

Determinants and barriers of prehospital emergency medical services utilization among general critical emergency patients in Thailand

Songsak Poomsaidorn¹, Kittipong Sornlorm¹, Wongsak Laohasiriwong¹, Roshan Kumar Mahato¹,
Nikom Thanomsieng¹, Chatree Charoencheewakul²

¹Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand

²Eastern University of Management and Technology, Ubon Ratchathani, Thailand

Article Info

Article history:

Received Aug 7, 2022

Revised Feb 20, 2023

Accepted Mar 11, 2023

Keywords:

Emergency medical services

General critical emergency

Patients

Thailand

ABSTRACT

This cross-sectional study identified the determinants and barriers of pre-hospital emergency medical services (EMS) utilization among general critical emergency patients in Thailand, using the data of general critical emergency patients (red zone) from the information technology for emergency medical system (ITEMS) of the National Emergency Medical Service Institute. The sample of 889 critical emergency patients was selected through multistage random sampling method. Data were analyzed by multiple logistic regression. The findings indicated that 41.51% of general critical emergency patients used EMS through the EMS rescue hotline system of the National Institute of Emergency Medicine in which most of them were diabetic patients (24.75%). The determinants relating to EMS utilization of general critical emergency patients consisted of level of knowledge on EMS system (AdjOR: 5.77; 95%CI: 2.8-11.87), confidence in the safety of service utilization (AdjOR: 5.04; 95%CI: 3.65-6.98), recognition in service and severity of illness (AdjOR: 3.22; 95%CI: 2.17-4.76), service adequacy (AdjOR: 1.92; 95%CI: 1.41-2.63), educational background (AdjOR:1.69; 95%CI: 1.13-2.53), and service satisfaction (AdjOR: 1.14; 95%CI: 1.07-1.21). Nearly half of the people were utilizing the EMS services in Thailand. However, required level of knowledge on EMS, confidence on safety on service utilization, service adequacy as well as patient's educational background had tremendous role on the proper utilization of EMS.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Kittipong Sornlorm

Faculty of Public Health, Khon Kaen University

Khon Kaen, Thailand

Email: kittsorn@kku.ac.th

1. INTRODUCTION

Critical emergency patients are defined by the Emergency Medical Committee and the National Institute of Emergency Medicine as the group of patients requiring immediate medical emergency services with advanced medical practice to reduce a sudden life-threatening illness or complications leading to possibilities of death [1], [2]. In 2019, it was reported that the use of prehospital emergency medical services through information technology for emergency medical system (ITEMS) of the National Institute of Emergency Medicine in Thailand was 1,790,006 times or 33.71% of emergency patients receiving services at ER at all types of hospitals under the Office of the Permanent Secretary, Ministry of Public Health, which was relatively low and might be a part of the second leading cause of death in Thai people from the 2007-2014 survey [1], [3]. The reasons for not using emergency medical services (EMS) included: preferring not to wait for EMS team (33.22%), using a private car is more

convenient and faster than EMS team (25.80%), being inconvenient to provide information on sickness and to identify the accident scene for requesting EMS via hotline 1669 (12.11%), having no information for requesting service (8.55%), and EMS center is far from the accident scene (12.11%) [1], [3], [4].

Although, there are two approaches of EMS utilization for critical emergency patients. The first one is the use of service through EMS system, which provides a chance to effectively save lives or prevent disability of critical emergency patients at 39.30% [5]–[8]. The second approach is the use of service without going through EMS system, providing a chance to save lives or prevent disability of critical emergency patients with efficiency as low as 60.70% [6], [9]–[11]. In addition, if categorizing critical emergency patients based on causes and patterns of EMS utilization, they are grouped as vehicle and other accident patients (20.70%) and general critical emergency patients (79.30%) [3], [12], [13]. The vehicle accident and other accident patients are found using EMS system up to 66.24%, while only 25.22% of the general critical emergency patients use the service through the EMS system to save lives or prevent disability [3], [14].

The aforementioned patterns of using EMS reflect the overlapping problems of EMS utilization of patients in three aspects: i) only 33.71% of all emergency patients receiving services at accident and emergency departments used EMS, ii) 60.70% of critically emergency patients used services without going through EMS system, iii) general critical emergency patients with a large number of 79.30% of critical emergency patients used EMS only 25.22% [1], [3], [4], [6], [15]. These three issues may be the main causes of death problem of Thai people from accidents and medical emergencies becoming more severe and affecting health, economy, and overall stability of the country. Therefore, it is necessary to study relevant factors, problems and obstacles in the use of prehospital EMS of general critical emergency patients in Thailand as a guideline for improving EMS operations of the country. So, this present study aimed to assess the determinants and barriers of prehospital emergency medical services utilization among general critical emergency patients in Thailand. The results may be useful to advance the EMS quality in Thailand in an effective manner.

