

# The Impact of the Coronavirus Disease 2019 (Covid-19) Pandemic on the Use of Emergency Medical Services System in Bangkok, Thailand

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**Background:** Coronavirus disease 2019 (COVID-19) has widely affected the global public health system, especially the emergency medical service (EMS), which has been the first responders since 2020. However, this pandemic persists with still limited studies on its impact on EMS. This study aimed to compare the number of EMS patients and the operation periods of Bangkok EMS in Thailand between 2020 (severe COVID-19 pandemic) and 2019 (prepandemic).

**Patients and Methods:** We retrospectively analyzed data of patients with severe COVID-19 were collected from the emergency medical information system of Bangkok EMS center. Data were compared between the two periods. The COVID-19 pandemic period (study period) spanned from January 01, 2020 to December 31, 2020, whereas the control period referred to the same period in the previous year (January 01, 2019 to December 31, 2019).

**Results:** A total of 178,594 patients were serviced by EMS, with 93,288 during the study period and 85,306 during the control period. The study period had more EMS patients overall by 9.36% (95% confidence interval [CI]: 9.16–9.55) and significantly more EMS patients per day, with a mean difference of 21.19 ( $254.90 \pm 25.55$  vs  $233.71 \pm 23.49$ ; 95% CI: 17.63–24.76,  $p < 0.001$ ), than the control period. Furthermore, all EMS operation periods studied were significantly longer during the study period.

**Conclusion:** During COVID-19 pandemic period, a significantly increased number of EMS patients compared to one during non-COVID-19 pandemic period for both traumatic and non-traumatic patients, as well as remarkably increased every EMS operation period of both groups during COVID-19 pandemic period were found in the present study. From this knowledge, provision of necessary EMS resources and preparation of emergency staff to be ready for management of future pandemics should be obtained to reduce EMS operation period in the future pandemics.

**Keywords:** coronavirus disease 2019, COVID-19, EMS, emergency medical services, Thailand

## Introduction

The World Health Organization announced that coronavirus disease 2019 (COVID-19) has resulted in a global outbreak; this disease is caused by SARS-CoV-2, a virus causing severe acute respiratory syndrome (SARS) in humans.<sup>1–3</sup> The COVID-19 outbreak began in Wuhan, Hubei Province, China, on December 30, 2019. After outbreak and retrospective investigations, the first infection was suspected to be on December 08, 2019.<sup>4</sup> On January 13, 2020, the Ministry of Public Health in Thailand confirmed their first COVID-19 case, a 61-year-old female patient who was a Chinese tourist from Wuhan; Thailand was one of the first countries to report COVID-19 cases outside China.<sup>5</sup> Since then, the number of COVID-19 cases in Thailand kept increasing. On December 31, 2020 (a year after the outbreak) Thailand had reached 8383 confirmed cases, with the largest proportion in Bangkok (>2590).<sup>6</sup> At the moment, the number did not reduce. An increasing number of patients with this disease negatively affected the public health system of numerous countries worldwide, including Thailand. Thailand attempted substantially to slow down the spread of infection. The Thai government implemented nationwide lockdown policies, social restrictions, social distancing, and closing of public places, schools, and unnecessary entertainment venues.<sup>7</sup> On March 26, 2020, they declared a nationwide state of emergency effective from March 26 to June 30 of 2020 and a curfew

from 10 PM to 4 AM.<sup>8</sup> They also established an emergency operations center for public health management regarding COVID-19.<sup>9</sup> These active measures aimed to decelerate COVID-19 infection to avoid burdening the health-care system, which might not be able to respond to an excessive number of people's needs.

COVID-19 has affected millions of people worldwide, but its impact on EMS, including the operating procedures and ambulance operations, is yet to be clarified. Emergency medical staffs, who are in the frontlines, must prepare in facing COVID-19 situations, particularly by wearing personal protective equipment (PPE) in times of limited operation resources, different from the usual situations; they must also avoid aerosol-generating procedures, such as advanced airways management and mechanical cardiopulmonary resuscitation.<sup>10,11</sup>

Studies on the impacts of COVID-19 pandemic on EMS are still insufficient. Currently available study results are tremendously different and mostly short-term. In the US, the number of patients managed by EMS during the COVID-19 pandemic period was markedly decreased compared with that in the same period of the previous year. The number of EMS calls decreased by 26.1% from the total EMS calls. Moreover, the number of injured patients decreased from 18.43% in the previous year to 15.27% in the COVID-19 pandemic period.<sup>12</sup> These results are consistent with the study in Northern Ostrobothnia, Finland, in which the number of EMS patients reduced and the response time increased during the COVID-19 pandemic period compared with those in the same period in the previous years (March 1 to June 30 of 2016 to 2019).<sup>13</sup> In Frankfurt, which is the fifth largest city in Germany, the number of EMS tasks decreased by 20% per 100,000 population during the pandemic.<sup>14</sup> In Western Pennsylvania, the EMS mission response rate was reduced by 26.5% in 2020 compared with that in the control period of March 15 to May 15 of 2016 to 2019.<sup>15</sup>

