Prehospital Time of Suspected Stroke Patients Treated by Emergency Medical Service: A Nationwide Study in Thailand

Phantakan Tansuwannarat  
Mahidol University Faculty of Medicine Ramathibodi Hospital

Pongsakorn Atiksawedparit  
Mahidol University, Faculty of Medicine Ramathibodi Hospital  
pongsakorn.ati@mahidol.edu  
https://orcid.org/0000-0003-0336-3715

Arrug Wibulpolprasert  
Mahidol University Faculty of Medicine Ramathibodi Hospital

Natdanai Mankasetkit  
Mahidol University Faculty of Medicine Ramathibodi Hospital

Original Research

Keywords: stroke, EMS, ambulance, prehospital care, response time, Thailand

DOI: https://doi.org/10.21203/rs.3.rs-105691/v1

License: © Creative Commons Attribution 4.0 International License.  Read Full License
Abstract

Background: This study was to study the prehospital time among suspected stroke patients who were transported by emergency medical service (EMS) system using national database.

Methods: National EMS database across 77 provinces of Thailand among suspected stroke patients who were treated by EMS system between January 1, 2015 to December 31, 2018 was retrospectively analyzed. Demographic data (i.e., regions, shifts, levels of ambulance and distance to scene) and prehospital time (i.e., dispatch, activation, response, scene and transportation times) were extracted. Time parameters were also categorized according to guideline.

Results: In total 53,536 subjects were included in analysis. Most of the subjects were transported during 06.00-18.00 and were in 10 kilometers from ambulance parking. Half of the subjects were treated by advanced life support (ALS) ambulance. Median total time was 29 minutes (IQR: 21, 39) which was mainly occupied for transporting patient from scene to hospital. Although most of subjects had dispatch and activation times ≤ 2 minutes, but only 48.3% had RT ≤ 8 minutes. However, 95% of service were at scene ≤ 15 minutes. ALS ambulance had the longer total time, compared to first responder and basic level (30 minutes versus 28 and 27 minutes).

Conclusions: Prehospital time from EMS call to hospital was approximately 30 minutes among suspected stroke patients. This was mainly utilized for travelling from ambulance parking to scene and transporting patient from scene to hospital. Although only 48% of services had RT ≤ 8 minutes, but 95% of them had scene time ≤ 15 minutes.

Background

Cerebrovascular accident (stroke) is time sensitive condition in which blood vessel infarction or hemorrhage causes disorder to brain function. This is the leading cause of death and disability, worldwide (1). The prevalence of stroke and stroke related death ranged from 60–700 per 100,000 population and 22.4-263.9 per 100,00 population, respectively (1, 2). To reduce magnitude of death and disability, stroke chain of survival has been introduced which included early recognition of signs/symptom of stroke, activation of emergency medical service (EMS) with timely response, transport to stroke center with pre-arrival notification, and implementing guideline based stroke care with high quality post-stroke rehabilitation (3, 4). Currently, several evidences indicated applying EMS system to stroke care process improved quality and decreased prehospital delays (5–7). Therefore, American Heart Association and American Stroke Association (AHA/ASA) introduced specific parameters to measure the quality of EMS care for stroke patients which included the highest level of care available for suspected stroke patients, dispatch time ≤ 90 seconds, activation time ≤ 90 seconds, response time (RT) ≤ 8 minutes and on-scene time ≤ 15 minutes (3).

In Thailand, prevalence of stroke was 122 per 100,000 population (8) and increased to 1.88% in 45 years old or older people (9). This was also one of the top 3 rank causes of burden of disease among the Thai population (10). Stroke fast track protocol has been widely implemented in emergency departments (ED) though in-hospital care process in Thailand. However, combining of EMS system into this protocol was not systematically initiated because EMS system is still in developing stage. To identify a strategy for developing EMS stroke fast track, the current situation of EMS performance among suspected stroke patients should be determined. Therefore, we aimed to study the prehospital specific parameters among suspected stroke patients who were transported by EMS system using national database.

Methods

Study design

We conducted a nationwide cross-sectional study among suspected stroke patients who were transported to hospital by EMS system in Thailand between January 1, 2015 to December 31, 2018. This study was approved by the Ethic Committee of Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand with a waiving of informed consent.

