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ORIGINAL RESEARCH

Association of Emergency Department Length of Stay and Hospital Mortality in Patients Under Investigation for COVID-19

Ar-aishah Dadeh, Itsada Chaisuwaseth, Wainik Sookmee

Department of Emergency Medicine, Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University Hat Yai, Songkhla, 90110, Thailand

Correspondence: Ar-aishah Dadeh, Department of Emergency Medicine, Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, 90110, Thailand, Tel +66 74-451705, Fax +66 74-451704, Email dadehstou@gmail.com

Objective: We aimed to determine the association between hospital mortality of patients under investigation (PUI) for COVID-19 and emergency department length of stay (EDLOS).

Patients and Methods: A retrospective study was conducted from April 3, 2020 to April 2, 2022. Adult PUI who presented with both clinical and epidemiological risk factors for COVID-19 disease and underwent sample collection with nasal swab for reverse transcription polymerase chain reaction were included in the study. The factors associated with EDLOS and hospital mortality were investigated using univariate logistic regression and multivariate logistic regression analyses.

Results: A total of 961 PUI were enrolled that included 836 (87%) non-COVID-19 patients. The median (interquartile range [IQR]) EDLOS durations for 7-day and 30-day mortality of all PUI were 3.1 hours (2.1,4.3, P = 0.231) and 3.2 hours (2.1,4.3, P = 0.653). Multivariate logistic regression analysis revealed that the significant factors associated with EDLOS longer than 4 hours were consultation of three departments (adjusted odds ratio (aOR) 27.3, 95% CI 2.42–309.71, P = 0.007), emergency severity index (ESI) level 3 (aOR 2.31, 95% CI 1.37–3.9), investigations >2 (aOR 2.62, 95% CI 1.62–4.25), nebulization (aOR 2.34, 95% CI 1.39–3.96), administration of intravenous fluid (aOR 2.62, 95% CI 1.59–4.33), performing ≥1 procedure (aOR 3.35, 95% CI 1.51–7.43), and discharged patients (aOR 2.13, 95% CI 1.02–4.48).

Conclusion: The significant factors associated with prolonged EDLOS in PUI included consultation of three departments, ESI level 3, investigations >2, ED treatment, ED procedures, and discharged patients. The median times of EDLOS and hospital LOS were 3.2 hours and 5.7 days. The EDLOS had no significant association with short-term mortality.

Keywords: emergency department length of stay, pandemic, COVID-19, patients under investigation, hospital mortality

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is an infectious disease that caused the worldwide coronavirus disease 2019 (COVID-19) pandemic. The first case detected was in Wuhan, Hubei Province, Republic of China in December 2019. The virus spread rapidly to other countries around the world.[1] The pandemic is an ongoing global crisis that has a widespread impact on every aspect of life. Nowadays, there are new cases, patients, and deaths from COVID-19 and a continued increase. According to a report in December 2019, there were more than 287.7 million confirmed cases and more than 5,458,145 deaths worldwide,[2–4] which led to an enormous stress on the healthcare system as a whole. Emergency departments (EDs) around the world have been faced with severe stress because they are on the frontlines of the health care system. Due to the increasing number of patients in the ED that can lead to overcrowding, some emergency patients possibly received delayed treatment or they experienced increased ED length of stay (EDLOS) potentially affecting quality of treatment. Longer durations of EDLOS were reported to be associated with increased inpatient mortality and modest increases in length of stay and costs for admitted patients.[5,6] Previous studies showed that the length of time a patient spent in the emergency department affected the death rate and hospital length of stay (HLOS). The death rate was 2.5% for

Received: 4 January 2024
Accepted: 12 September 2024
Published: 16 September 2024

