Original Article

Outcome of Stroke Fast-Track Patients Arrival by Emergency Medical Services

Weerasak Phongphuttha, MD[1], Somsak Tiamkao, MD[2,3]

[1] Department of Emergency Medicine, Khon Kaen Hospital, Khon Kaen, Thailand
[2] Division of Neurology, Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand
[3] Integrated Epilepsy Research Group, Khon Kaen University, Khon Kaen, Thailand

Objective: To compare duration of door to needle time (DTN) of stroke patients between patients delivered to hospital by a stroke fast-track emergency medical system (SEFT) and those who came to hospital by a non-stroke EMS fast-track service (SNEFT) or, by themselves.

Materials and Methods: Retrospective descriptive study to compare the outcomes of stroke fast track patients.

Results: The present study retrieved medical records of 177 stroke fast track patients came to Khon Kaen hospital between October, 2018 and August, 2020. Over half the patients were male (60.5%). Ninety-nine (55.90%) came to hospital by Stroke EMS Fast Track (SEFT) and 78 (44.10%) by themselves or via Stroke Non-EMS Fast Track (SNEFT). The mean age of the SEFT and SNEFT groups was 62.11±13.63 and 59.37±15.39 years, respectively. Results showed the SEFT group had mean times door to CT, door to laboratory, door to physician, and door to needle of 16.53±4.63, 30.57±9.87, 33.99±15.16 and 45.37±7.91 minutes, respectively. Duration to treatment for all of the four treatment phases was statistically significantly shorter in the SEFT group than in the SNEFT group (p<0.001).

Conclusion: The SEFT group had significantly shorter door to CT, door to lab, door to physician, and door to needle time than SNEFT group.

Keywords: Stroke fast track, Emergency medical service system, Duration to treatment

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Stroke has high incidence rate globally and is the leading cause of disability and death. The mortality rate is 16.0 to 23.0% worldwide[1] and it is a major public health problem in Thailand[1]. It is the first and third cause of death among Thai women and men, respectively. The mortality rate is 10% and 50% of patients are left with disabilities[1]. The Thai Ministry of Public Health has a policy to develop treatment guidelines for stroke fast track patients to reduce the rate of death and disability as much as possible[1].

Khon Kaen Hospital is a hospital center under the Ministry of Public Health. It established a Stroke Fast Track in 2010[2] and has been continuously improving guidelines to increase efficiency. In 2017, there were 1,129 ischemic stroke patients, 268 were admitted according to the stroke fast track plan, and 88 of them were treated with thrombolytic therapy[2]. However, duration to treatment was delayed to specific neurological treatments[2] with poor outcomes for these patients.

There are several studies globally investigating aspects of duration to treatment for stroke patients. Mosley found that stroke patients reported on by emergency medical service (EMS) during ambulance transit had reduced door to physician time of 10 minutes[3]. In addition, it was found that transient ischemic attack (TIA) patients had lower rates of calls to EMS. Therefore, it was recommended that stroke fast-track guidelines should be promoted from pre-hospital, in the community, EMS, and in hospital[4].

Crocco studied the validity of a stroke diagnosis by the EMS team using the Cincinnati Pre hospital Stroke Scale (CPSS) that includes FAST symptoms, including facial weakness (Face), limb weakness or numbness (Arm), speech difficulty (Speech), time of onset of less than 4.5 hours (Time). The CPSS sensitivity was more than 90%[5]. This study also reported quick duration of onset to hospital, door to physician, door to CT scan brain, and also door to needle time.