Study setting and population
In 2019, there were approximately 66.5 million people (11) who lived in 76 provinces and 1 capital city, Bangkok, which is categorized according to geography into 6 regions (i.e., north, north-east, middle, east, west and south), see Figure 1(A) (12). Each province is divided into districts and there are provincial and district hospitals based.

For a decade, multi-tiers ground EMS system in Thailand has been established to cover prehospital care. Dispatch centers were located at provincial hospitals. Levels of ambulance are divided into advance life support (ALS), intermediate life support (ILS), basic life support (BLS) and first responder (FR). ALS ambulances are fixed deploying model and parked at provincial and district hospitals, whereas BLS and FR are fluid deploying model. Dispatch center categorizes all emergency calls into one of 25 criteria-based dispatch (CBD) chief complaints and subsequently prioritizes the severities which aims to dispatch appropriate level of ambulances. In case of ALS ambulance is not available, the highest ambulance available is dispatched. Generally, patients are sent to the nearest hospital after prehospital treatment. Information during prehospital operation have to be uploaded to the national database via Information Technology for Emergency Medical System (ITEMS) which is managed by National Institute for Emergency Medicine of Ministry of Public Health.

This study enrolled all suspected stroke adult patient CBD code 18: paralysis (weakness/ loss of sensation) who were transported to hospital by EMS system between January 1, 2015 to December 31, 2018. We excluded patients whose time variables were missing.

**Variables and data collection**

All data were retrieved from ITEMS database. Duplicated records were explored and excluded. Data was cleaned and checked for correctness before final analysis. The primary outcome was prehospital time intervals (i.e., dispatch, activation, response, scene and transportation times). Definitions of prehospital time were described as Figure 2. Dispatch triage was prioritized into emergency and urgency levels.

**Statistical analysis**

Complete case analysis was applied. Continuous and categorical data were displayed as median (interquartile range; IQR) and number (%), respectively. Dispatch time, activation time, RT and distance from EMS base to scene were categorized, according to cut off point of national key performance indicator (KPI) (3, 13, 14). Further, the scene time was categorized based on AHA/ASA 2018 recommendation (3). The Chi² test was used to compare the difference between categorical data, whereas more than 2 groups of continuous data were compared by Kruskal Wallis test. All analyses were performed using STATA version 15.0 (Stata Corp, College Station, Texas, USA), except map charts which were constructed by Microsoft Excel (2019). Statistical significance was considered if P value < 0.05.

**Results**

During the study period, there were 55,372 suspected stroke subjects who were transported to emergency room by ambulance. Of those, 1,836 (3.3%) subjects were excluded due to incomplete information. Therefore, 53,536 subjects were included in final analysis.