2. RESEARCH METHOD

2.1. Population and sample

Population was critical emergency patients (Red Zone) of a general critical group who came to receive treatment at emergency rooms of regional hospitals or provincial hospitals in every province under the Ministry of Public Health. Which included those who used and did not use an EMS system under ITEMS of the National Institute of Emergency Medicine between January-December 2019. The inclusion criteria consisted of the population having complete and correct information, not being a critical emergency patient of vehicle accidents and other accidents (vehicle accidents; accidental falls and pain; drowning, scuba diving injuries, water injuries; fire, heat, chemical burns; electric shock; and choking, obstruction of the airway). The exclusion criteria were the groups of unclear symptoms due to abnormal vital signs notified by medical staff (Code 26, e.g. arrhythmias, oxygen saturation less than 90, systolic blood pressure less than 90 mmHg) according to the Declaration of Emergency Classification Assessment Criteria and Emergency Operating Standards B.E.2554 of the Emergency Medicine Committee.

2.2. Research design and sample size determination

This is a cross-sectional analytical study. The sample was a group of general critical emergency patients (red zone) who received treatment at emergency rooms of regional hospitals or provincial hospitals in every province under the Ministry of Public Health. The sample was calculated using the sample size calculation formula for a multivariate analysis based on multiple logistic regression statistics [16]. The sample size of 889 was determined by using the formula for multiple logistic regression ($n = [P(1-P)(Z1-\alpha+Z1-\beta)^2/B(1-B)(P0-P1)^2 * 1/(1-P)^2]$). The proportion was obtained from a previous study in Thailand where P (26%) is proportion of utilizing EMS, $P0$ (16%) is the proportion of the respondents having lack of knowledge on EMS facilities, $P1$ (32%) was the proportion of who were not utilize EMS, B (60%) is proportion of perceiving patients not receiving EMS because of lack of knowledge, $\alpha=5\%$, and $1-\beta=84\%$ [17].

The multistage random sampling method has been applied by adopting proportionate to size of the population. The 76 Province of the Thailand have 13 public health regions therefore we have selected one province from each public health regions by simple random sampling. After that, as per the emergency patients utilized EMS services from the public health regions of that province, the estimated study participants had been extracted. Finally, systematic random sampling method was applied to select the study population from the emergency patients utilized EMS of those selected provinces.

2.3. Data collection methods

This present study was conducted by administration of structured questionnaire interview among critical emergency patients (Red Zone) of a general critical group who came to receive treatment at emergency rooms of regional hospitals or provincial hospitals in every province under the Ministry of Public Health after

the completion of their treatment. A structured questionnaire was reviewed and initially verified the quality by researcher based on the construct validity and the multiple choice of questions. The pre-testing of the questionnaire was conducted in 30 people similar content in other provinces and calculated for reliability. The questionnaires were adjusted corrected accordingly to ensure the validity and reliability of the tool. Cronbach's alpha coefficients of the level of perception on emergency medical condition, level of knowledge on EMS, level of satisfaction towards EMS utilization and level of confidence on EMS services were calculated. The Cronbach's alpha coefficients was 0.74. In addition, the research advisor provided additional suggestions and improvements. Furthermore, the quality of data collection tools was verified by 5 experts with the Index of item objective congruence (IOC) at 0.78.

2.4. Data processing and analysis

Descriptive statistics of the personal information presented through the frequency distribution table with percentage, arithmetic mean, standard deviation, median, minimum and maximum values. Crude odds ratio (OR) and 95% confidence interval (CI) for each variable was obtained from simple logistic regression (bivariate analysis) to evaluate the independence of the observed associations, the variables with a value $p < 0.25$ were simultaneously entered in a multiple logistic regression analysis. The backward elimination solution was applied to control confounding effect and selected to consider fitting model [18]. The p -value of $p < 0.05$ was considered to indicate statistical significance. The written informed consent was obtained from each respondent as well as one family member when the respondents were unable to provide consent by themselves. In addition, this study was approved by the Human Research Ethics Center of Khon Kaen University on February 17, 2021 with license number HE642012.