patients who boarded for less than 2 hours and 4.5% for those who stayed for more than 12 hours, and the HLOS increased from 5.6 to 8.7 days. Furthermore, the outcome of ICU patients with a 6-hour delay in ICU transfer from an ED had a longer HLOS (7 vs 6 days) and a higher mortality rate (10.7% vs 8.4%).[7,8] In the year 2000, the Department of Public Health of England established standards of care in the National Health Service (NHS) development plan (NHS plan) that specified the duration of all ED visits should not exceed four hours.[9,10] In Thailand, Panitpichetvong reported that the median EDLOS was 1 hour, 51 minutes.[11] Thongphan and Chantaphet reported the time spent for imaging studies, evening shift (16:01–24:00), and specialist consultation were the leading causes of patients spending >8 hours in the ED.[12] On the other hand, during the COVID-19 pandemic, Singh reported that the median (interquartile range [IQR]) EDLOS was 1.75 hours (0–30 hours).[13] O'Reilly et al reported that the strong clinical predictors of the SARS-CoV-2 test result included self-reported fever, sore throat, bilateral infiltrates on chest X-rays, and absence of leukocytosis in the initial ED blood tests ($P < 0.05$).[14] Kurihara et al reported a prevalence of COVID-19 of 17.9% (457/2,555) while the prevalence of non-COVID-19 diagnoses was 82.1% of all cases, and the common cold had the highest prevalence of 33.0% of all final diagnoses.[15] In summary, many potentially fatal diseases remain hidden among patients who present with suspected COVID-19 symptoms (COVID-19 mimics). A thorough differential diagnosis needs to be considered before diagnosing COVID-19. Kim and colleagues investigated the characteristics of patients who visited regional emergency medical centers. A particular emphasis was placed on the changes in EDLOS and emergency room use for severely ill patients using the Korean Triage and Acuity Scale. The study concluded there was a 37.6% decrease in total emergency room visits, a 203.7% increase in EDLOS for severely ill patients, and a 9.0% increase in emergency hotline ambulance utilization rate for emergency patients. Furthermore, a 2.1% increase in severity in the emergency room and an increase in emergency room deaths of severely ill patients were observed following the COVID-19 outbreak.[16] To date, few studies or analyses have been published on the impact of the widespread outbreak of COVID-19 on EDLOS of patients who visit the ED. The aim of this study was to determine the association between hospital mortality of patients under investigation for COVID-19 and EDLOS.

Patients and Methods

Study Design and Setting

This single-center retrospective cohort study was conducted in patients aged ≥18 years who were patients under investigation (PUI) for coronavirus disease 2019 during an ED visit at Songklanagarind Hospital, which is a tertiary referral and academic hospital on the campus of Prince of Songkla University in southern Thailand. The hospital electronic medical record database was reviewed for patient data from April 3, 2020 to April 2, 2022.

Study Population

Adult patients aged 18 years and older who visited the ED and met the criteria of PUI for coronavirus disease 2019 were included in the study. The excluded patients included dead on arrival, either referred from or to another hospital, trauma patients, and patients with incomplete data. The study sample size was calculated using a two-tailed test based on a study by Kurihara.[15] The sample size was calculated using n4Studies and found to be 1,171 patients. However, the researchers included all patients who were PUI of coronavirus disease 2019 during the two-year study period.

Data Collection

The PUI patients were categorized into either the positive COVID-19 or negative COVID-19 (non-COVID) based on the reverse transcription polymerase chain reaction (RT-PCR) test. The data collected from the electronic medical records and ED data registry included baseline characteristics, comorbidities, visit type, triage level, presenting symptoms, investigations, treatment in the ED, consulted department(s), ED shift, number of patients during that shift, EDLOS, type of ED disposition, and mortality.

Outcome Measures

The primary outcome was to determine the association between hospital mortality of PUI for COVID-19 and EDLOS. The secondary outcome was to identify the factors affecting EDLOS in PUI and treatment outcomes. Patients who presented with

Table 1 Definition of Patients Under Investigation (PUI) Who Presented with Both Clinical and Epidemiological Risk Factors for a COVID-19 During the Study Period