Another study on EMS team's stroke diagnosis with MASS (Melbourne Ambulance Stroke Screen) in 850 patients found that sensitivity was 93%[6], and CPSS had 88% sensitivity (p = 0.120). Fothergill et al compared the stroke diagnosis of EMS teams using CPSS with ROSIER (Recognition of stroke in the emergency room). CPSSS had 97% sensitivity and 13% specificity, ROSIER had 97% sensitivity and 18% specificity, with no statistical difference

Correspondence to:
Tiamkao S.
Division of Neurology, Department of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.
Phone: +66-43-348397, **Fax:** +66-43-348397
Email: somtia@kku.ac.th

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detected[7]. Harbison compared validity of stroke diagnosis in 487 patients by primary care doctors (PCDs) and by paramedics. Results showed anterior circulation stroke diagnostic validity by paramedics was not statistically different from the PCDs, 39% and 14%, respectively (p<0.0001), while for lacunar stroke patients, paramedic diagnostic accuracy lower at 14%, than PCDs (31%) (p<0.001)[8].

Kwan[9] reported pre-hospital care system reduced onset to CT scan brain time from 5.2 to 3.3 hours, onset to needle time from 2.6 to 1.6 hours, and also increased rate of thrombolytic treatment from 2% to 11%. EMS guidelines for stroke patient treatment were able to reduce delayed to CT scan time from 63 minutes to 7 minutes (p<0.0001) and reduce door to needle time from 88 minutes to 55 minutes[10]. In 2018 the Emergency Medical Service (EMS) team of Khon Kaen Hospital established a Stroke Fast Track EMS Protocol (SEFT) with guidelines for patient treatment at the scene of the incident and/or in ambulance transit by the EMS. Patient information is reported to the emergency room, along with signs and symptoms of patients for confirmation of a stroke fast track patient. Emergency room physicians can decide on treatment using the fast-track protocol even before the patient arrives at the hospital. On arrival the patient can be taken for CT scan without having to go to the emergency room at all and drawn in the ambulance can be taken for testing immediately upon reaching the hospital. However, no study has yet been done evaluating the impact of this SEFT protocol on DTN.

This study was designed to compare duration to treatment access for patients who received a recombinant tissue Plasminogen Activator (rt-PA) under Stroke EMS Fast Track system (SEFT) protocols and patients who came to the hospital by themselves Stroke Non-EMS Fast Track (SNEFT). It studied duration to treatment time phases, as follows: door to CT, door to laboratory, door to physician, and door to needle time with the goal of further improving stroke fast track guidelines.

Materials and Methods

Study design

This was a retrospective descriptive study using records of stroke fast-track patients admitted to Khon Kaen Hospital between October 2018 to August 2020. Patients were divided in two groups: SEFT and SNEFT. The demographic data collected was gender, age, underlying disease (diabetes, hypertension, dyslipidemia, and heart disease), and risk factors included smoking, alcohol used and data on treatment duration, including door to CT scan (DTC), door to laboratory (DTL), door to physician (DTD), door to needle (DTN) time. Clinical findings included systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR), Glasgow Coma Scale (GCS), severity assessment score before and after rt-PA treatment (NIHS Scale), patient's CT scan results including cerebral infarction and cerebral hemorrhage.

Khon Kaen Hospital Stroke Fast-Track guidelines for the 2 two patient groups are as follows:

1) Acute stroke patients who came to emergency room by themselves within 4 hours 30 minutes (stroke non-EMS fast track, SNEFT) should be treated as follows:

Nurse at the screening point takes vital signs and patient's information from patient or relative. Then, medical record is prepared at registration section as soon as possible to activate stroke fast track procedure. Then stretcher staff take the patient to be weighed before being brought into the emergency room. Nurse informs the emergency physician and the doctor visits patient immediately. When stroke fast track (SFT) patient diagnosis is confirmed, then the doctor writes documents for CT scan brain (CT scan), and blood tests. Nurses perform blood collection for testing (including CBC, BUN/Cr, electrolyte, coagulogram, blood sugar, AST/ALT) and install intravenous opening for drug and intravenous fluid infusion.

Emergency physician informs the neurologist, radiologist, and evaluates the symptom and risk assessment for rt-PA treatment. When the patient returns from CT scan to the emergency room, the emergency physician evaluates CT scan. If cerebral hemorrhage is found, doctor will consult a neurosurgeon according to hospital guidelines. If the finding is cerebral infarction, the neurologist will assess before deciding on rt-PA treatment at stroke unit.