3. RESULTS AND DISCUSSION

Our study observed that 41.51% of general critical emergency patients used EMS through the 1669 EMS hotline of the National Institute of Emergency Medicine, while the use of EMS without going through the EMS hotline was 58.49%. Most of general critical emergency patients who engaged EMS utilization in regional hospitals as well as general hospitals were female (51.41%) with average 45.67 years of age ($SD = 21.53$ Min = 1 month, Max = 89 years). 32.06% of the respondents were graduated with bachelor's degrees or higher; most of the sample were agriculturist (25.53%), followed by 23.40% private sector employees; most of them were single (55.79%) as shown in Table 1.

Overall perception on emergency medical conditions of general critical emergency patients indicated that most of the respondents were aware of emergency medical conditions at a moderate level with 39.14%, followed by a low level of perception at 36.00% and a high level at 24.86%. Overall knowledge on EMS system of general critical emergency patients indicated that most of the patients had knowledge about the EMS system at a low level or 80.20%, followed by 12.82% of a moderate level, and 6.97% of a high level. The satisfaction of general critical emergency patient's EMS utilization indicated that most of the respondents were satisfied with EMS at a high level (63.22%), followed by a moderate level (26.88%), and at a low level (9.9%). In terms of confidence in EMS, it indicated that most of the patients (54.44%) had confidence in the safety of EMS utilization at a highest level, followed by 25.98% of a moderate level, and 19.58% of a low level as shown in Table 1.

As per the emergency operations standards B.E. 2554 of the Emergency Medicine Committee (EMC), the five most common critical emergency symptoms required to be treated in any hospital. According to the declaration of the assessment criteria for classification of emergencies, our study also revealed that most common critical emergency includes diabetes (24.75%); headache, disorders in eyes, ears, throat, nose (7.99%); dyspnea, shortness of breath (7.42%), abdominal pain in back, pelvic, groin (6.97%); and unconsciousness of being allergic to drug, food, animal sting (5.74%) in Thailand respectively. The last three common diseases include: being unconscious, unresponsive, sudden fainting (2.81%); pregnancy, childbirth, gynecology (1.69%); and non-traumatic bleeding (0.01%), as shown in Table 2.

Our Bivariate analysis observed that the determinants related with the use of EMS among critical emergency patients were secondary education level and higher (OR: 1.56; 95%CI: 1.10-2.20; p -value < 0.011); waiting time to see doctor less than 30 minutes (OR: 13.28; 95%CI: 9.25-19.06; p -value < 0.001); emergency taking place at home/resident (OR: 3.08; 95%CI: 1.24-7.65; p -value < 0.001); emergency teams affiliated with local agencies and foundations (OR: 1.68; 95%CI: 1.12-2.51; p -value < 0.001); availability of adequate services (OR: 1.87; 95%CI: 1.43-2.45; p -value < 0.001); multi-distributed parking area of EMS vehicles (OR: 1.77; 95%CI: 1.34-2.35; p -value < 0.001); distance from EMS parking area to accident scene (OR: 1.95; 95%CI: 1.52-2.50; p -value < 0.001); perception of service and illness severity level (OR: 2.85; 95%CI: 2.02-4.01; p -value < 0.001); advanced level of EMS knowledge (OR: 7.42; 95%CI: 3.81-14.45; p -value < 0.001); high level of service satisfaction (OR: 2.27; 95%CI: 1.51-3.42; p -value < 0.001); and high level of confidence in service utilization (OR: 4.99; 95%CI: 3.70-6.71; p -value < 0.001) respectively as shown in Table 3.