However, in New York EMS, the number of 911 calls increased 30,469 times from March 16 to April 15 of 2020 compared with that in the same period in 2019; especially, the calls increased to more than 60% in late March of 2020.<sup>16</sup> In Osaka, Japan, the number of patients transported by EMS ambulances had increased since the 12th week, particularly in April 2020, which was the period that had the highest number of COVID-19 cases in Japan.<sup>17</sup>

The COVID-19 pandemic has substantially affected Bangkok EMS. Bangkok has the highest cumulative number of patients with COVID-19 in Thailand. However, the presumption was neither approved nor studied. Therefore, this study aimed to compare the number of patients managed by EMS and the EMS operation period of Bangkok EMS between the severe COVID-19 pandemic period and the pre-pandemic period. This knowledge will aid in the development of an EMS strategy in developing countries managing new pandemics in the future.

## Materials and Methods

### Study Design and Setting

For this retrospective cross-sectional study, data was collected from the emergency medical information system of Bangkok EMS center. Data were compared between the two periods. The COVID-19 pandemic period (study period) spanned from January 01, 2020 to December 31, 2020, whereas the control period referred to the same period in the previous year (January 01, 2019 to December 31, 2019).

Bangkok EMS center is the dispatch center for responsible zone leaders in Bangkok, operating medical hotlines (1669 and 1646), coordinating with, and improving the network for support of emergency medical operations in both normal situations and disaster. Currently, Bangkok's emergency medical operation utilizes cooperation from this network, which consists of 60 organizations that comprises hospitals under the Medical Service Department in Bangkok, other public and private hospitals, and even charitable foundations. Ambulances that were registered with Bangkok EMS on September 30, 2021, are divided into 154 advanced life support (ALS) and 66 basic life support ambulances. Bangkok has nine ALS area zones,<sup>18</sup> which are responsible for more than 1568.737 km<sup>2</sup> of area with a population of more than 5.6 million.<sup>19</sup>

During each operation, most EMS teams in study areas have at least three staff members, including emergency physicians, paramedics or emergency nurse practitioners as the operation leaders, advanced emergency medical technicians, and emergency medical technicians.

As mentioned, the Ministry of Public Health confirmed Thailand's first COVID-19 case on January 13, 2020, a nationwide state of emergency was declared from April 3 to June 12 of 2020, and a countrywide curfew from 10 PM to 4 AM was implemented.

During the COVID-19 pandemic, the EMS operation format was changed. For instance, patients under investigation were screened by emergency medical call taker and emergency medical dispatcher inquiring regarding this topic apart from history and signs and symptoms, to evaluate COVID-19 infection risk of every EMS patient. The Department of Medical Services, Ministry of Public Health, and Thai College of Emergency Physician established guidelines for COVID-19 emergency patient management in 2020.<sup>20</sup> However, many EMS units have assigned emergency medical directors to create their own guidelines that fit for their locations.

## Eligibility Criteria

We included patients aged 18 years and above and managed by Bangkok EMS center (Erawan Center) in Thailand.

## Exclusion Criteria

Exclusion criteria were patients getting interfacility transports and those with incomplete data.

## Variables and Measurements

From the registry of Bangkok EMS center, entire patients' and EMS's data recorded in the emergency medical information database by dispatchers and operating EMS staff were collected. These data are generally used to evaluate a part of compensation for EMS units.

General data consisted of sex, age, operation team type, zone, operation time, patient type, primary treatment results at the scene and treatment results in the hospital, severity level at triages (dispatch triage, scene triage, and hospital triage), and EMS operation period (response time, on-scene time, transportation time, and total prehospital time). All data were gathered and saved in Microsoft Excel.

Study factors are defined as follows:

1. Study period refers to the COVID-19 pandemic period in Bangkok, Thailand (January 01, 2020–December 31 of 2020).
2. Control period refers to the year before the COVID-19 pandemic period in Bangkok, Thailand (January 1, 2019–December 31, 2019).
3. Dispatch triage means triage via telephone call using Thai emergency medical triage protocol and criteria-based dispatch (25 symptoms; their severities are classified into red, yellow, green, white, and unknown) to provide an operation team by a dispatcher during EMS call.<sup>21</sup>
4. Scene triage means triage at the scene before delivery to the hospital; it is done by physicians, paramedics, and nurses, and divided into red, yellow, green, white, and unknown.<sup>21</sup>
5. Hospital triage means triage done in a hospital by physicians and nurses to evaluate severity of patients at the emergency room; it is divided into red, yellow, green, white, and unknown.
6. Response time means the duration from emergency call to scene arrival.<sup>22</sup>
7. On-scene time means the duration from scene arrival to scene departure.<sup>22</sup>
8. Transportation time means the duration from scene departure to hospital arrival.<sup>22</sup>
9. Total prehospital time means the duration from emergency call to operation arrival.<sup>22</sup>

## Statistical Analyses

Sample size was estimated for the comparison of the number of EMS patients of Bangkok EMS between the two periods, and it was reported using change % difference (95% confidence interval [CI]). We used the formula for estimating an infinite population proportion.<sup>23</sup> The level of statistical power at 5% alpha and an error margin of 1% were determined. Population proportion referred to change % difference from calculation using the data of Bangkok EMS patients recorded during the two periods. The change % difference was 4.86%. The calculated sample size for the control period was at least 1777. The data of all eligible patients during the study period were then collected.