**Characteristics of EMS operation**

Most of the subjects were in North-East region (38.9%). Approximately 77.5% of subjects were transported during 06.00–18.00. Only half of subjects were treated by ALS ambulance and prioritized into emergency level. There was 80.2% of subjects who were within 10 kilometers from ambulance parking. The characteristics of subjects from 2015 to 2018 were consistent, see Table 1.
| Characteristics | Total | Years |
|----------------|-------|-------|
|                | n     | (%)   | n     | (%)   | n     | (%)   | n     | (%)   |
|                | 53,536 | (100) | 9,829 | (100) | 11,844 | (100) | 14,456 | (100) | 17,407 | (100) |
| Regions       |       |       |       |       |       |       |       |       |       |
| North         | 4,736 | (8.8) | 764   | (7.8) | 1,088  | (9.2) | 1,306  | (9)   | 1,578   | (9.1) |
| North-East    | 20,831 | (38.9)| 4,100 | (41.7)| 4,565  | (38.5)| 5,645  | (39)  | 6,521   | (37.5)|
| West          | 3,587 | (6.7) | 684   | (7)   | 815    | (6.9)| 895    | (6.2) | 1,193   | (6.9) |
| Middle        | 9,926 | (18.5)| 1,761 | (17.9)| 2,085  | (17.6)| 2,761  | (19.1)| 3,319   | (19.1)|
| East          | 3,482 | (6.5) | 583   | (5.9) | 776    | (6.6)| 949    | (6.6) | 1,174   | (6.7) |
| South         | 8,072 | (15.1)| 1,523 | (15.5)| 1,752  | (14.8)| 2,140  | (14.8)| 2,657   | (15.3)|
| Bangkok       | 2,902 | (5.4) | 414   | (4.2) | 763    | (6.4)| 760    | (5.3) | 965     | (5.5) |
| Shift         |       |       |       |       |       |       |       |       |       |
| 06.00–18.00   | 41,476 | (77.5)| 7,634 | (77.7)| 9,169  | (77.4)| 11,264 | (77.9)| 13,409  | (77) |
| 18.00–06.00   | 12,060 | (22.5)| 2,195 | (22.3)| 2,675  | (22.6)| 3,192  | (22.1)| 3,998   | (23) |
| Levels        |       |       |       |       |       |       |       |       |       |
| ALS           | 26,813 | (50.1)| 4,855 | (49.4)| 5,910  | (49.9)| 7,336  | (50.7)| 8,712   | (50) |
| ILS and BLS   | 8,502 | (15.9)| 1,718 | (17.5)| 1,877  | (15.8)| 2,135  | (14.8)| 2,772   | (15.9)|
| FR            | 18,221 | (34) | 3,256 | (33.1)| 4,057  | (34.3)| 4,985  | (34.5)| 5,923   | (34) |
| Dispatch triage|       |       |       |       |       |       |       |       |       |
| Emergency     | 27,940 | (52.2)| 5,041 | (51.3)| 6,157  | (52) | 7,641  | (52.9)| 9,101   | (52.3)|
| Urgency       | 25,596 | (47.8)| 4,788 | (48.7)| 5,687  | (48) | 6,815  | (47.1)| 8,306   | (47.7)|
| Distance (kms), median (IQR) | | | | | | | | | |
| ≤ 10 kms      | 42921 | (80.2)| 7893 | (80.3)| 9563 | (80.7)| 11541 | (79.8)| 13924 | (80) |
| > 10 kms      | 10615 | (19.8)| 1936 | (19.7)| 2281 | (19.3)| 2915 | (20.2)| 3483 | (20) |
| Dispatch time |       |       |       |       |       |       |       |       |       |
| > 2 minutes   | 2262 | (4.2) | 343  | (3.5) | 504  | (4.3) | 548  | (3.8) | 867 | (5) |
| ≤ 2 minutes   | 51274 | (95.8)| 9486 | (96.5)| 11340 | (95.7)| 13908 | (96.2)| 16540 | (95) |
| Activation time|       |       |       |       |       |       |       |       |       |
| > 2 minutes   | 6262 | (11.7)| 1038 | (10.6)| 1368 | (11.6)| 1698 | (11.7)| 2158 | (12.4)|
| ≤ 2 minutes   | 47274 | (88.3)| 8791 | (89.4)| 10476 | (88.4)| 12758 | (88.3)| 15249 | (87.6)|
| Response time |       |       |       |       |       |       |       |       |       |
| > 8 minutes   | 27661 | (51.7)| 4900 | (49.9)| 6009 | (50.7)| 7578 | (52.4)| 9174 | (52.7)|

ALS = advanced life support; BLS = basic life support; FR = first responder; kms = kilometers; ILS = intermediate life support; IQR = interquartile range.
| Characteristics | Total | 2015 | 2016 | 2017 | 2018 |
|-----------------|-------|------|------|------|------|
| ≤ 8 minutes     | 25875 | 4929 | 5835 | 6878 | 8233 |
| Scene time      |       |      |      |      |      |
| > 15 minutes    | 2,682 | 419  | 646  | 732  | 885  |
| ≤ 15 minutes    | 50854 | 9410 | 11198| 13724| 16522|

ALS = advanced life support; BLS = basic life support; FR = first responder; kms = kilometers; ILS = intermediate life support; IQR = interquartile range.