2) Acute stroke patients who come to emergency room via stroke fast-track EMS ambulance service (SEFT) should be treated as follows (Figure 1):

The EMS team is dispatched to a patient with a suspected acute stroke fast track. A history and physical examination is taken on site to confirm the diagnosis. If stroke fast track patient diagnosis confirmed, the following SEFT protocol guidelines will be followed.

The patient's information, including name,

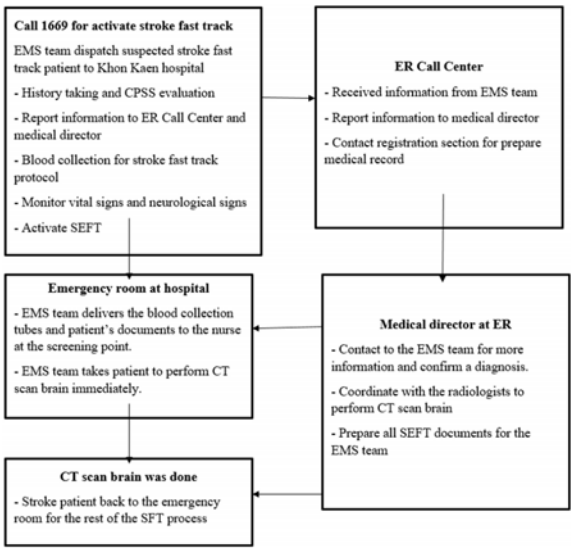

Figure 1. Khon Kaen Hospital Stroke EMS Fast Track protocol (SEFT protocol).

surname, 13-digit ID number, is passed to the emergency room's information center (ER Call Center), as well as the patient's current condition report. Nurse at the ER Call Center, passes information to the registration section to prepare medical record. Medical record will be taken to the medical screening point waiting to receive the EMS team and the ER Call Center nurse reports patient symptoms to the emergency physician. The emergency room physician contacts to the EMS team for more information to confirm a diagnosis and then coordinates with the radiologists to perform CT scan brain and prepares all SEFT documents for the EMS team arrival at the hospital.

The EMS team draws patient blood in the ambulance in accordance with SFT guidelines. The EMS team inserts an intravenous opening in readiness for drug and intravenous fluid infusion and stands by ready for treatment and surveillance according to pre hospital care principles.

Upon arrival at the hospital, the EMS team delivers the blood collection tubes and patient's documents to the nurse at the screening point. EMS team takes patient to perform CT scan brain immediately. After CT scan brain is complete, the stroke patient is returned to the emergency room for the rest of the SFT process.

Results

A total of 177 stroke fast track patient medical records were found, with 99 patients (55.90%) admitted under SEFT, and 78 (44.10%) patients under SNEFT protocols, respectively. 107 of 177 stroke patients were male, mean age 60.90±14.46 years, with the youngest aged 18 and the eldest 91 years. The mean ages of SEFT and SNEFT patients were 62.11±13.63 and 59.37±15.39 years. Regarding the underlying disease, 31.10% had diabetes mellitus, 44.60% hypertension, 7.90% dyslipidemia, and 10.20% had cardiovascular diseases. In terms of risk factors, 21.50% were smokers and 20.30% drank alcohol. Demographic data of both groups showed similar characteristic, with no statistically significant differences (Table 1).