Variables were examined by descriptive analysis. Continuous variables are presented as the mean  $\pm$  standard deviation or median and interquartile range (IQR), and categorical variables are presented as frequencies and proportions.

Differences between two groups were analyzed using independent *t*-tests or Mann–Whitney *U*-tests for the continuous variables and chi-square tests or Fisher's exact tests for the categorical variables. Furthermore, the number of EMS patients was compared between the study period and the control period; the results are reported using change % difference (95% CI). Statistical data were analyzed analyses using STATA version 14.1 (StataCorp LP, College Station, TX, USA), and a *p* value of 0.05 was considered significant.

## Results

### General Data of EMS Patient Samples

During the study and control periods, patients were mostly male (55.5% and 55.6%,  $p < 0.001$ ), with a mean age of  $54.85 \pm 22.07$  and  $54.91 \pm 22.67$  years ( $p = 0.628$ ), were managed by ALS teams (51.6% and 50.7%,  $p = 0.009$ ), and were serviced by EMS within 8 AM to 3:59 PM (39.5% and 39.3%,  $p = 0.001$ ), respectively. Most patients were classified as red (49.1%) in the study period and yellow in the control period (48.9%) ( $p < 0.001$ ) for dispatch triage; red in both periods (45.9% and 44.6%,  $p < 0.001$ ) for scene triage; and yellow in both periods (40.3% and 42.8%,  $p < 0.001$ ) for hospital triage, respectively. Moreover, almost half of the patients in the study and control periods had stable primary treatment results at the scene (48.1% and 46.5%,  $p < 0.001$ ), and one-third had improved treatment results in the hospital (36.8% and 36.4%, respectively;  $p < 0.001$ ).

We found 83,427 patients without trauma. These patients during the study and control periods were mostly male (51.6% and 51.3%,  $p = 0.002$ ), with a mean age of  $59.62 \pm 20.56$  and  $60.67 \pm 20.76$  years ( $p = 0.628$ ), were managed by ALS teams (61.9% and 61.4%,  $p = 0.009$ ), and were serviced by EMS within 8 AM to 3:59 PM (40.4% and 41.5%,  $p < 0.001$ ), respectively. Most patients were classified as red in the study and control periods for dispatch triage (59.6% and 59.9%,  $p = 0.032$ ) and scene triage (55.9% and 55.6%,  $p < 0.001$ ), and yellow for hospital triage (35.2% and 37.2%, respectively;  $p < 0.001$ ). In addition, nearly half of the patients in the study and control periods had stable primary treatment results at the scene (48.2% vs 46.5%;  $p < 0.001$ ), and only 29.0% and 27.6% had improved treatment results in the hospital ( $p < 0.001$ ), respectively.

Patients with trauma accounted for 32,812. These patients in the study and control periods were mostly male (65.8% and 65.9%, respectively;  $p = 0.507$ ), with a mean age of  $41.36 \pm 20.57$  and  $40.24 \pm 20.64$  years ( $p < 0.001$ ), and were serviced by EMS within 4:00 PM to 11:59 PM (40.0% and 42.6%,  $p < 0.001$ ), respectively. Most patients were categorized as yellow in both periods for dispatch triage (72.9% and 75.2%,  $p < 0.001$ ), scene triage (62.2% and 64.7%,  $p < 0.001$ ), and hospital triage (53.5% and 56.2%,  $p < 0.001$ ). Almost half of the patients in the study and control periods had stable primary treatment results at the scene (47.7% and 46.8%,  $p < 0.001$ ), and half had improved treatment results in the hospital (57.3% and 57.2%, respectively;  $p < 0.001$ ) (Table 1).

### Number of Bangkok EMS Patients Between the Study and Control Periods

Out of 178,594 recorded patients, 93,288 were in the study period, and 85,306 were in the control period, with a difference of 9.36% (95% CI: 9.16–9.55). The number of EMS patients per day was  $254.90 \pm 25.55$  in the study period and  $233.71 \pm 23.49$  in the control period, with a statistically significant increase per day in the study period compared with that in the control period (mean difference = 21.19, 95% CI: 17.63–24.76,  $p < 0.001$ ) (Figure 1).