Table 2 described number (%) of subjects who were ≤ 10 kilometers versus > 10 kilometers from ambulance parking. Results indicated these percentages ranged from 70–84.7% across 6 regions, whereas only 66.3% was found in Bangkok. Compared to ALS ambulance, subjects who were transported by FR were significantly nearer than BLS and ALS ambulance (90.4% versus 83% and 72.3%, respectively).
| Factors         | N   | ≤ 10 kilometers | > 10 kilometers | P value |
|-----------------|-----|-----------------|-----------------|---------|
|                 | n   | (%)            |     n           | (%)     |
| Regions         |     |                |                 |         |
| North           | 4,736 | 3,827.00 (80.8) | 909 (19.2) | <0.001 |
| North-East      | 20,831 | 17,291.00 (83) | 3,540.00 (17) |         |
| West            | 3,587 | 2,820.00 (78.6) | 767 (21.4) |         |
| Middle          | 9,926 | 7,778.00 (78.4) | 2,148.00 (21.6) |         |
| East            | 3,482 | 2,439.00 (70) | 1,043.00 (30) |         |
| South           | 8,072 | 6,841.00 (84.7) | 1,231.00 (15.3) |         |
| Bangkok         | 2,902 | 1,925.00 (66.3) | 977 (33.7) |         |
| Shifts          |     |                |                 |         |
| 06.00–18.00     | 41,476 | 32,908.00 (79.3) | 8,568.00 (20.7) | <0.001 |
| 18.00–06.00     | 12,060 | 10,013.00 (83) | 2,047.00 (17) |         |
| Levels          |     |                |                 |         |
| ALS             | 26,813 | 19,395.00 (72.3) | 7,418.00 (27.7) | <0.001 |
| ILS and BLS     | 8,502 | 7,053.00 (83) | 1,449.00 (17) |         |
| FR              | 18,221 | 16,473.00 (90.4) | 1,748.00 (9.6) |         |
| Dispatch triage |     |                |                 |         |
| Emergency       | 27,940 | 20,846.00 (74.6) | 7,094.00 (25.4) | <0.001 |
| Urgency         | 25,596 | 22,075.00 (86.2) | 3,521.00 (13.8) |         |

ALS = advanced life support; BLS = basic life support; FR = first responder; kms = kilometers; ILS = intermediate life support.

Characteristics of EMS operation (i.e. Phone triage and levels of ambulance) among 6 regions and Bangkok were different, see Table 3. The percentage of subjects who were prioritized to be emergency level ranged from 33.3–85.1%. The higher percentage of emergency case, the higher percentage of ALS ambulance were deployed. There was no FR ambulance dispatched among subjects in Bangkok.
Table 3
Characteristics of EMS operation based on regions

| Characteristics | Regions | North | North-East | West | Middle | East | South | Bangkok |
|-----------------|---------|-------|------------|------|--------|------|-------|---------|
|                 | n (%)   | n (%) | n (%)      | N (%)| n (%)  | n (%)| n (%) | n (%)   |
| Phone Triage    |         |       |            |      |        |      |       |         |
| Emergency       | 2,126 (55.6) | 5,759 (33.3) | 1,347 (47.8) | 5,266 (67.7) | 1,436 (58.9) | 3,273 (47.8) | 1,639 (85.1) |
| Urgency         | 1,701 (44.4) | 11,532 (66.7) | 1,473 (52.2) | 2,512 (32.3) | 1,003 (41.1) | 3,568 (52.2) | 286 (14.9) |
| Levels          |         |       |            |      |        |      |       |         |
| ALS             | 1,883 (49.2) | 5,204 (30.1) | 1,520 (53.9) | 5,085 (65.4) | 1,411 (57.9) | 2,674 (39.1) | 1,618 (84.1) |
| ILS and BLS     | 642 (16.8) | 2,733 (15.8) | 657 (23.3) | 1,038 (13.3) | 94 (3.9) | 1,582 (23.1) | 307 (15.9) |
| FR              | 1,302 (34.0) | 9,354 (54.1) | 643 (22.8) | 1,655 (21.3) | 934 (38.3) | 2,585 (37.8) | 0       |

ALS = advanced life support; BLS = basic life support; FR = first responder; ILS = intermediate life support.

EMS operation times

During the study period, percentage of dispatch and activation times ≤ 2 minutes were 98% and 88.3%, respectively. There was only 48.3% of total operations had RT ≤ 8 minutes. However, most of operations (95%) were at scene in less than 15 minutes. These statistics for years 2015 to 2018 were not much different, see Table 1. Median total prehospital time among enrolled subjects was 29 minutes (IQR: 21, 39). Most of the total time was occupied by transportation time (median 10 minutes with IQR 6, 17), response time (median 9 minutes with IQR 5, 14) and scene time (median 10 minutes with IQR 2, 8), respectively. Among 3 levels of ambulances, dispatch and activation times were not clinically different. Compared to ILS/ BLS and ALS ambulance, response time and scene time of FR was shorter, but transportation time was longer. ALS ambulance had the longest total prehospital time, see Table 4.

