

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

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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 \leq 2 minutes, but only 48.3% had RT \leq 8 minutes. However, 95% of service were at scene \leq 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 \leq 8 minutes, but 95% of them had scene time \leq 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 \leq 90 seconds, activation time \leq 90 seconds, response time (RT) \leq 8 minutes and on-scene time \leq 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.

Table 1

Characteristics of suspected stroke patients who were transported to hospital by ambulance between 2015–2018

Characteristics	Total	Years								
		2015		2016		2017		2018		
		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)	5	(2, 9)	5	(2, 9)	5	(2, 9)	5	(2, 9)	5	(2, 9)
≤ 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	Years				
		2015	2016	2017	2018	
≤ 8 minutes	25875	(48.3)	4929	(50.1)	5835	(49.3)
Scene time						
> 15 minutes	2,682	(5.0)	419	(4.3)	646	(5.5)
≤ 15 minutes	50854	(95.0)	9410	(95.7)	11198	(94.5)
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).

Table 2
Number of subjects who were far from parking \leq 10 kilometers versus $>$ 10 kilometers

Factors	N	\leq 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 (%)
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)	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			P value	
			FR	ILS and BLS	ALS		
Dispatch time	1	(1, 1)	1	(1, 1)	1	(1, 1)	< 0.001
Activation time	1	(1, 2)	1	(1, 1)	1	(0, 1)	< 0.001
Response time	9	(5, 14)	6	(4, 10)	8	(5, 13)	< 0.001
Scene time	5	(2, 8)	3	(2, 5)	4	(2, 7)	< 0.001
Transportation time	10	(6, 17)	14	(8, 21)	10	(5, 15)	< 0.001
Total prehospital time	29	(21, 39)	28	(20, 37)	27	(19, 36)	< 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.

Table 5
Number of RT \leq 8 minutes among overall and subjects in 10 kilometers from parking

Factors	Overall (N = 53,536)						\leq 10 kms distance (N = 42,921)					
	Total	\leq 8 minutes		> 8 minutes		P	Total	\leq 8 minutes		> 8 minutes		P
		n	%	n	%			n	%	n	%	
Region												
North	4,736	2,172	(45.9)	2,564	(54.1)	< 0.001	3,827	2,134	(55.8)	1,693	(44.2)	< 0.001
North-East	20,831	11,799	(56.6)	9,032	(43.4)		17,291	11,606	(67.1)	5,685	(32.9)	
West	3,587	1,654	(46.1)	1,933	(53.9)		2,820	1,624	(57.6)	1,196	(42.4)	
Middle	9,926	4,000	(40.3)	5,926	(59.7)		7,778	3,927	(50.5)	3,851	(49.5)	
East	3,482	1,270	(36.5)	2,212	(63.5)		2,439	1,234	(50.6)	1,205	(49.4)	
South	8,072	4,601	(57)	3,471	(43)		6,841	4,519	(66.1)	2,322	(33.9)	
Bangkok	2,902	379	(13.1)	2,523	(86.9)		1,925	331	(17.2)	1,594	(82.8)	
Shifts												
06.00–18.00	41,476	19,696	(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	6,179	(51.2)	5,881	(48.8)		10,013	6,075	(60.7)	3,938	(39.3)	
Levels												
ALS	26,813	9,094	(33.9)	17,719	(66.1)	< 0.001	19,395	8,859	(45.7)	10,536	(54.3)	< 0.001
BLS	8,502	4,527	(53.2)	3,975	(46.8)		7,053	4,446	(63)	2,607	(37)	
FR	18,221	12,254	(67.3)	5,967	(32.7)		16,473	12,070	(73.3)	4,403	(26.7)	
Dispatch triage												
Emergency	27,940	10,667	(38.2)	17,273	(61.8)	< 0.001	20,846	10,399	(49.9)	10,447	(50.1)	< 0.001
Urgency	25,596	15,208	(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 \leq 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 \leq 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 \leq 8 minutes, but almost of them (95%) had scene time \leq 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.