### Bangkok EMS Operation Period Between the Study and Control Periods

EMS operation periods included response time, on-scene time, transportation time, and total prehospital times. A total of 117,135 patients had complete data (65.6%), with 62,333 (66.8%) in the study period and 54,802 (64.2%) in the control period.

During the study and control periods, the mean response time was  $17.06 \pm 10.92$  and  $16.40 \pm 10.65$  minutes, the mean on-scene time was  $11.04 \pm 9.15$  and  $10.18 \pm 8.73$  minutes; the mean transportation time was  $11.10 \pm 8.11$  and  $10.89 \pm 7.90$  minutes, and the mean total prehospital time was  $64.49 \pm 36.37$  and  $62.03 \pm 35.25$  minutes, respectively. All EMS operation periods showed a statistically significant increase in the study period compared with those in the control period

**Table 1** General Characteristics of EMS Patients

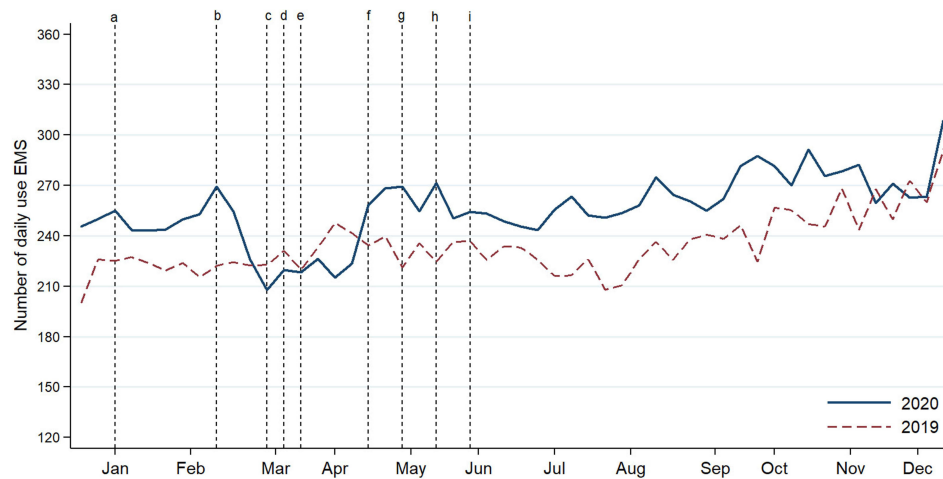
Characteristics	Total (n = 117,135)*					Non-Trauma (n = 83,427)					Trauma (n = 32,812)				
	Study Period (n = 62,333)		Control Period (n = 54,802)		p-value	Study Period (n = 45,006)		Control Period (n = 38,421)		p-value	Study Period (n = 16,995)		Control Period (n = 15,817)		p-value
Sex															
Male	34,618	(55.5)	30,473	(55.6)	<0.001	23,234	(51.6)	19,719	(51.3)	0.002	11,191	(65.8)	10,427	(65.9)	0.507
Female	25,941	(41.6)	22,550	(41.1)		20,778	(46.2)	17,708	(46.1)		5043	(29.7)	4643	(29.4)	
Unknown	1774	(2.8)	1779	(3.2)		994	(2.2)	994	(2.6)		761	(4.5)	747	(4.7)	
Age (years), Mean ± SD	54.85 ± 22.07		54.91 ± 22.67		0.628	59.62 ± 20.56		60.67 ± 20.76		<0.001	41.36 ± 20.57		40.24 ± 20.64		<0.001
Type of operation team															
BLS	30,197	(48.4)	27,041	(49.3)	0.009	17,161	(38.1)	14,818	(38.6)	0.009	12,861	(75.7)	11,876	(75.1)	0.400
ALS	32,133	(51.6)	27,758	(50.7)		27,844	(61.9)	23,601	(61.4)		4132	(24.3)	3940	(24.9)	
Unknown	3	(0.0)	3	(0.0)		1	(0.0)	2	(0.0)		2	(0.0)	1	(0.0)	
Zone															
1	7208	(11.6)	6743	(12.3)	<0.001	6235	(13.9)	5739	(14.9)	0.334	947	(5.6)	969	(6.1)	<0.001
2	1153	(1.8)	1096	(2.0)		935	(2.1)	854	(2.2)		211	(1.2)	235	(1.5)	
3	4775	(7.7)	4123	(7.5)		4160	(9.2)	3571	(9.3)		596	(3.5)	523	(3.3)	
4	4898	(7.9)	4369	(8.0)		4272	(9.5)	3744	(9.7)		598	(3.5)	586	(3.7)	
5	8100	(13.0)	6113	(11.2)		5253	(11.7)	4037	(10.5)		2819	(16.6)	2059	(13)	
6	19,992	(32.1)	18,317	(33.4)		11,658	(25.9)	9885	(25.7)		8202	(48.3)	8140	(51.5)	
7	6214	(10)	5730	(10.5)		4650	(10.3)	4258	(11.1)		1549	(9.1)	1457	(9.2)	
8	4552	(7.3)	4191	(7.6)		3836	(8.5)	3474	(9.0)		679	(4)	655	(4.1)	
9	3760	(6.0)	3498	(6.4)		2868	(6.4)	2469	(6.4)		868	(5.1)	971	(6.1)	
Unknown	1681	(2.7)	622	(1.1)		1139	(2.5)	390	(1.0)		526	(3.1)	222	(1.4)	
Operation time															
Morning shift (8.00–15.59)	24,634	(39.5)	21,545	(39.3)	0.001	18,180	(40.4)	15,944	(41.5)	<0.001	6335	(37.3)	5329	(33.7)	<0.001
Evening shift (16.00–23.59)	23,028	(36.9)	20,766	(37.9)		16,099	(35.8)	13,835	(36)		6792	(40)	6740	(42.6)	
Night shift (0.00–7.59)	14,671	(23.5)	12,491	(22.8)		10,727	(23.8)	8642	(22.5)		3868	(22.8)	3748	(23.7)	
Dispatch triage															
Red	30,629	(49.1)	26,436	(48.2)	<0.001	26,846	(59.6)	23,015	(59.9)	0.032	3783	(22.3)	3421	(21.6)	<0.001
Yellow	29,865	(47.9)	26,803	(48.9)		17,481	(38.8)	14,910	(38.8)		12,384	(72.9)	11,893	(75.2)	
Green	1382	(2.2)	922	(1.7)		557	(1.2)	421	(1.1)		825	(4.9)	501	(3.2)	
White	125	(0.2)	77	(0.1)		122	(0.3)	75	(0.2)		3	(0.0)	2	(0.0)	
Unknown	332	(0.5)	564	(1.0)		0	(0.0)	0	(0.0)		0	(0.0)	0	(0.0)	