Table 4
EMS operations times among suspected stroke patients based on levels of ambulance

| Times                      | overall | Levels of ambulance |
|----------------------------|---------|---------------------|
|                            | FR      | ILS and BLS | ALS   | P value |
| Dispatch time              | 1 (1, 1)| 1 (1, 1)     | 1 (1, 1)| 1 (1, 1) | < 0.001 |
| Activation time            | 1 (1, 2)| 1 (1, 1)     | 1 (0, 1)| 1 (1, 2) | < 0.001 |
| Response time              | 9 (5, 14)| 6 (4, 10)| 8 (5, 13)| 11 (7, 17)| < 0.001 |
| Scene time                 | 5 (2, 8)| 3 (2, 5)     | 4 (2, 7)| 5 (3, 10)| < 0.001 |
| Transportation time        | 10 (6, 17)| 14 (8, 21)| 10 (5, 15)| 9 (5, 14)| < 0.001 |
| Total prehospital time     | 29 (21, 39)| 28 (20, 37)| 27 (19, 36)| 30 (21, 42)| < 0.001 |

ALS = advanced life support; BLS = basic life support; FR = first responder; ILS = intermediate life support.

The result indicated the percentage of RT ≤ 8 minutes ranged from 13.1–56.6% across 6 regions. The highest percentage was found in the north-east, whereas the lowest percentage was found in Bangkok. Operation during 18.00–06.00 achieved RT ≤ 8 minutes more than in 06.00–18.00 (51.2% versus 47.5%). Operation by FR had the highest percentage of RT ≤ 8 minutes, compared to BLS and ALS teams with 67.3% versus 53.3% and 33.9%, respectively. Operations which were prioritized to be emergency level
had lower percentage of RT $\leq 8$ minutes, compared to urgent cases (38.2% versus 59.4%). There was higher percentage of RT $\leq 8$ minutes when considered only subjects who were within 10 kilometers from ambulance parking, see Table 5.

| Factors            | Overall (N = 53,536) | ≤ 10 kms distance (N = 42,921) |
|--------------------|----------------------|---------------------------------|
|                    | Total ≤ 8 minutes | > 8 minutes | P       | Total ≤ 8 minutes | > 8 minutes | P       |
|                    | n       | %          | n       | %          | n       | %          | n       | %          |
| Region             |          |            |          |            |          |            |          |            |
| North              | 4,736   | (45.9)     | 2,564   | (54.1)     | < 0.001 | 3,827   | (55.8)     | 1,693   | (44.2)     | < 0.001 |
| North-East         | 20,831  | (56.6)     | 9,032   | (43.4)     | 17,291  | 11,606   | (67.1)     | 5,685   | (32.9)     |
| West               | 3,587   | (46.1)     | 1,933   | (53.9)     | 2,820   | 1,624    | (57.6)     | 1,196   | (42.4)     |
| Middle             | 9,926   | (40.3)     | 5,926   | (59.7)     | 7,778   | 3,927    | (50.5)     | 3,851   | (49.5)     |
| East               | 3,482   | (36.5)     | 2,212   | (63.5)     | 2,439   | 1,234    | (50.6)     | 1,205   | (49.4)     |
| South              | 8,072   | (57)       | 3,471   | (43)       | 6,841   | 4,519    | (66.1)     | 2,322   | (33.9)     |
| Bangkok            | 2,902   | (13.1)     | 2,523   | (86.9)     | 1,925   | 331      | (17.2)     | 1,594   | (82.8)     |
| Shifts             |          |            |          |            |          |            |          |            |
| 06.00–18.00        | 41,476  | (47.5)     | 21,780  | (52.5)     | < 0.001 | 32,908  | 19,300     | (58.6)  | 13,608     | (41.4)  | < 0.001 |
| 18.00–06.00        | 12,060  | (51.2)     | 5,881   | (48.8)     | 10,013  | 6,075    | (60.7)     | 3,938   | (39.3)     |
| Levels             |          |            |          |            |          |            |          |            |
| ALS                | 26,813  | (33.9)     | 17,719  | (66.1)     | < 0.001 | 19,395  | 8,859      | (45.7)  | 10,536     | (54.3)  | < 0.001 |
| BLS                | 8,502   | (53.2)     | 3,975   | (46.8)     | 7,053   | 4,446    | (63)       | 2,607   | (37)       |
| FR                 | 18,221  | (67.3)     | 5,967   | (32.7)     | 16,473  | 12,070   | (73.3)     | 4,403   | (26.7)     |
| Dispatch triage    |          |            |          |            |          |            |          |            |
| Emergency          | 27,940  | (38.2)     | 17,273  | (61.8)     | < 0.001 | 20,846  | 10,399     | (49.9)  | 10,447     | (50.1)  | < 0.001 |
| Urgency            | 25,596  | (59.4)     | 10,388  | (40.6)     | 22,075  | 14,976   | (67.8)     | 7,099   | (32.2)     |

ALS = advanced life support; BLS = basic life support; FR = first responder; ILS = intermediate life support.