Signs and Symptoms	Risk factors
Scenario 1: Surveillance at points of entry quarantine stations Patient with body temperature ≥37.3 °C or any of the following respiratory symptoms such as cough, runny nose, sore throat, anosmia, tachypnea, or shortness of breath, or difficulty breathing	Having history of travel to or from foreign countries from all flights and points of entry
Scenario 2: Surveillance in PUI/patients 2.1 Symptomatic PUI with any of the following respiratory symptoms such as cough, runny nose, sore throat, anosmia, tachypnea, or shortness of breath, or difficulty breathing and/or having temperature ≥37.5 °C	(1) Any history within 14 days prior to symptom onset as follows: (1.1) Travel history to/ from or reside in areas with ongoing local transmission in the past month (1.2) History of contact with a confirmed COVID-19 case (1.3) Travel history to crowded places in the community or places of gathering where confirmed cases have been reported in the past month eg, flea markets, malls, hospitals, public transportation (1.4) Work in a quarantine facility (2) Suspected of having COVID-19 by attending physician
2.2 Patients with pneumonia	Any of the following characteristics: (1) Severe symptoms requiring intubation or death (2) Etiology unclear or cannot be identified within 48 hours (3) Suspected of having COVID-19 by attending physician
Scenario 3: Surveillance in health personnel With any of the following symptoms: history of fever/body temperature ≥37.5 °C, cough, runny nose, sore throat, anosmia, ageusia, tachypnea, or shortness of breath, or difficulty breathing	Working in health care facilities eg, hospitals, clinics, health promotion hospitals, laboratories, drug stores, members of investigation teams or personnel working in quarantine facilities (test as determined appropriate)
Scenario 4: Surveillance in community clusters of patients with respiratory infection - A cluster of ≥3 health personnel in the same department - A cluster of ≥5 patient with respiratory symptoms in the same specific area (for school setting: in the same classroom)	Clusters in the same area, in the same week with epidemiological linkage.

Notes: Data from Ministry of Public Health.[17]

both clinical and epidemiological risk factors for the COVID-19 disease and defined as PUI (Table 1)[17] who underwent sample collection with nasal swab for RT-PCR were included in the study. The patients were categorized into COVID-19 positive PUI and non-COVID-19 PUI groups. The exclusion criteria were patients who presented with out-of-hospital cardiac arrest on ED arrival, referred patients from other facilities, and patients who were transferred to other hospitals.

Statistical Analysis

The study population sample size was calculated using the n4Studies program to test two independent proportions, which was based on a study by Kurihara.[15] The total final calculated sample size was 1,171 patients assuming a 10% drop-out rate. We included a total of 961 PUI with complete recorded data and met the enrolment criteria. All data were entered into EpiData Manager (version 4.4.2.1). R software (version 4.0.3) was used for all statistical analyses (R Foundation for Statistical Computing, Vienna, Austria). Continuous data are reported as median (IQR) or the mean and standard deviation. Counts and percentages were used to present categorical data. The categorical variables were compared using Pearson's chi-square test. In the analysis to determine any independent factors of the primary outcome variables, variables having a P-value <0.2 in a univariate analysis and those regarded clinically relevant were included in the multivariate analysis using odds ratio (OR) and 95% confidence interval (CI). Statistical significance was set at $P < 0.05$.

Compliance with Ethical Requirements

The ethics committee of Prince of Songkla University approved this study. The institutional review board of Prince of Songkla University is affiliated with the International Conference on Harmonization in Good Clinical Practice. According to our institutional review board protocol for waiver of informed consent, the requirement for consent was waived because the participants had no more than minimal risk and the patients received standard treatment procedures. All research information was kept as confidential data in an encrypted file with password and limited data access by only the researcher and assistant. The ethical registration number was REC. 65–380-20-4. This study was conducted in accordance with the Declaration of Helsinki.

Results

Characteristics of the Study Population

During the study period, 1,672 PUI visited the ED. A total of 961 patients met the inclusion criteria and were enrolled in the study (Figure 1). The baseline characteristics of the patients are shown in Table 2. The median (IQR) age of all participants was 72.6 years (59.9, 82.3) and 53.4% were male. The number of patients in the non-COVID-19 group was 836 (86.9%) and the median (IQR) age of this group was older than the median (IQR) of the COVID-19 group (73 [60.9, 82.5] vs 70.1 [58.3, 80.8], P < 0.075). The non-COVID-19 group had a higher percentage of visits during the day shift (52.6% vs 48%, P = 0.001) and a higher percentage of ED triage emergency severity index (ESI) level 1 (27.9% vs 18.4%, P = 0.053). However, the presenting symptoms were not different between the two groups. The three common presenting symptoms were respiratory symptoms (74.4%), gastrointestinal symptoms (9.2%), and neurological symptoms (8.3%). The five most common co-morbidities in the non-COVID-19 group compared with the COVID-19 group were hypertension (46.8% vs 41.6%, P = 0.324), diabetes mellitus (30.3% vs 25.6%, P = 0.337), chronic kidney disease (20.6% vs 20.8%, P = 1.000), malignancy (21.1% vs 12%, P = 0.025), and cerebrovascular disease (16.1% vs 15.2%, P = 0.89).