(Continued)

Table I (Continued).

Characteristics	Total (n = 117,135)*				Non-Trauma (n = 83,427)				Trauma (n = 32,812)						
	Study Period (n = 62,333)		Control Period (n = 54,802)		Study Period (n = 45,006)		Control Period (n = 38,421)		Study Period (n = 16,995)		Control Period (n = 15,817)		p-value		
Scene triage															
Red	28,587	(45.9)	24,436	(44.6)	<0.001	25,150	(55.9)	21,352	(55.6)	<0.001	3398	(20)	3028	(19.1)	<0.001
Yellow	26,617	(42.7)	23,864	(43.5)		16,039	(35.6)	13,619	(35.4)		10,564	(62.2)	10,227	(64.7)	
Green	1333	(2.1)	874	(1.6)		563	(1.3)	401	(1.0)		770	(4.5)	473	(3.0)	
White	134	(0.2)	86	(0.2)		131	(0.3)	85	(0.2)		3	(0.0)	1	(0.0)	
Unknown	5662	(9.1)	5542	(10.1)		3123	(6.9)	2964	(7.7)		2260	(13.3)	2088	(13.2)	
Hospital triage															
Red	17,071	(27.4)	14,339	(26.2)	<0.001	14,868	(33)	12,427	(32.3)	<0.001	2116	(12.5)	1809	(11.4)	<0.001
Yellow	25,091	(40.3)	23,441	(42.8)		15,839	(35.2)	14,284	(37.2)		9095	(53.5)	8892	(56.2)	
Green	6116	(9.8)	5796	(10.6)		3852	(8.6)	3486	(9.1)		2228	(13.1)	2204	(13.9)	
White	69	(0.1)	29	(0.1)		62	(0.1)	28	(0.1)		6	(0.0)	1	(0.0)	
Black	33	(0.1)	29	(0.1)		25	(0.1)	26	(0.1)		7	(0.0)	3	(0.0)	
Unknown	13,953	(22.4)	11,168	(20.4)		10,360	(23)	8170	(21.3)		3543	(20.8)	2908	(18.4)	
Primary treatment results at the scene															
No treatment	2498	(4.0)	1352	(2.5)	<0.001	1424	(3.2)	817	(2.1)	<0.001	1071	(6.3)	532	(3.4)	<0.001
Relieved	19,757	(31.7)	18,737	(34.2)		14,120	(31.4)	12,946	(33.7)		5520	(32.5)	5557	(35.1)	
Stable	29,963	(48.1)	25,491	(46.5)		21,677	(48.2)	17,848	(46.5)		8112	(47.7)	7396	(46.8)	
Worsened	310	(0.5)	358	(0.7)		246	(0.5)	264	(0.7)		63	(0.4)	89	(0.6)	
Dead at scene	3745	(6.0)	3274	(6.0)		3177	(7.1)	2729	(7.1)		555	(3.3)	520	(3.3)	
Dead during transportation	27	(0.0)	23	(0.0)		22	(0.0)	19	(0.0)		5	(0.0)	4	(0.0)	
Unknown	6033	(9.7)	5567	(10.2)		4340	(9.6)	3798	(9.9)		1669	(9.8)	1719	(10.9)	
Treatment results in hospital															
Relieved	22,965	(36.8)	19,967	(36.4)	<0.001	13,053	(29)	10,602	(27.6)	<0.001	9738	(57.3)	9044	(57.2)	<0.001
Transferred	437	(0.7)	778	(1.4)		276	(0.6)	486	(1.3)		154	(0.9)	284	(1.8)	
Died in hospital	606	(1.0)	696	(1.3)		476	(1.1)	553	(1.4)		125	(0.7)	137	(0.9)	
Treated beyond the last day of the month	1788	(2.9)	1598	(2.9)		1470	(3.3)	1324	(3.4)		294	(1.7)	252	(1.6)	
Denying treatment/escaping from hospital	23	(0.0)	28	(0.1)		20	(0.0)	16	(0.0)		3	(0.0)	11	(0.1)	
To die at home	16	(0.0)	16	(0.0)		10	(0.0)	10	(0.0)		6	(0.0)	6	(0.0)	
Not reported	1595	(2.6)	1548	(2.8)		1307	(2.9)	1214	(3.2)		280	(1.6)	316	(2.0)	
Unknown	34,903	(56.0)	30,171	(55.1)		28,394	(63.1)	24,216	(63)		6395	(37.6)	5767	(36.5)	