Figure 1 showed heat map of percentage of subjects who were within 10 kilometers from ambulance parking (B), RT $\leq 8$ minutes (C) and scene time $\leq 15$ minutes (D) across 76 provinces and Bangkok. The percentage of subjects who were within 10 kilometers in most provinces of north, north-east and south regions were higher than middle, east, west regions and Bangkok, see Fig. 2(B). Moreover, most provinces had low percentages of RT $\leq 8$ minutes, especially west, lower part of middle, east regions and Bangkok, see Fig. 2(C). However, all provinces had high percentage of scene time $\leq 15$ minutes, except Bangkok and vicinity, see Fig. 3(D).

**Discussion**

Analysis of national database showed only half of suspected stroke patients in Thailand were transported by ALS ambulance. A median total prehospital time was approximately 30 minutes which was mainly occupied by transportation, response and scene times. Although, there was good performance of dispatch, activation and scene times, only half of operations met the target KPI of RT.
Current recommendation for prehospital management for suspected stroke patients includes early recognition of signs/symptoms, immediate activation of EMS system, response with high level EMS ambulance, applying prehospital stroke screening tools and finally rapid transporting of the patients to stroke center (3, 14–16). Our results indicated only half of suspected stroke subjects who called EMS system were transported to receiving hospital by ALS ambulances. The percentage was significantly lower than previous studies in the developed countries (17–19). This was caused by limited number and distribution of ALS ambulances across Thailand. Therefore, lower level ambulances were deployed instead, and stroke screening tools at prehospital phase might not be used. Moreover, inconsistent level of phone triage was also found across regions of Thailand and this might reflect differences of phone triage and dispatch protocol. There were evidences which supported that early recognition of stroke and prearrival notification by EMS personnel improved time and quality of stroke care at receiving hospital (20–22). Therefore, training EMT and FR to access stroke signs/symptom with supervision by standardized direct medical command via tele-consultation might be an area for improvement if the number of ALS ambulances are difficult to increase.

The results showed median total prehospital time was approximately 30 minutes which corresponded to previous studies (17–19, 23–26). Our result also revealed high percentage of dispatch and activation ≤ 2 minutes (13, 14). However, our median RT was longer than recommendation and other studies (3, 14, 16–19, 23, 25), and only half of subjects experienced RT ≤ 8 minutes. Although, short dispatch and activation time pointed out prompt ambulances were available, but long RT also indicated ambulances took a long time to reach to patients. This might be the result of long distance from parking to scene (Tables 1 and 2), traffic and geographic problem. Therefore, exploring abundance/distribution of patients might be required to improve reallocating EMS service for suspected stroke patients.

Most of our total prehospital time was spent for travelling from parking to scene and from scene to hospital, which differed from previous studies (18, 19, 25) that most of prehospital time was occupied at scene. This might be due to general concept of EMS system which is implemented in Thailand is scoop and run model. Patients are initially evaluated at scene and, then provided necessary medical intervention, before transporting to the nearest hospital. Most interventions for stroke protocol (e.g., EKG, intravenous assessment, blood collection, etcetera) primarily begin at ED of receiving hospital. Therefore, our scene time was very short. However, this finding also supported extension and continuation of stroke protocol between prehospital and hospital care should be implemented to complete stroke chain of survival (3, 14–16).

The strength of this study included we used a national database which represented all EMS operations across Thailand. In addition, this dataset contained low number of missing time information and this decreased selection bias. However, limitations were also identified. This database did not contain clinical important factors (e.g., last seen normal time interval, facility of receiving hospitals, diagnosis and outcomes, etcetera). Therefore, the scope of this study included only prehospital phase of suspected stroke patients.