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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

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Figures

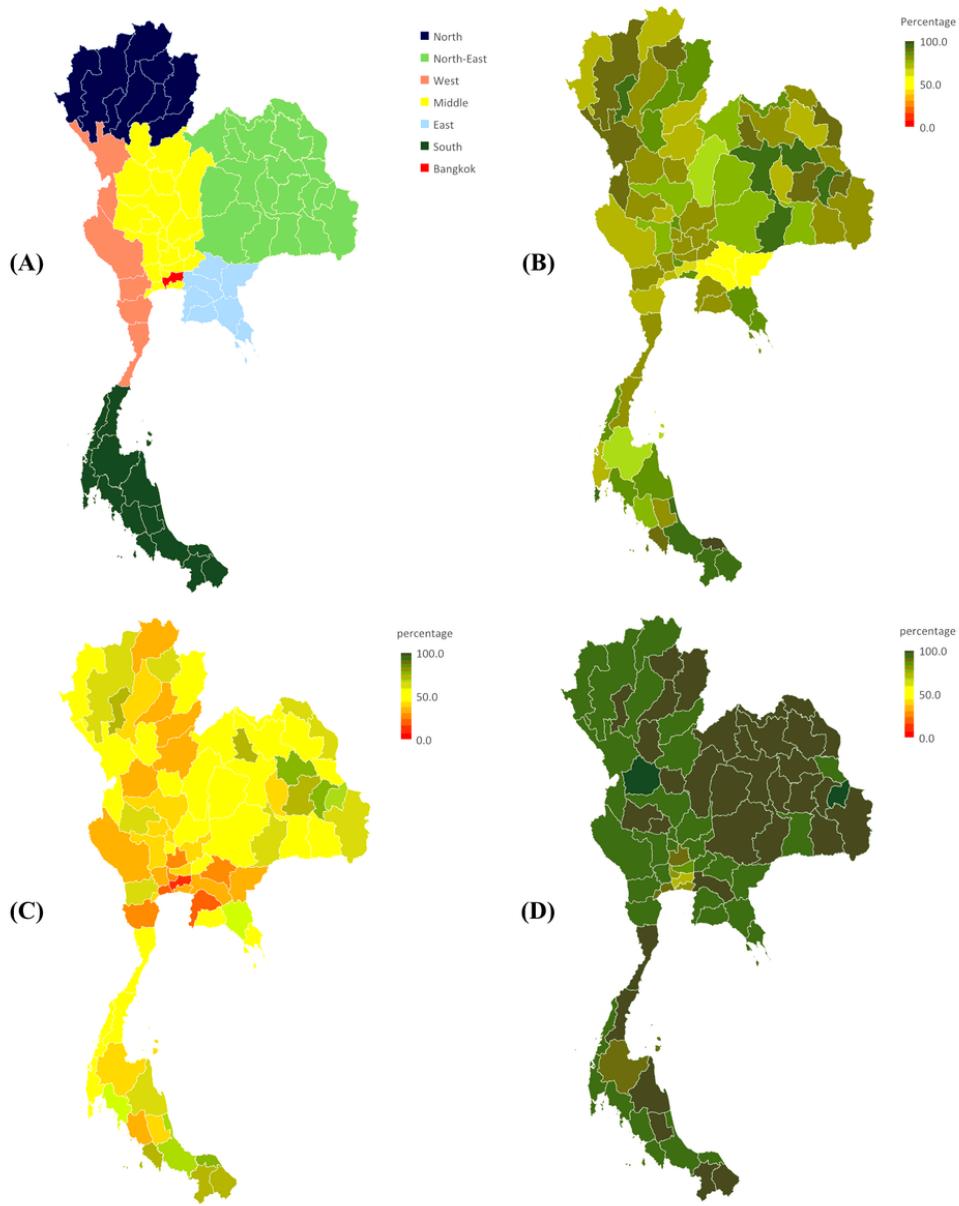


Figure 1

Regions of Thailand and heat map of indicators. (A) Regions of Thailand, (B) were in 10 kilometers from parking, (C) Percentage of subjects whose RT \leq 8 minutes, and (D) Percentage of subjects whose scene time \leq 15 minutes. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

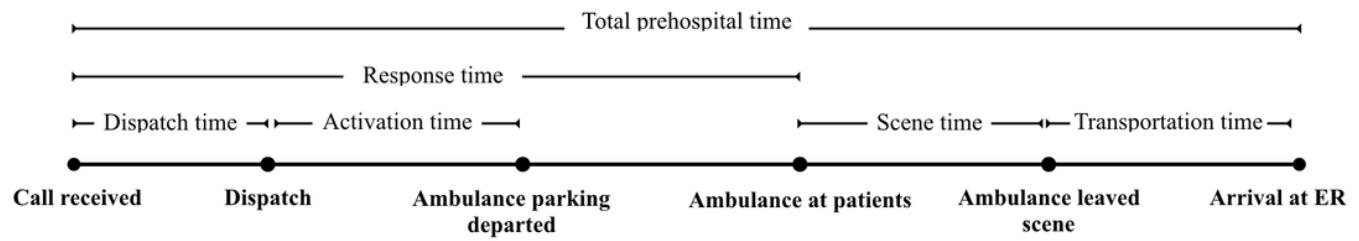


Figure 2

Definition of EMS operation times