Note: \*Including unknown code (n=896).



**Figure 1** The number of daily use of Emergency Medical Services System in Bangkok since 1 January. The vertical dashed lines represent the date of the important events. **Notes:** The important events. a) January 13, 2020; The first confirmed case in Thailand. b) March 1, 2020; The first dead case in Thailand. c) March 22, 2020; 26 high-risk places were ordered to close in Bangkok. d) March 26, 2020; The Thai Government declared an emergency decree nationwide. e) April 3, 2020; The Thai Government declared curfew nationwide from 10 PM to 4 AM. f) May 3, 2020; The Thai Government lessened the Phase 1 of defensive measure that allowed the opening of 6 low-risk businesses. g) May 17, 2020; The Thai Government lessened the Phase 2 measure which was to allow the opening of department stores and adjust the curfew period 11 PM to 4 AM. h) June 1, 2020; The Thai Government lessened the Phase 3 measure and adjusted the curfew period to 11 PM– 3 AM. i) June 12, 2020; The Thai Government decided to cancel the curfew and lessened the Phase 4 measure.

(mean difference = 0.66, 0.86, 0.20, and 2.47; 95% CI: 0.54–0.79, 0.76–0.96, 0.11–0.30, and 2.05–2.88;  $p < 0.001$  in all, respectively).

For patients without trauma, the mean response time was  $18.89 \pm 11.06$  and  $18.24 \pm 10.80$  minutes, the mean on-scene time was  $12.49 \pm 9.39$  and  $11.71 \pm 9.01$  minutes, the mean transportation time was  $11.80 \pm 8.43$  and  $11.73 \pm 8.29$  minutes, and the mean total prehospital time was  $69.77 \pm 36.77$  and  $67.72 \pm 35.75$  minutes during the study and control periods, respectively. All EMS operation periods, except for the transportation time, demonstrated a statistically significant increase during the study period compared with those in the control period (response time, on-scene time, and total prehospital time: mean difference = 0.65, 0.78, and 2.05; 95% CI: 0.50–0.80, 0.65–0.91, and 1.55–2.54;  $p < 0.001$  in all three, respectively). Transportation time was not different between the two periods (mean difference = 0.07, 95% CI:  $-0.05$ – $0.18$ ,  $p = 0.236$ ).

For patients with trauma, the mean response time was  $12.47 \pm 9.06$  and  $12.27 \pm 9.01$  minutes, the mean on-scene time was  $7.31 \pm 7.27$  and  $6.64 \pm 6.81$  minutes, the mean transportation time was  $9.30 \pm 6.94$  and  $8.95 \pm 6.51$  minutes, and the mean total prehospital time was  $50.96 \pm 31.54$  and  $48.95 \pm 30.27$  minutes during the study and control periods, respectively. All EMS operation periods, except for the response time, demonstrated a statistically significant increase during the study period compared with those in the control period (on-scene time, transportation time, and total prehospital time: mean difference = 0.68, 0.36, and 2.01; 95% CI: 0.52–0.83, 0.21–0.50, and 1.34–2.68;  $p < 0.001$  in all three, respectively). Response time was not different between the study and control periods (mean difference = 0.19, 95% CI:  $-0.01$ – $0.39$ ,  $p = 0.056$ ) (Table 2).