Conclusions

In summary, this study indicates prehospital time which was spent from EMS call to ER arrival was approximately 30 minutes. This time interval was mainly utilized for travelling from ambulance parking to scene and transporting patient from scene to ER. Only 48% of total operation had RT ≤ 8 minutes, but almost of them (95%) had scene time ≤ 15 minutes.

Abbreviations

ALS: advanced life support; BLS: basic life support; CBD: criteria-based dispatch; ECG: electrocardiogram; ED: emergency department; EMS: emergency medical service; EMT: emergency medical technician; FR: first responder; ILS: intermediate life support; IQR: interquartile range; ITEMS: Information Technology for Emergency Medical System; kms: kilometers; KPI: key performance indicator; RT: response time.

Declarations

Acknowledgements

None.
Authors’ contributions
PT and PA conceived the study concept and designed methods. PT and PA carried out acquisition of the data and performed the statistical analysis. PT, PA, AW and NM interpreted the data and drafted the manuscript. All authors criticized the revised manuscript and proved final version.

Consent for publication
Not applicable

Availability of data and material
The datasets during and/or analyzed during the current study available from the corresponding author on reasonable request.

Acknowledgements
None

Founding
None.

Ethics approval and consent to participate
This study was approved by the Ethic Committee of Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand with a waiving of informed consent.

Competing interest
The authors declare that they have no competing interests

References
1. Donkor ES. Stroke in the 21(st) Century: A Snapshot of the Burden, Epidemiology, and Quality of Life. Stroke Res Treat. 2018;2018:3238165. (doi):10.1155/2018/3238165. eCollection 2018.
2. Kim AS, Cahill E, Cheng NT. Global Stroke Belt: Geographic Variation in Stroke Burden Worldwide. Stroke. 2015;46(12):3564-70. doi: 10.1161/STROKEAHA.115.008226. Epub 2015 Oct 20.
3. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2018;49(3):e46-e110. doi: 10.1161/STR.0000000000000158. Epub 2018 Jan 24.
4. Kessler C, Khaw AV, Nabavi DG, Glahn J, Grond M, Busse O. Standardized prehospital treatment of stroke. Dtsch Arztebl Int. 2011;108(36):585-91. doi: 10.3238/arztebl.2011.0585. Epub 2011 Sep 9.
5. Binning MJ, Sanfilippo G, Rosen W, D’ambrosio M, Veznedaroglu E, Liebman K, et al. The neurological emergency room and prehospital stroke alert: the whole is greater than the sum of its parts. Neurosurgery. 2014;74(3):281-5; discussion 5. doi: 10.1227/NEU.0000000000000259.
6. Madhok DY, Keenan KJ, Cole SB, Martin C, Hemphill JC, 3rd. Prehospital and Emergency Department-Focused Mission Protocol Improves Thrombolysis Metrics for Suspected Acute Stroke Patients. J Stroke Cerebrovasc Dis. 2019;28(12):104423. doi:
10.1016/j.jstrokecerebrovasdis.2019.. Epub 2019 Oct 9.

7. Olascoaga Arrate A, Freijo Guerrero MM, Fernández Maiztegi C, Azkune Calle I, Silvariño Fernández R, Fernández Rodríguez M, et al. Use of emergency medical transport and impact on time to care in patients with ischaemic stroke. Neurologia. 2019;34(2):80-8. doi: 10.1016/j.nrl.2016.11.004. Epub 7 Jan 13.

8. Kongbunkiat K, Kasemsap N, Thepsuthammarat K, Tiamkao S, Sawanyawisuth K. National data on stroke outcomes in Thailand. J Clin Neurosci. 2015;22(3):493-7. doi: 10.1016/j.jocn.2014.08.031. Epub 5 Jan 13.

9. Hanchaiphiboolkul S, Poungvarin N, Nidhinandana S, Suwanwela NC, Puthkhao P, Towanabut S, et al. Prevalence of stroke and stroke risk factors in Thailand: Thai Epidemiologic Stroke (TES) Study. J Med Assoc Thai. 2011;94(4):427-36.

10. Bundhamcharoen K, Odton P, Phulkerd S, Tangcharoensathien V. Burden of disease in Thailand: changes in health gap between 1999 and 2004. BMC Public Health. 2011;11:53. doi:10.1186/1471-2458-11-53.

11. Report of population and house statistics Year 2019. Official Statistics Registration System. 2020: Ministry of Interior; 2020.