Table 1. Characteristics of the study population

Basic information	Frequency (n)	Percentage (%)
Gender		
Female	457	51.41
Male	432	48.59
Age (Years)		
<10 years	64	7.20
10-19 years	73	8.21
20-29 years	7	8.66
30-39 years	107	12.04
40-49 years	162	18.22
50-59 years	158	17.77
60-69 years	147	16.54
>70 years	101	11.36
Mean=45.67, S.D.=21.53, Min=1 month, Max=89		
Education background		
Bachelor's degree or higher	285	32.06
Diploma/high vocational certificate	244	27.45
Elementary school or lower/no educational background	178	20.02
Senior high school/vocational certificate	133	14.96
Junior high school	49	5.51
Occupation		
Agriculturist	227	25.53
Private sector employee	208	23.40
Public sector employee/government officer	202	22.72
Student	113	12.71
Freelancer	139	15.64
Marital status		
Single	496	55.79
Married	211	23.73
Widowed/divorced/separated	182	20.47
EMS utilization		
Use of EMS hotline 1669	369	41.51
Use the service without EMS hotline 1669	520	58.49
Waiting time for doctor (minutes)		
≥30 minutes	629	70.25
≤30 minutes	260	29.25
Scene of emergency		
Public places/ public roads	39	4.39
House/residential building	234	26.32
Workplace/office building	616	69.29
Affiliated organization		
Hospital	125	14.06
Local government/private foundation	764	85.94
Service adequacy		
Inadequate	442	49.72
Adequate	447	50.28
Parking station of EMS vehicles		
One area	581	65.35
Multi-distributed area	308	34.65
Distance from EMS parking to emergency scene		
>15 kilometers	349	39.30
≤15 kilometers	540	60.70
Levels of Perception on Emergency Medical Conditions		
High (6-7 scores)	221	24.86
Moderate (4-5 scores)	348	39.14
Low (1-3 scores)	320	36.00
Mean 4.17, S.D.=1.38, Min =1, Max=7		
Levels of EMS Knowledge System		
High (5-6 scores)	62	6.97
Moderate (4 scores)	114	12.82
Low (1-3 scores)	713	80.20
Mean=2.98, S.D.=0.92, Min=0, Max=6		
Levels of Satisfaction towards EMS utilization		
High satisfaction	562	63.22
Moderate satisfaction	239	26.88
Low satisfaction	88	9.9
Level of Confidence in EMS Safety		
Highest (keep using EMS every time and tell others to use)	484	54.44
Moderate (keep using EMS and tell others to use)	231	25.98
Low (no return to use and tell no one to use)	174	19.58

Table 2. Number and percentage of critical emergency symptoms according to the symptoms of EMC declaration causing general critical emergency patients to use EMS in hospital (n=889)

No.	Critical emergency symptoms	Number	Percentage
1	Diabetes	220	24.75
2	Headache, disorders in eyes, ears, throat, nose	71	7.99
3	Dyspnea, shortness of breath	66	7.42
4	Abdominal pain in back, pelvic, groin	62	6.97
5	Unconsciousness of being allergic to drug, food, animal sting	51	5.74
6	Angina pectoris, heart problems	48	5.4
7	Seizures, signs of seizures	46	5.17
8	Bitten by an animal	45	5.06
9	Poisoning, overdose	43	4.84
10	Fatigue, chronic paralysis with unknown specific cause	43	4.84
11	Being hurt	40	4.5
12	Cardiac arrest	31	3.49
13	Paralysis, muscle weakness, feeling loss, suddenly unable to stand or walk	29	3.26
14	Mania, psychotic and emotional state	28	3.15
15	Infant or young child	25	2.81
16	Unconscious, unresponsive, sudden fainting	25	2.81
17	Pregnancy, childbirth, gynecology	15	1.69
18	Non-traumatic bleeding	1	0.11
	Total	889	100

Table 3. Determinants relating to EMS utilization of general critical emergency patients (Bivariate analysis) (n=889)

Determinants	Number	% EMS	Crude OR	95% CI	p-value
Educational background					0.011
Elementary school	178	33.15	1		
Secondary school and higher	711	43.60	1.56	1.10-2.20	
Waiting time for doctor (minutes)					<0.001
≥ 30 minutes	629	24.96	1		
≤ 30 minutes	260	81.54	13.28	9.25-19.06	
Scene of emergency					<0.001
Public places/ public roads	39	15.38	1		
House/residential building	234	35.90	3.08	1.24-7.65	
Workplace/office building	616	45.29	4.55	1.88-11.02	
Affiliated organization					0.011
Hospital	125	31.20	1		
Local government/private foundation	764	43.19	1.68	1.12-2.51	
Service adequacy					<0.001
Inadequate	442	33.94	1		
Adequate	447	48.99	1.87	1.43-2.45	
Parking station of EMS vehicles					<0.001
One area	581	36.66	1		
Multi-distributed area	308	50.65	1.77	1.34-2.35	
Distance from EMS parking to emergency scene					<0.001
> 15 kilometers	349	49.11	1		
≤ 15 kilometers	540	32.95	1.95	1.52-2.50	
Perception of service and illness severity level					<0.001
High	221	23.98	1		
Low to moderate	668	47.31	2.85	2.02-4.01	
EMS knowledge level					<0.001
Low to moderate	827	38.45	1		
High	62	82.26	7.42	3.81-14.45	
Service satisfaction level					<0.001
Low to moderate	781	39.05	1		
High	108	59.26	2.27	1.51-3.42	
Confidence in service utilization					<0.001
Low to moderate	405	21.73	1		
High	484	58.06	4.99	3.70-6.71	