The non-COVID-19 group had a higher percentage of performing blood test than the COVID-19 group (91.4% vs 77.6%, P < 0.001). The rate of nebulization was significantly higher in the non-COVID-19 group than the COVID-19 group (17.9% vs 9.6%, P = 0.028). Oxygen therapy in all patients was oxygen cannula in 59.6% and intubation in 31.8%.

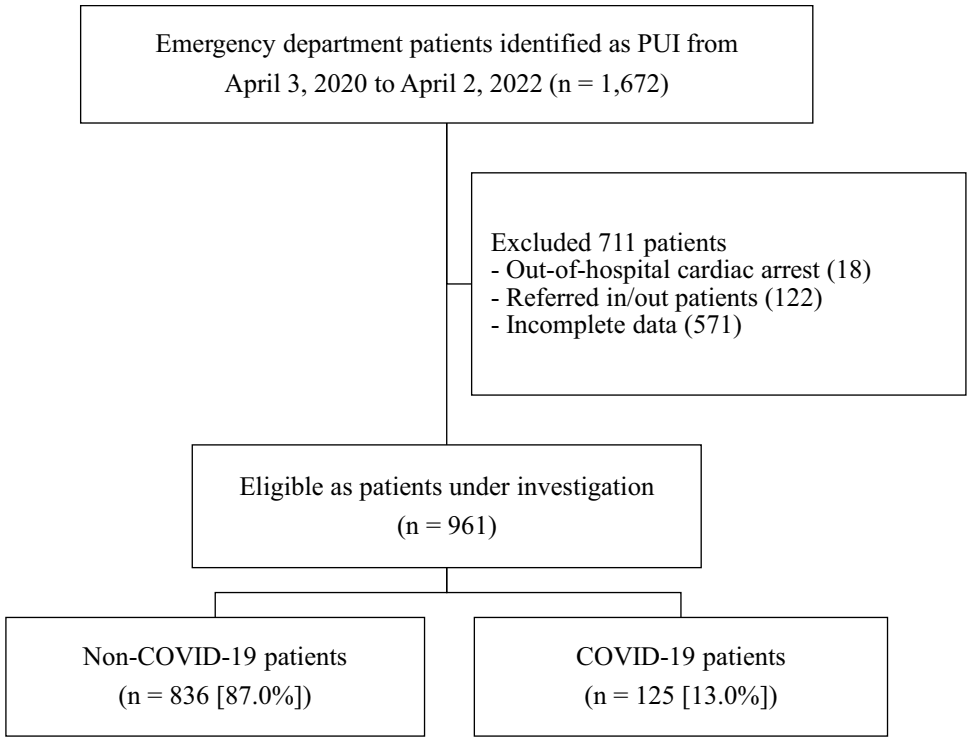

Figure 1 Study flow diagram of enrollment process.

Table 2 Demographic and Baseline Characteristics of Patients Under Investigation (PUI)