## Discussion

Previous studies demonstrated that EMS patients during the COVID-19 pandemic period (study period) were more than those during the non-COVID-19 pandemic period (control period). In the present study, the number of patients was also higher in the study period than in the control period, with a difference of 9.36%, and showed a statistically significantly increase per day in the study period. However, these results conflicted with the results of previous studies conducted in developed countries.<sup>12–15,17</sup> For example, in 47 states of the US, the number of EMS calls was markedly decreased by 26.1% (140,292 times) during the COVID-19 pandemic period compared with that during the non-COVID-19 period.<sup>12</sup> In Osaka, Japan, the number of patients decreased more than half during the COVID-19 pandemic period.<sup>17</sup> This decrement could probably result from people's preference to EMS to access the healthcare system during the pandemic.

**Table 2** Comparison of EMS Operation Duration

EMS Operation Times (min)	Total (n = 117,135)*				Non-Trauma (n = 83,427)				Trauma (n = 32,812)			
	Study Period (n = 62,333)	Control Period (n = 54,802)	Mean Difference	p-value	Study Period (n = 45,006)	Control Period (n = 38,421)	Mean Difference	p-value	Study Period (n = 16,995)	Control Period (n = 15,817)	Mean Difference	p-value
Response time (min)	17.06 ± 10.92	16.40 ± 10.65	0.66 (0.54 to 0.79)	<0.001	18.89 ± 11.06	18.24 ± 10.80	0.65 (0.5 to 0.8)	<0.001	12.47 ± 9.06	12.27 ± 9.01	0.19 (-0.01 to 0.39)	0.056
On-scene time (min)	11.04 ± 9.15	10.18 ± 8.73	0.86 (0.76 to 0.96)	<0.001	12.49 ± 9.39	11.71 ± 9.01	0.78 (0.65 to 0.91)	<0.001	7.31 ± 7.27	6.64 ± 6.81	0.68 (0.52 to 0.83)	<0.001
Transportation time (min)	11.10 ± 8.11	10.89 ± 7.90	0.20 (0.11 to 0.30)	<0.001	11.80 ± 8.43	11.73 ± 8.29	0.07 (-0.05 to 0.18)	0.236	9.30 ± 6.94	8.95 ± 6.51	0.36 (0.21 to 0.50)	<0.001
Total prehospital time (min)	64.49 ± 36.37	62.03 ± 35.25	2.47 (2.05 to 2.88)	<0.001	69.77 ± 36.77	67.72 ± 35.75	2.05 (1.55 to 2.54)	<0.001	50.96 ± 31.54	48.95 ± 30.27	2.01 (1.34 to 2.68)	<0.001

**Note:** \*Including unknown code (n=896).



In Thailand, EMS is freely provided by the government; especially for emergency conditions, people could access EMS and ambulances all the time. This presumption might cause patients to think that EMS is an option to access the public health system and is also safely accessible.

However, Figure 1 depicts that during the study period, the Thai government declared emergency decree and curfew nationwide, and the number of EMS patients decreased substantially, consistent with a previous study focusing only the nationwide curfew period. During the severe COVID-19 pandemic period in Frankfurt, which is the fifth largest city in Germany, the number of EMS missions decreased by more than 23.02%, particularly from March 23, 2020 to May 03, 2020, when lockdown was still imposed.<sup>14</sup> In Western Pennsylvania, the number of patients accessing EMS decreased by more than 26.5% during the nationwide curfew.<sup>15</sup> The decrease in the number of EMS patients in Bangkok during emergency decree and nationwide curfew can be possibly explained by the fact that they were restricted to be on outdoors and the implementation of curfew. The emergency decree was implemented from March 26, 2020 to June 30, 2020, with a curfew from 10:00 PM to 4:00 AM, prohibiting people from going out, particularly in Bangkok, which had the highest cumulative number of patients with COVID-19 in Thailand. Therefore, the government considered Bangkok as a specially controlled area. They closed 26 businesses with high COVID-19 infection risk, such as entertainment venues, schools, and department stores, from March 22, 2020. In this period, the emergency departments of many hospitals needed to temporarily deny nonemergency patients because of the COVID-19 admissions and limited hospital capacity. The decreased number of EMS patients in this situation was probably caused by two factors. First, the Thai government publicized signs and symptoms of suspected COVID-19 infection through public media, such as TV programs, every day. They specifically enumerated signs and symptoms that warrant EMS access and described the level of urgency for ambulance calls. Hence, patients understood that without urgent symptoms, they were not allowed to access ambulance service. Second, people in Thailand knew that COVID-19 can be spread by direct contact and aerosolized droplets. They were aware that the infection risk is increased if they are transported by an ambulance and sent to a hospital with patients diagnosed with COVID-19. Thai government's measures including social distancing and self-isolation were also implemented. Our entire explanations are similar to the discussions of previous studies.<sup>8,17</sup> The proportion of patients, especially those without trauma, significantly increased during the COVID-19 pandemic period, but the difference was not statistically significant between those with and without trauma. This finding is comparable to previous studies in many developed countries.<sup>12,16,17,24</sup> For example, in EMS patients delivered to six level 1 trauma centers in the US, the number of injured patients decreased to 21% in 2020 (COVID-19 pandemic period), whereas in 2019, it was 79%.<sup>24</sup> In New York, the number of EMS calls made by patients without trauma increased to 117,086, whereas that of calls made by patients with trauma was 76,017; the difference was statistically significant, consistent with the decreased number of patients transported by ambulances due to traffic accidents.<sup>16</sup>