Determinants relating to the use of EMS among general critical emergency patients based on the multivariate correlation analysis observed that the level of knowledge on EMS system (Adj. OR: 5.77; 95% CI: 2.81–11.87; p-value <0.001); confidence in the safety of service utilization (Adj. OR: 5.04; 95% CI: 3.65–6.98; p-value <0.001); perception of service and illness severity level (Adj. OR: 3.22; 95% CI: 2.17–4.76; p-value <0.001); service adequacy (Adj. OR: 1.92; 95% CI: 1.41–2.63; p-value <0.001); educational background (Adj. OR: 1.69; 95% CI: 1.13–2.53; p-value <0.010); and service satisfaction among the patients (Adj. OR: 1.14; 95% CI: 1.07–1.21; p-value <0.001) respectively as shown in Table 4.

Table 4. Determinants relating to EMS utilization of general critical emergency patients (multivariate analysis) (n=889)

Determinants	Number	% EMS	Crude OR	Adj.OR	95% CI	p-value
Level of knowledge on EMS system						
Low to moderate	827	38.45	1	1	-	<0.001
High	62	82.26	7.42	5.77	2.81-11.87	
Confidence in the safety of service utilization						
Low to moderate	405	21.73	1	1	-	<0.001
High	484	58.06	4.99	5.04	3.65-6.98	
Perception of service and illness severity level						
High	221	23.98	1	1	-	<0.001
Low to moderate	668	47.31	2.85	3.22	2.17-4.76	
Service adequacy						
Inadequate	442	33.94	1	1	-	<0.001
Adequate	447	48.99	1.87	1.92	1.41-2.63	
Service Satisfaction						
Low to moderate	781	39.05	1	1	-	<0.001
High	108	59.26	2.27	1.14	1.07-1.21	
Educational background						
Elementary school	178	33.15	1	1	-	<0.001
Secondary school or higher	711	43.60	1.56	1.69	1.13-2.53	

The current study illustrated problems and barriers in the use of prehospital EMS of general critical emergency patients in Thailand. Although Thailand EMS system has been developing since 1989, still nearly half of the population use EMS hotline 1669 (41.51%). In our setting, it has been observed that the female is utilizing EMS services more than that of male i.e. 51.41%. The level of knowledge has been one of the strongest barriers to the utilization of EMS. Only 6.97% of the critical emergency patients has high level of knowledge on EMS system. Our recent study also revealed that the level of satisfaction toward the utilization is progressively increasing (63.22%). The previous study in Thailand revealed that only about one third of the critically ill patients utilized EMS [3], [19]–[21]. This might be the impact of announcement of the Ministry of Public Health Thailand that emergency vehicles would not speed over 90 kilometers per hour to prevent accidents while transporting patients. Therefore, that may affect people's decision to use prehospital emergency medical services, affecting their access or utilization before the patient's hospitalization. Similarly, study in Thailand and Iran also revealed only 30-40% of the prevalence of utilization of EMS [22], [23] And another possible reason for not using EMS may have been that patients might not have noticed or might have forgotten the four-digit (1669) number for ambulance services [14], [24]. So, rising awareness for the utilization of EMS and use of hotline number is one of the steppingstones towards the reducing mortality from critical emergencies. A study conducted in Pakistan reported that very low percentage of people received emergency ambulance care earlier [25]. Furthermore, study from China revealed that the Female gender was associated with non-utilization of EMS, although our study observed more than half of them utilized it [26]. This might be due to the education quality of female in Thailand is quite higher which allows them to decide themselves than that of China.

Moreover, nearly one fourth (24.75%) of the critically ill diabetic patients used EMS in Thailand followed by patients with headache, disorders in eyes, ears, throat, nose, dyspnea, shortness of breath and so on. As of the prevalence of diabetes is increasing worldwide, study suggested that the prehospital EMS demand for diabetes emergencies is in increasing trend [27]. Therefore, the abovementioned results were identified in our study.

The multivariate analysis of recent study identified that the level of knowledge on EMS, confidence in the safety of services utilization, perception of the illness severity level, level of service adequacy high level of service satisfactions and education background had significant role on the utilization of EMS in Thailand. Study suggested that communication is the cornerstone of the clinician-patient as well as clinician-parent relationship for effective health care delivery therefore having limited language proficiency on accessing prehospital emergency medical services recognized as one of the biggest barriers to the service seekers. Therefore, some study also suggested that there should be targeted educational interventions to increase awareness of EMS among population. Any such targeted educational intervention should not only be culturally appropriate, but also be in the native language [28] which will have more strength for the utilization of EMS [29]. It is extremely necessary to provide access to emergency medical services for critically ill patients, if there is a lack of such factors, that will lead to a lack of awareness of the inability to fully run EMS system for critically ill patients which offer less satisfaction with medical services.