12. Regional division of Thailand. 2020: Office of the Royal Society.

13. Quality assessment and reimbursement for EMS system 2015. Financial development. National Institute for Emergency Medicine: Ministry of Public Health; 2015. p. 87-8.

14. Glober NK, Sporer KA, Guluma KZ, Serra JP, Barger JA, Brown JF, et al. Acute Stroke: Current Evidence-based Recommendations for Prehospital Care. West J Emerg Med. 2016;17(2):104-28. Epub 2016 Mar 02 doi:10.5811/westjem.2015.12.28995.

15. Kim DH, Kim B, Jung C, Nam HS, Lee JS, Kim JW, et al. Consensus Statements by Korean Society of Interventional Neuroradiology and Korean Stroke Society: Hyperacute Endovascular Treatment Workflow to Reduce Door-to-Reperfusion Time. J Korean Med Sci. 2018;33(19):e143. doi: 10.3346/jkms.2018.33.e143. eCollection May 7.

16. Kircher C, Kretzner N, Adeoye O. Pre and intrahospital workflow for acute stroke treatment. Curr Opin Neurol. 2016;29(1):14-9. doi:0.1097/WCO.0000000000000281.

17. Brown AT, Wei F, Culp WC, Brown G, Tyler R, Balamurugan A, et al. Emergency transport of stroke suspects in a rural state: opportunities for improvement. Am J Emerg Med. 2016;34(8):1640-4. Epub 2016 Jun 14 doi:10.1016/j.ajem.2016.06.044.

18. Golden AP, Odoi A. Emergency medical services transport delays for suspected stroke and myocardial infarction patients. BMC Emerg Med. 2015;15:. doi:10.1186/s12873-015-0060-3.

19. Puolakka T, Strbian D, Harve H, Kuisma M, Lindsberg PJ. Prehospital Phase of the Stroke Chain of Survival: A Prospective Observational Study. J Am Heart Assoc. 2016;5(5):. doi:10.1161/JAHA.115.002808.

20. Arimizu T, Yokota C, Tomari S, Hino T, Wada S, Ohnishi H, et al. Improving Call-to-Door Time Using School-Based Intervention by Emergency Medical Technicians: The Akashi Project. J Stroke Cerebrovasc Dis. 2018;27(6):1552-5. doi:10.1016/j.jstrokecerebrovasdis.2018.01.006.

21. Hsieh HC, Hsieh CY, Lin CH, Sung PS, Li CY, Chi CH, et al. Development of an educational program for staffs of emergency medical service to improve their awareness of stroke within 3 hours of symptom onset: a pilot study. Acta Neurol Taiwan. 2013;22(1):4-12.

22. Lin CB, Peterson ED, Smith EE, Saver JL, Liang L, Xian Y, et al. Emergency medical service hospital prenotication is associated with improved evaluation and treatment of acute ischemic stroke. Circ Cardiovasc Qual Outcomes. 2012;5(4):514-22. doi:10.1161/CIRCOUTCOMES.112.965210. Epub 2012 Jul 10.

23. Patel MD, Brice JH, Moss C, Suchindran CM, Evenson KR, Rose KM, et al. An Evaluation of Emergency Medical Services Stroke Protocols and Scene Times. Prehosp Emerg Care. 2014;18(1):15-21. Epub 2013 Sep 12 doi:10.3109/10903127.2013.825354.

24. Drenck N, Viereck S, Bækgaard JS, Christensen KB, Lippert F, Folke F. Pre-hospital management of acute stroke patients eligible for thrombolysis – an evaluation of ambulance on-scene time. Scand J Trauma Resusc Emerg Med. 2019;27:. doi:10.1186/s13049-018-0580-4.

25. Simonsen SA, Andresen M, Michelsen L, Viereck S, Lippert FK, Iversen HK. Evaluation of pre-hospital transport time of stroke patients to thrombolytic treatment. Scand J Trauma Resusc Emerg Med. 2014;22:. doi:10.1186/s13049-014-0065-z.

26. Ohwaki K, Watanabe T, Shinohara T, Nakagomi T, Yano E. Relationship between time from ambulance call to arrival at emergency center and level of consciousness at admission in severe stroke patients. Prehosp Disaster Med. 2013;28(1):39-42. doi: 10.1017/S1049023X12001549. Epub 2012 Oct 23.