All patients (n = 103)	EMS (n = 28)	Non-EMS (n = 75)	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Onset to ER (min)	106.74 ± 63.54	105.93 ± 67.05	107.04 ± 62.64	0.938
Door to laboratory (min)	30.55 ± 15.14	27.85 ± 9.90	31.54 ± 16.6	0.178
Door to CT (min)	13.29 ± 6.71	12.44 ± 5.32	13.60 ± 7.15	0.446
Door to needle time (min), (n = 46)	36.74 ± 12.07	37.33 ± 12.11	36.45 ± 12.24	0.819
Onset to rt-PA (min), (n = 46)	137.43 ± 52.97	149.47 ± 62.73	131.61 ± 47.59	0.289

†Independent samples t-test

Table III: Comparison of clinical outcomes between stroke fast track patients who arrived by emergency medical services and non-emergency medical services. (n = 103)

Variables	All patients (n = 103)	EMS (n = 28)	Non-EMS (n = 75)	p-value
Receiving rt-PA	44 (42.7)	15 (53.6)	29 (38.7)	0.174[c]
Subgroup NIHSS				
0-4	0 (0.0)	0 (0.0)	0 (0.0)	NA
5-14	23 (63.9)	9 (75.0)	14 (58.3)	0.326[c]
15-24	18 (75.0)	4 (80.0)	14 (73.7)	0.772[c]
≥25	3 (60.0)	2 (66.7)	1 (50.0)	1.000[d]
NIHSS <15	24 (32.0)	9 (45.0)	15 (27.3)	0.146[c]
NIHSS >15	20 (71.4)	6 (75.0)	14 (70.0)	0.791[c]
Refer MT	29 (28.2)	12 (42.9)	17 (22.7)	0.043[c]
MT	14 (13.6)	6 (21.4)	8 (10.7)	0.197[d]
NIHSS at baseline	7 (3 - 16)	12 (3.5 - 17.5)	5 (3 - 16)	0.112[b]
0-4	38 (36.9)	8 (28.6)	30 (40.0)	0.193[d]
5-14	36 (35.0)	12 (42.9)	24 (32.0)	
15-24	24 (23.3)	5 (17.9)	19 (25.3)	
≥25	5 (4.9)	3 (10.7)	2 (2.7)	
NIHSS >15 (severe) at baseline	28 (27.2)	8 (28.6)	20 (26.7)	0.847[c]
NIHSS at discharge	4 (1 - 13)	7 (1 - 18)	3 (1 - 11.5)	0.296[b]
0-4	56 (54.4)	12 (42.9)	44 (58.7)	0.378[d]
5-14	23 (22.3)	8 (28.6)	15 (20.0)	
15-24	9 (8.7)	2 (7.1)	7 (9.3)	
≥25	15 (14.6)	6 (21.4)	9 (12)	
NIHSS >15 (severe) at discharge	24 (23.3)	8 (28.6)	16 (21.3)	0.493[d]
mRS at discharge				
0	26 (25.2)	8 (28.6)	18 (24.0)	0.621[d]
1	21 (20.4)	3 (10.7)	18 (24.0)	
2	9 (8.7)	3 (10.7)	6 (8.0)	
3	4 (3.9)	0 (0.0)	4 (5.3)	
4	5 (4.9)	1 (3.6)	4 (5.3)	
5	26 (25.2)	9 (32.1)	17 (22.7)	
6	12 (11.7)	4 (14.3)	8 (10.7)	
mRS after discharge 90 days				
0	40 (38.8)	12 (42.9)	28 (37.3)	0.798[d]
1	18 (17.5)	3 (10.7)	15 (20.0)	
2	2 (1.9)	0 (0.0)	2 (2.7)	
3	4 (3.9)	1 (3.6)	3 (4.0)	
4	7 (6.8)	3 (10.7)	4 (5.3)	
5	14 (13.6)	3 (10.7)	11 (14.7)	
6	18 (17.5)	6 (21.4)	12 (16.0)	
Change in mRS	27 (26.2)	9 (32.1)	18 (24.0)	0.403[c]

Abbreviations: EMS, emergency medical services; mRS, Modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale.
Data are presented as number (%), mean ± standard deviation or median (interquartile range).
p-value corresponds to aIndependent samples t-test, bMann-Whitney U test, cChi-square test or dFisher's exact test.

thrombectomy, receipt of mechanical thrombectomy, NIHSS scores at admission and before discharge, and mRS scores at discharge and at 90 days post-discharge.

Outcome assessment

Outcome measures included the administration of intravenous rt-PA, referral for mechanical thrombectomy, and receipt of mechanical thrombectomy. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS), which ranges from 0 to 42, with higher scores indicating greater severity. Stroke severity was categorized as follows: 0–4 = mild impairment, 5–14 = moderate impairment, 15–24 = severe impairment, and ≥25 = very severe impairment. NIHSS scores were recorded at hospital admission and before discharge. Disability was assessed using the modified Rankin Scale (mRS), which ranges from 0 (no symptoms) to 6 (death), with higher scores indicating greater functional deficits. The mRS was assessed before discharge and at 90 days post-discharge.