This study analyzed six EMS factors: response time, medical care provided, explanation of care by provider, ability to reduce patient anxiety, ability to meet patient's nonmedical needs as well as level of

courtesy/politeness are the main responsible factors towards the utilization of EMS. In addition, dissatisfaction has been related to the following factors: not receiving help when needed, poor explanation of causes of problems, not being informed about waiting time, not being described when to resume normal activities, poor explanation of test results and not being informed when to return to the emergency department [3], [30]. So, most of the samples' lifestyles are in an extended family in which decision-making process is made by family members, especially adult relatives in obtaining EMS for patients as well decision-making time for it is 21-30 minutes, therefore, relevant authorities should focus on promoting knowledge of EMS, pointing out how safe the patient will be if using EMS as well as explaining the procedures for service utilization and the severity of the illness in Thailand will be effective way to enhance the quality of EMS utilization.

As similar with other studies, this current study has also few limitations that should be considered. First, it was a retrospective analysis, which has some potential for selection and confounding bias. Similarly, the duration of data collection or collecting data using self-answer questionnaires, may affect the in-depth understanding of the decision to receive services in the emergency medical system, especially in recognizing and assessing the severity of illness, and the urgency of receiving treatment. However, this study has been carried out with the largest population to overcome those bias and confounders. Furthermore, it will be worth to conduct longitudinal study for the detail explanation of the predictors of prehospital emergency medical services utilization.

4. CONCLUSION

In summary, half of general critical emergency patients used EMS through the EMS hotline system of the National Institute of Emergency Medicine. Which reflects the use of EMS among critical emergency patients and most of them are diabetic and related symptoms. EMS among general critical emergency patients, based on the multivariate correlation analysis include: educational background, level of knowledge on EMS system, confidence in the safety of service utilization, perception of service and illness severity level, service adequacy, and service satisfaction. The findings reflect the use of EMS among critical emergency patients which are based on level of knowledge on EMS system, confidence in service utilization, perception on service and illness severity level, service adequacy, educational background, and satisfaction in EMS utilization.