During the study period, people in Bangkok seldom went out because they were afraid of getting infected with COVID-19. In addition to government's measure of closing public areas, tourist attractions, and department stores, remote working was also highly encouraged. Thus, decreased driving and recreational participation were observed, leading to a reduced number of accidents compared with that in the previous year. Consistent with the previous empirical research in a province of northeastern region of Thailand reporting 11% decreased number of traumatic EMS patients, particularly ones due to traffic accidents during COVID-19 pandemic period, although the research was studied in a province with only little impact of COVID-19.<sup>25</sup>

Furthermore, every EMS operation period (response time, on-scene time, transportation time, and total prehospital time) was statistically significantly longer than that during the non-COVID-19 pandemic period, comparable to the study in Northern Ostrobothnia, Finland. The EMS response time during the COVID-19 pandemic period was longer than that in the same period of March 1 to June 30 of 2016–2019.<sup>13</sup> In a fire department located in Okayama, Japan, the total prehospital time in April 2020 was significantly longer than that in 2019 ( $33.8 \pm 11.6$  minutes vs  $32.2 \pm 10.8$  minutes,  $p < 0.001$ ) because of longer response time ( $9.3 \pm 3.8$  minutes vs  $8.7 \pm 3.7$  minutes,  $p < 0.001$ ) and on-scene time ( $14.4 \pm 7.9$  minutes vs  $13.5 \pm 6.2$  minutes,  $p < 0.001$ ).<sup>22</sup> During the COVID-19 pandemic period in Busan, South Korea, the EMS processing time (response time and scene time) was statistically significantly longer than during the non-COVID-19 period.<sup>26</sup> In our study, every EMS operation period was longer during the study period than during the control period, probably because the COVID-19 pandemic period affected the overall total prehospital time. Additionally, during this

unanticipated pandemic, EMS units were inadequately prepared to manage emergency patients, leading to a prolonged response time before hospital arrival. The emergency medical staff members were still required to wear PPE and entertain additional inquiries from emergency medical dispatchers, especially in patients with suspected COVID-19 infection; some of the questions were related to the abnormal perception of taste and smell and travel history in high-risk areas. Destined hospitals were also hesitant to admit patients because they were afraid of COVID-19 infection spread; acceptance of patients with confirmed or suspected COVID-19 infection might burden the hospitals because of limited hospital capacities.

## Strengths and Limitations of This Study

The strength of this study is the use of this information to improve service quality, know the effect of COVID-19 pandemic in terms of the number of EMS patients and EMS operation period in Bangkok, Thailand. Our study had several limitations. First, it is retrospective in design, so incomplete data were expected. Out of 178,594 patients, only 117,135 had complete data (65.6%), with 62,333 (66.8%) recorded in the study period and 54,802 (64.2%) in the control period. Second, only the Bangkok EMS center, which was heavily affected by COVID-19 pandemic, was studied. Therefore, generalizability might be applied only in the setting with the same level, thereby inappropriate for other contexts. Third, the study period began in January 1, 2020 and ended in December 31, 2020. To date, the COVID-19 pandemic still persisted without improvement. Lastly, there was a high risk of bias caused by an underlying secular trend in pre-post study design. Therefore, the impact of COVID-19 on the EMS operation period and the actual number of EMS patients could not possibly be concluded in the aspect of this pre-post study design in the present. Hence, in the future, for proper identification of these causes, the qualitative study following the population needs to be conducted appropriately in the future.

## Conclusion

During COVID-19 pandemic period, a significantly increased number of EMS patients compared to one during non-COVID-19 pandemic period for both traumatic and non-traumatic patients, as well as remarkably increased every EMS operation period of both groups during COVID-19 pandemic period were found in the present study. From this knowledge, provision of necessary EMS resources and preparation of emergency staff to be ready for management of future pandemics should be obtained to reduce EMS operation period in the future pandemics.

## Data Sharing Statement

The datasets are available from the corresponding author with reasonable request.

## Ethics Approval and Consent to Participate

The ethical consideration of the study protocol was granted by The Committee on Human Rights Related to Research Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital, Mahidol University (MURA2021/821) and Bangkok Metropolitan Administration Human Research Ethics Committee (U022h/64\_EXP). The requirement for informed consent was waived due to the retrospective design. The study data were kept under confidentiality to ensure the privacy of the study participants. This study was conducted in accordance with the Declaration of Helsinki.

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## Author Contributions

All authors made a significant contribution to the study conception, design, execution, acquisition of data, analysis or interpretation of data, or in all these areas. All authors took part in drafting, revising, or critically reviewing the article.

All authors gave final approval of the version to be published, have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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