Statistical analysis

The baseline demographic and clinical characteristics of acute ischemic stroke patients who arrived by Emergency Medical Services (EMS) and those who arrived without EMS (non-EMS) were presented as frequencies or percentages and compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables were presented as means ± standard deviation (SD) for normally distributed data or as medians and interquartile ranges for non-normally distributed data, as appropriate. The mean treatment duration between stroke fast-track patients who arrived by EMS and those who arrived by non-EMS was compared using an independent samples t-test. Clinical outcomes between stroke fast-track patients who arrived by EMS and non-EMS were compared using the independent samples t-test, Mann-Whitney U test, Chi-square test, or Fisher's exact test, as appropriate. To analyze the relationships among dependent and independent variables, including clinical outcomes, between stroke fast-track patients who arrived by EMS and those who arrived by non-EMS, univariate and multivariate

Table IV: Multivariable analyses for comparison of clinical outcomes between stroke fast track patients who arrived by emergency medical services and non-emergency medical services. (n = 103)

Variables	Univariable analysis		Multivariable analysis	
	Absolute difference/ Effect estimate (95% CI)	p-value	Absolute difference/ Effect estimate (95% CI)	p-value
Receiving rt-PA	1.83 (0.76, 4.40)[d]	0.176	1.47 (0.33, 6.48)[d]	0.611
Subgroup NIHSS				
0-4	-	NA	-	NA
5-14	2.14 (0.46, 9.98)[d]	0.331	-	NA
15-24	1.43 (0.13, 16.03)[d]	0.772	-	NA
≥25	2.00 (0.05, 78.25)[d]	0.711	-	NA
NIHSS <15	2.18 (0.75, 6.31)[d]	0.150	5.00 (0.93, 26.86)[d]	0.060
NIHSS >15	1.29 (0.20, 8.29)[d]	0.792	3.44 (0.09, 136.97)[d]	0.511
Refer MT	2.56 (1.02, 6.44)[d]	0.046	4.23 (0.91, 19.70)[d]	0.066
MT	2.28 (0.71, 7.31)[d]	0.164	3.31 (0.45, 24.54)[d]	0.242
NIHSS at baseline	6.00 (0.99, 11.01)[†]	0.019	0.45 (-1.93, 2.84)[†]	0.706
NIHSS >15 (severe) at baseline	1.10 (0.42, 2.89)[d]	0.847	0.32 (0.01, 8.98)[d]	0.502
NIHSS at discharge	4.00 (-0.67, 8.67)[†]	0.092	-1.18 (-4.98, 2.62)[†]	0.538
NIHSS >15 (severe) at discharge	1.48 (0.55, 3.96)[d]	0.441	1.23 (0.18, 8.39)[d]	0.834
mRS at discharge	1.28 (0.58, 2.82)[§]	0.539	0.89 (0.34, 2.34)[§]	0.813
mRS after discharge 90 days	1.02 (0.46, 2.28)[§]	0.953	0.54 (0.19, 1.57)[§]	0.261
Change in mRS	1.50 (0.58, 3.89)[d]	0.405	1.33 (0.43, 4.11)[d]	0.620

Abbreviations: EMS, emergency medical services; mRS, Modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale.
[†]Absolute difference is the median difference with 95%CIs from a median regression model.
[d]Effect estimate is odds ratio from a binary logistic regression model.
[§]Effect estimate is odds ratio from a ordinal logistic regression model.

linear regression analyses were performed. A two-sided α level of 0.05 was used for all tests. All analyses were conducted using Stata 17.0 (StataCorp, College Station, TX, USA).

RESULTS

This study aimed to compare the administration of thrombolytic agents (rt-PA) and treatment outcomes between acute ischemic stroke patients who visited Buddhasothorn Hospital with and without the use of the Emergency Medical Services (EMS) system. A total of 103 patients were included in the study, comprising 28 patients (27.2%) in the EMS group and 75 patients (72.8%) in the non-EMS group. The general and clinical characteristics of the patients showed that 56.3% were male, with a mean age of 66.15 ± 13.84 years.

Regarding medication history, the proportions of patients taking antihypertensive drugs were 53.6% in the EMS group and 64.0% in the non-EMS group (p = 0.334). For lipid-lowering agents, the proportions were 17.9% and 46.7%, respectively (p = 0.008). The use of antidiabetic medications was 10.7% in the EMS group and 29.3% in the non-EMS group (p = 0.050).(Table I)

The mean onset-to-hospital arrival time was 105.93 ± 67.05 minutes in the EMS group and 107.04 ± 62.64 minutes in the non-EMS group (p = 0.938). The mean times to laboratory examination and brain CT were 27.85 ± 9.90 and 12.44 ± 5.32 minutes, respectively, in the EMS group, compared with 31.54 ± 16.60 and 13.60 ± 7.15 minutes in the non-EMS group (p = 0.178 and p = 0.446, respectively). Among patients receiving intravenous thrombolysis, the mean door-to-needle time was 37.33 ± 12.11 minutes in the EMS group and 36.45 ± 12.24 minutes in the non-EMS group (p = 0.819), while the mean onset-to-needle time was 149.47 ± 62.73 and 131.61 ± 47.59 minutes, respectively (p = 0.289) (Table II).