REFERENCES

- [1] National Institute for Emergency Medicine, "T. Annual Report 2019," 2019. Accessed Feb 7, 2022. [Online]. Available: <https://www.niems.go.th/1/Ebook/Detail/10123?group=23>.
- [2] B. T. Pun *et al.*, "Caring for Critically Ill Patients with the ABCDEF Bundle: Results of the ICU Liberation Collaborative in Over 15,000 Adults," *Critical Care Medicine*, vol. 47, no. 1, pp. 3–14, Jan. 2019, doi: 10.1097/CCM.0000000000003482.
- [3] S. Poomsaidorn, W. Laohasiriwong, and K. Soeung, "Prehospital Emergency Medical Services Utilization For Critical Patients And Its Determinants In Thailand," *Journal of Southwest Jiaotong University*, vol. 56, no. 5, pp. 514–523, Oct. 2021, doi: 10.35741/issn.0258-2724.56.5.47.
- [4] World Health Organization, "Global health estimates 2016 summary tables: global DALYs by cause, age and sex, 2000-2016." 2016. <https://www.who.int/data/global-health-estimates>. (accessed Feb 7, 2022).
- [5] A. Setyarini and H. D. Windarwati, "Influence Factors of Emergency Medical Services (EMS) Prehospital Time Interval Variety: A Systematic Review," *Jurnal Ners*, vol. 15, no. 1Sp, pp. 440–451, 2020, doi: 10.20473/jn.v15i1sp.19786.
- [6] C. Rungratmaneeam and T. Lorsuwanarat, "Effectiveness of Emergency Medical Services Networks," *Annals of the Romanian Society for Cell Biology*, vol. 25, no. 4, pp. 5579–5595, 2021, doi: 10.14457/NIDA.the.2020.13.
- [7] J. G. Jollis *et al.*, "Impact of Regionalization of ST-Segment–Elevation Myocardial Infarction Care on Treatment Times and Outcomes for Emergency Medical Services–Transported Patients Presenting to Hospitals With Percutaneous Coronary Intervention," *Circulation*, vol. 137, no. 4, pp. 376–387, Jan. 2018, doi: 10.1161/CIRCULATIONAHA.117.032446.
- [8] M. Swaroop, D. Straus, O. Agubuzu, T. Esposito, C. Schermer, and M. Crandall, "Pre-hospital transport times and survival for Hypotensive patients with penetrating thoracic trauma," *Journal of Emergencies, Trauma, and Shock*, vol. 6, no. 1, p. 16, 2013, doi: 10.4103/0974-2700.106320.
- [9] J. B. Brown *et al.*, "Not all prehospital time is equal," *Journal of Trauma and Acute Care Surgery*, vol. 81, no. 1, pp. 93–100, Jul. 2016, doi: 10.1097/TA.0000000000000999.
- [10] Z. Nehme, E. Andrew, and K. Smith, "Factors Influencing the Timeliness of Emergency Medical Service Response to Time Critical Emergencies," *Prehospital Emergency Care*, vol. 20, no. 6, pp. 783–791, Nov. 2016, doi: 10.3109/10903127.2016.1164776.
- [11] A. M. K. Harmsen, G. F. Giannakopoulos, P. R. Moerbeek, E. P. Jansma, H. J. Bonjer, and F. W. Bloemers, "The influence of prehospital time on trauma patients outcome: A systematic review," *Injury*, vol. 46, no. 4, pp. 602–609, Apr. 2015, doi: 10.1016/j.injury.2015.01.008.
- [12] S. Chinprasatsak, S. Sathaphong, and K. Maporn, *Prehospital Care by Telegraphic Medicine System for Advanced Emergency Medical Service at Maharat Nakhon Ratchasima Hospital*, vol. 25, no. 4, 2016.
- [13] I. B. Lidal, H. H. Holte, and G. E. Vist, "Triage systems for pre-hospital emergency medical services - a systematic review," *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, vol. 21, no. 1, p. 28, Dec. 2013, doi: 10.1186/1757-7241-21-28.
- [14] H. K. Mell, S. N. Mumma, B. Hiestand, B. G. Carr, T. Holland, and J. Stopyra, "Emergency Medical Services Response Times in Rural, Suburban, and Urban Areas," *JAMA Surgery*, vol. 152, no. 10, p. 983, Oct. 2017, doi: 10.1001/jamasurg.2017.2230.
- [15] O. Pochaisan, R. Pattanarattanamolee, W. Pongphuttha, W. Chadbunchachai, and S. Nakahara, "Development of an emergency medical services system in Thailand: Roles of the universal health coverage and the national lead agency," *Emergency Medicine Australasia*, vol. 33, no. 4, pp. 756–758, Aug. 2021, doi: 10.1111/1742-6723.13794.