From Table 2, shows the 177 patients had mean NIHS Scale, systolic blood pressure, heart rate, respiratory rate and Glasgow Coma Scale of 8.31±6.78, 166.42±35.00 mmHg, 84.72±18.12 beats/min, 19.51±4.57 times/min and 14.06±2.19 respectively. Systolic blood pressure, heart rate, and Glasgow Coma Scale scores were not statistically

Table 1. Demographic data of stroke fast track patients

Characteristics	SEFT (n = 99)		SNEFT (n = 78)		Total (n = 177)		*p*-value
	n	%	n	%	n	%	
Sex							0.111
Male	65	65.7	42	53.8	107	60.5	
Female	34	34.3	36	46.2	70	39.5	
Age (years)							
<30	1	1.0	2	2.6	3	1.7	
30 to 39	5	5.1	5	6.4	10	5.6	
40 to 49	13	13.1	12	15.4	25	14.1	
50 to 59	24	24.2	20	25.6	44	24.9	
60 to 69	24	24.2	16	20.5	40	22.6	
70 to 79	19	19.2	18	23.1	37	20.9	
80+	13	13.1	5	6.4	18	10.2	
Mean ± SD	62.11±13.63		59.37±15.39		60.90±14.46		0.212
Min-max	28 to 84		16 to 91		16 to 91		
Underlying disease							
Diabetes	31	31.3	24	30.8	55	31.1	0.938
Hypertension	45	45.5	34	43.6	79	44.6	0.804
Dyslipidemia	5	5.1	9	11.5	14	7.9	0.112
Heart disease	10	10.1	8	10.3	18	10.2	0.973
Risk factor							
Smoking	21	21.2	17	21.8	38	21.5	0.925
Alcohol used	23	23.2	13	16.7	36	20.3	0.281

SEFT = Stroke EMS Fast Track, SNEFT = Stroke Non-EMS Fast Track

different between the SEFT and SNEFT groups. However, the SEFT NIHS Scale was significantly higher than the SNEFT group (9.67±7.27 vs. 6.58±5.69; $p = 0.002$) while the mean respiratory rate for the SEFT group was significantly lower than the SNEFT group (18.83±5.76 vs. 20.38±2.04; $p = 0.014$). CT results showed 84.20% of the patients had cerebral infarcts, while the SEFT group had significantly higher hemorrhagic stroke than the SNEFT group (21.2% vs. 9%; $p = 0.037$).

From Table 3 shows most patients were assessed by a neurologist 81.90% at the emergency room, and 54 (30.50%) were treated with rt-PA. There was no significant difference for rt-PA treatment between SEFT and SNEFT groups.

Table 4 shows the mean treatment time durations for rt-PA, door to CT scan, door to laboratory, door to physician, and door to needle time mean were 27.22±13.50, 37.35±13.09, 39.94±16.07 and 54.93±19.93 minutes, respectively. The duration of treatment times in SEFT group, door to CT scan, door to laboratory, door to physician, and door to needle time mean were 16.53±4.63, 30.57±9.87, 33.99±15.16 and 45.37±7.91 minutes, respectively. The duration of the four treatment phases above was statistically significantly shorter for the SEFT group than the SNEFT group ($p<0.001$). Mean door to needle time for the SEFT group was 45.37±7.91 minutes shorter than the SNEFT group at 66.88±23.85 minutes.

Discussion

Mean door to needle time of the SEFT group was 45.37±7.91 minutes, shorter than the SNEFT group at 66.88±23.85 minutes. Similarly, mean duration to treatment for all other stroke fast track guideline procedures, door to CT scan, door to laboratory, door to physician, were shorter for the SEFT group than the SNEFT group. The mean door to needle time of SEFT group, 45.37±7.91 minutes, was well

Table 2. Vital signs, Glasgow Coma Score and CT scan brain

Characteristics	SEFT (n = 99)		SNEFT (n = 78)		Total (n = 177)		*p*-value
	Mean ± SD	Min-max	Mean ± SD	Min-max	Mean ± SD	Min-max	
NIHS scale	9.67±7.27	1 to 24	6.58±5.69	1 to 24	8.31±6.78	1 to 24	0.002*
Systolic blood pressure (mmHg)	166.48±35.40	102 to 258	166.35±34.71	101 to 246	166.42±35.00	101 to 258	0.979
Heart rate (beat/minute)	84.26±18.39	11 to 140	85.31±17.88	48 to 130	84.72±18.12	11 to 140	0.704
Respiratory rate (time/minute)	18.83±5.76	0 to 40	20.38±2.04	16 to 28	19.51±4.57	0 to 40	0.014*
Glasgow coma scale	13.84±2.51	5 to 15	14.33±1.67	7 to 15	14.06±2.19	5 to 15	0.118
CT scan brain; n (%)							
Hemorrhagic	21 (21.2)		7 (9.0)		28 (15.8)		0.037*
Ischemic	78 (78.8)		71 (91.0)		149 (84.2)		