A comparative analysis showed that 53.6% of EMS patients and 38.7% of non-EMS patients received thrombolytic therapy (p = 0.174, Table III). EMS users were 1.83 times more likely to receive rt-PA (95% CI: 0.76–4.40, p = 0.176), though not significant after adjustment (Adjusted OR = 1.47, 95% CI: 0.33–6.48, p = 0.611, Table IV). Referral for mechanical thrombectomy (MT) was higher in EMS patients (42.9% vs. 22.7%, p = 0.043, Table III), with a crude OR of 2.56 (95% CI: 1.02–6.44, p = 0.046) and an adjusted OR of 4.23 (95% CI: 0.91–19.70, p = 0.066, Table IV). Among those undergoing MT, 21.4% were EMS users and 10.7% non-EMS (p = 0.197, Table III), with no significant difference after adjustment (Adjusted OR = 3.31, 95% CI: 0.45–24.54, p = 0.242, Table IV). The median NIHSS score at admission was higher in EMS users (12 vs. 5, p = 0.112, Table III), with a significant crude difference (median difference = 6.00, 95% CI: 0.99–11.01, p = 0.019), but nonsignificant after adjustment (adjusted difference = 0.45, 95% CI: -1.93 to 2.84, p = 0.706, Table IV). At discharge, NIHSS was 6.5 for EMS and 3 for non-EMS patients (p = 0.296, Table III), with no significant crude or adjusted differences (Table IV).

At 90 days, functional outcomes by mRS were similar, with most patients achieving mRS 0 (42.9% EMS vs. 37.3% non-EMS, p = 0.798, Table III). Severe disability risk was comparable (Crude OR = 1.02, p = 0.953; Adjusted OR = 0.54, p = 0.261, Table IV). Disability worsening occurred in 32.1% of EMS and 24.0% of non-EMS patients (p = 0.403, Table III), with nonsignificant crude and adjusted odds (Adjusted OR = 1.33, p = 0.620, Table IV).

DISCUSSION

This study found a relatively low utilization rate of Emergency Medical Services (EMS) among acute ischemic stroke patients compared with previous reports [9], though higher than that reported by Gu et al. [10]. The difference may relate to patient selection, as only ischemic strokes within 4.5 hours were included, and to the urban setting of this study, where EMS access is more available.[9,10] Patients with hyperlipidemia were less likely to use EMS, possibly reflecting limited stroke education in NCD clinics.

EMS users presented with higher baseline NIHSS scores, consistent with previous studies[6,8-11] indicating that patients with more severe symptoms are more likely to call EMS. However, onset-to-door, door-to-needle, and onset-to-needle times did not differ significantly between groups. This may be explained by the stroke fast-track system. The lack of significant differences observed in this study highlights the need to refine EMS protocols to incorporate early clinical assessment and the initiation of intravenous antihypertensive therapy in hypertensive patients prior to hospital arrival. Such prehospital interventions could facilitate rt-PA eligibility upon admission and thereby diminish the expected time advantage of EMS utilization.

The rate of rt-PA use did not differ significantly, consistent with Phongphuttha et al. [8] but contrasting with Ekundayo et al. [9] and Gu et al. [10], who reported higher rt-PA administration rates among EMS users. These discrepancies may be due to differences in study design, sample size, or patient selection criteria. Referral for mechanical thrombectomy (MT) was higher among EMS users, reflecting a higher likelihood of large vessel occlusion in this group, though overall MT rates were lower than international reports [12], possibly due to differences in resources or treatment pathways. Functional outcomes at 90 days were similar across groups despite greater initial severity among EMS users, suggesting that rapid in-hospital management mitigated outcome disparities.

Clinically, these findings highlight the role of EMS in identifying severe cases and facilitating MT referral. Enhancing prehospital triage protocols and promoting EMS use among high-risk groups (e.g., diabetes, hyperlipidemia) may improve equity in stroke care. Limitations include the small sample size and single-center, urban setting, which may limit generalizability. Larger multicenter studies are needed to validate these findings and further assess the impact of prehospital interventions on treatment timelines and outcomes.

CONCLUSION

For acute stroke patients admitted to Buddhasothorn Hospital, the receipt of rt-PA treatment did not differ between those who used EMS services and those who did not. Similarly, there were no significant differences in NIHSS scores assessed prior to rt-PA administration and at discharge. Importantly, no significant difference was observed in mRS scores at follow-up, both before and after 90 days.

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ETHICS STATEMENT

This study was approved by the Ethics Committee of Buddhasothorn Hospital (BSH-IRB No. 009/2567). The authors adhered to the applicable EQUATOR Network guidelines (https://www.equator-network.org/) throughout the conduct of this research.

CONFLICT(S) OF INTEREST

None

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