- [16] F. Y. Hsieh, D. A. Bloch, and M. D. Larsen, "A simple method of sample size calculation for linear and logistic regression," *Statistics in Medicine*, vol. 17, no. 14, pp. 1623–1634, Jul. 1998, doi: 10.1002/(SICI)1097-0258(19980730)17:14<1623::AID-SIM871>3.0.CO;2-S.
- [17] S. Khuntongkaew, "The Study of Factors Related to Use Emergency Medical Services Ratchaburi Province," *Journal of Prachomklao College of Nursing*, vol. 2, no. 1, pp. 31–44, 2019.
- [18] D. W. Hosmer, S. Lemeshow, and R. X. Sturdivant, *Applied Logistic Regression*. Wiley, 2013. doi: 10.1002/9781118548387.
- [19] T. Ananchaisarp *et al.*, "Delayed pre-hospital time in acute coronary syndrome patients and associated factors in a hospital in Southern Thailand," *Journal Of Health Research*, vol. 37, no. 2, 2022, doi: 10.56808/2586-940X.1004.
- [20] A. Pangma and S. Taneapanichskul, "the Outcome of Emergency Patient Transported By Public Air Ambulance Service in Thailand," *Journal of Health Research*, vol. 31, no. 1, pp. S129–S135, 2017, doi: 10.14456/jhr.2017.76.
- [21] K. Katsomboon, S. Sindhu, K. Utriyaprasit, and C. Viwatwongkasem, "Factors Associated with 24-Hour Clinical Outcome of Emergency Patients; a Cohort Study," *Archives of Academic Emergency Medicine*, vol. 10, no. 1, 2022, doi: 10.22037/aaem.v10i1.1590.
- [22] A. Monsomboon *et al.*, "Prevalence of emergency medical service utilisation in patients with out-of-hospital cardiac arrest in Thailand," *Emergency Medicine Journal*, vol. 33, no. 3, pp. 213–217, Mar. 2016, doi: 10.1136/emmermed-2015-204818.
- [23] A. A. Zeinalhajlou, R. R. Ghafouri, and H. Matlabi, "Utilization of Emergency Medical Services among Older People: A Case Study in Iran," *Elderly Health Journal*, vol. 3, no. 31, pp. 23–27, 2017, doi: 20.1001.1.24236179.2017.3.1.4.1.
- [24] S. Riyapan, P. Thitichai, W. Chaisirin, T. Nakornchai, and T. Chakorn, "Outcomes of Emergency Medical Service Usage in Severe Road Traffic Injury during Thai Holidays," *Western Journal of Emergency Medicine*, vol. 19, no. 2, pp. 266–275, Mar. 2018, doi: 10.5811/westjem.2017.11.35169.
- [25] N. Zia *et al.*, "Ambulance use in Pakistan: an analysis of surveillance data from emergency departments in Pakistan," *BMC Emergency Medicine*, vol. 15, no. S2, p. S9, Dec. 2015, doi: 10.1186/1471-227X-15-S2-S9.
- [26] S. H. Lee *et al.*, "Pre-hospital delay and emergency medical services in acute myocardial infarction," *The Korean Journal of Internal Medicine*, vol. 35, no. 1, pp. 119–132, Jan. 2020, doi: 10.3904/kjim.2019.123.
- [27] M. Villani, A. Earnest, N. Nanayakkara, K. Smith, B. de Courten, and S. Zoungas, "Time series modelling to forecast prehospital EMS demand for diabetic emergencies," *BMC Health Services Research*, vol. 17, no. 1, p. 332, Dec. 2017, doi: 10.1186/s12913-017-2280-6.
- [28] A. Riera, A. Navas-Nazario, V. Shabanova, and F. E. Vaca, "The impact of limited English proficiency on asthma action plan use," *Journal of Asthma*, vol. 51, no. 2, pp. 178–184, Mar. 2014, doi: 10.3109/02770903.2013.858266.
- [29] L. Ridsdale, C. Virdi, A. Noble, and M. Morgan, "Explanations given by people with epilepsy for using emergency medical services: A qualitative study," *Epilepsy & Behavior*, vol. 25, no. 4, pp. 529–533, Dec. 2012, doi: 10.1016/j.yebeh.2012.09.034.
- [30] T. L. Byczkowski *et al.*, "A Comprehensive View of Parental Satisfaction With Pediatric Emergency Department Visits," *Annals of Emergency Medicine*, vol. 62, no. 4, pp. 340–350, Oct. 2013, doi: 10.1016/j.annemergmed.2013.04.025.

BIOGRAPHIES OF AUTHORS






Songsak Pomsaidorn    is a lecturer in the Department of Public Health, Faculty of Science and Health Technology, Kalasin University. He has worked at the National Institute of Emergency Medicine and has published articles related to Thailand's emergency medical system and public health. He can be contacted at email: Songsak.p@ksu.ac.th.






Kittipong Sornlorm    is a Lecturer of Biostatistics and Geoinformatics in Faculty of Public Health Khon Kaen University. He has published over ten peer-reviewed scientific articles in major journals on the subjects of public health and Spatial distribution. He can be contacted at email: kittsorn@kku.ac.th.






Wongsala Laohasirivong    is a full-time Professor and Dean of Faculty of Public Health, Khon Kaen University, Khon Kaen Thailand. She has been published more than 200 articles in the major journals on the subject of Public Health, Epidemiology and Health system researches. She can be contacted at email: wongsa@kku.ac.th.






Roshan Kumar Mahato    is an Assistant Professor in Faculty of Public Health, Khon Kaen University, his area of interest is Epidemiology, Infectious Diseases, Public Health, Health System Research as well as Geoinformatics. He was also worked in Department of Public Health, Kathmandu University, Nepal. He has been published more than twelve peer-reviewed scientific articles in the major international journals on the subject of infectious diseased and epidemiology. He can be contacted at email: roshan@kku.ac.th



Nikom Thanomsieng    is an Assistant Professor in Department of Epidemiology and Biostatistics, Faculty of Public Health, Khon Kaen University. He is a Lecturer of Biostatistics, his area of interest is Epidemiology, Infectious Diseases. He can be contacted at email: nikom@kku.ac.th.



Chatree Charoencheewakul    is a lecturer in the Eastern University of Management and Technology, Ubon Ratchathani. He has worked Secretary-General of the National Institute for Emergency Medicine and has published articles related to Thailand's emergency medical system and public health. He can be contacted at email: Charoencheewakul.th@gmail.com.