SEFT = Stroke EMS Fast Track, SNEFT = Stroke Non-EMS Fast Track,
* Significant at $p<0.05$

Table 3. Evaluation and treatment

	SEFT (n = 99)		SNEFT (n = 78)		Total (n = 177)		*p*-value
	n	%	n	%	n	%	
Evaluation							0.408
Emergency physician reported to neurologist	20	20.2	12	15.4	32	18.1	
Neurologist at ER	79	79.8	66	84.6	145	81.9	
Treatment							0.947
Without rt-PA	69	69.7	54	69.2	123	69.5	
With rt-PA	30	30.3	24	30.8	54	30.5	

SEFT = Stroke EMS Fast Track, SNEFT = Stroke Non-EMS Fast Track

Table 4. Duration of treatment

Time (EMS: Non EMS: Total)	SEFT		SNEFT		Total		*p*-value
	Mean ± SD	Min-max	Mean ± SD	Min-max	Mean ± SD	Min-max	
Door to CT (99:78:177)	16.53±4.63	3 to 31	40.79±7.47	25 to 64	27.22±13.50	3 to 64	<0.001*
Door to laboratory (96:78:174)	30.57±9.87	10 to 60	45.69±11.69	23 to 100	37.35±13.09	10 to 100	<0.001*
Door to physician (79:66:125)	33.99±15.16	8 to 100	47.08±14.20	20 to 104	39.94±16.07	8 to 104	<0.001*
Door to needle time (30:24:54)	45.37±7.91	32 to 65	66.88±23.85	45 to 150	54.93±19.93	32 to 150	<0.001*
Door to needle time							<0.001*
Within 45 minutes	17 (56.7%)		1 (4.2%)		18 (33.3%)		
Over 45 minutes	13 (43.3%)		23 (95.8%)		36 (66.7%)		

SEFT = Stroke EMS Fast Track, SNEFT = Stroke Non-EMS Fast Track
* Significant at $p<0.05$

within the target stroke fast track guideline for Khon Kaen Hospital (less than 60 minutes). In terms of symptom severity, SEFT group had a higher average NIHS scale score of 9.67±7.27, while SNEFT group had a mean of 6.58±5.69. The Emergency Medical Service Team (EMS) was able to significantly shorten the access time for all procedures for patients it delivered to hospital. The result of the present study clearly showed shorted duration time to treatment for stroke fast track patients with thrombolytic treatment using SEFT protocol. This finding confirms previous studies[3-10]. We therefore recommend implement SEFT protocols for all hospitals in Thailand.

Limitations

As this was a retrospective medical records study there may be some incomplete information. Patient numbers were also small. Further studies should also evaluate stroke fast track service clinical outcomes such as recovery rate, death rate, and disability rate.

Conclusion

The results showed that the SEFT group had shorter door to CT scan brain, door to laboratory, door to physician, and door to needle times than the SNEFT group. The mean door to needle time for the SEFT group was 45.37±7.91 minutes. In addition, there was a significantly different door to needle time for the SEFT group (56.7% in less than 45 minutes), compared to le only 4.2% of the SNEFT group who achieved this.

What is already known in this topic?

Stroke fast track benefits duration to treatment times and reduces morbidity rate of stroke patients.

What this study adds?

Stroke EMS Fast Track protocol can reduce onset to needle time for thrombolytic treatment and duration times over all the various treatment phases under the stroke fast track guideline.

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Conflicts of interest

The authors declare no conflict of interest.

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