Characteristics	COVID-19 patients (n = 125)	Non-COVID-19 patients (n = 836)	Total (n = 961)	P value
Gender				0.733
Male	69 (55.2)	444 (53.1)	513 (53.4)	
Female	56 (44.8)	392 (46.9)	448 (46.6)	
Age, median (IQR)	70.1 (58.3,80.8)	73 (60.9,82.5)	72.6 (59.9,82.3)	0.075
Mode of arrival				0.62
Walk in	102 (81.6)	694 (83)	796 (82.8)	
BLS	11 (8.8)	68 (8.1)	79 (8.2)	
EMS	8 (6.4)	32 (3.8)	40 (4.2)	
Referral	0 (0)	1 (0.1)	1 (0.1)	
OPD	4 (3.2)	41 (4.9)	45 (4.7)	
Work shift				0.001
8:00–16:00	60 (48)	440 (52.6)	500 (52)	
16:01–24:00	55 (44)	248 (29.7)	303 (31.5)	
00:01–07:59	10 (8)	148 (17.7)	158 (16.4)	
ED Triage				0.053
ESI 1 (Resuscitated)	23 (18.4)	233 (27.9)	256 (26.6)	
ESI 2 (Emergent)	77 (61.6)	494 (59.1)	571 (59.4)	
ESI 3 (Urgency)	24 (19.2)	106 (12.7)	130 (13.5)	
ESI 4 (Less urgency)	1 (0.8)	3 (0.4)	4 (0.4)	
Presenting symptoms				
Respiratory	95 (76)	620 (74.2)	715 (74.4)	0.742
Cardiovascular	4 (3.2)	39 (4.7)	43 (4.5)	0.612
GI	12 (9.6)	76 (9.1)	88 (9.2)	0.986
Neurologic	8 (6.4)	72 (8.6)	80 (8.3)	0.508
Skin	0 (0)	18 (2.2)	18 (1.9)	0.193
Others	10 (8)	64 (7.7)	74 (7.7)	1.000
Comorbidities				
Asthma	5 (4)	40 (4.8)	45 (4.7)	0.873
COPD	6 (4.8)	66 (7.9)	72 (7.5)	0.297
Hypertension	52 (41.6)	391 (46.8)	443 (46.1)	0.324
Diabetes mellitus	32 (25.6)	253 (30.3)	285 (29.7)	0.337
Coronary heart disease	18 (14.4)	121 (14.5)	139 (14.5)	1.000
Liver disease	5 (4)	37 (4.4)	42 (4.4)	1.000
Chronic kidney disease	26 (20.8)	172 (20.6)	198 (20.6)	1.000
Malignancy	15 (12)	176 (21.1)	191 (19.9)	0.025
Cerebrovascular disease	19 (15.2)	135 (16.1)	154 (16)	0.89
Dementia	2 (1.6)	26 (3.1)	28 (2.9)	0.515
Investigation				
Uninvestigated	4 (3.2)	13 (1.6)	17 (1.8)	0.348
Laboratory (blood)	97 (77.6)	764 (91.4)	861 (89.6)	<0.001
Plain film X-ray	121 (96.8)	800 (95.7)	921 (95.8)	0.736
CT scan	7 (5.6)	84 (10)	91 (9.5)	0.156
Ultrasonography	0 (0)	10 (1.2)	10 (1)	0.449

(*Continued*)

Table 2 (Continued).

Characteristics	COVID-19 patients (n = 125)	Non-COVID-19 patients (n = 836)	Total (n = 961)	P value
ED treatment				
Nebulization	12 (9.6)	150 (17.9)	162 (16.9)	0.028
Intravenous fluid	59 (47.2)	441 (52.8)	500 (52)	0.288
IV antibiotics	68 (54.4)	476 (56.9)	544 (56.6)	0.662
Type of oxygen therapy				
None	60 (48)	341 (40.8)	401 (41.7)	0.153
Oxygen cannula	40 (61.5)	294 (59.4)	334 (59.6)	0.844
Oxygen mask with bag	5 (7.7)	40 (8.1)	45 (8)	1.000
HFNC	8 (12.3)	39 (7.9)	47 (8.4)	0.331
BiPAP	6 (9.2)	85 (17.2)	91 (16.2)	0.146
Endotracheal intubation	19 (29.2)	159 (32.1)	178 (31.8)	0.742
Procedures				
CVC insertion	0 (0)	4 (0.5)	4 (0.4)	0.976
Intercostal drainage	2 (1.6)	17 (2)	19 (2)	1.000
Cardiopulmonary resuscitation	1 (0.8)	9 (1.1)	10 (1)	1.000
Consulted department				
General medicine	109 (87.2)	750 (89.7)	859 (89.4)	0.487
General surgery	8 (6.4)	72 (8.6)	80 (8.3)	0.508
Neurological surgery	3 (2.4)	12 (1.4)	15 (1.6)	0.671
Orthopedic surgery	1 (0.8)	12 (1.4)	13 (1.4)	0.874
Ophthalmology	1 (0.8)	2 (0.2)	3 (0.3)	0.85
Otolaryngology	1 (0.8)	22 (2.6)	23 (2.4)	0.349
Obstetrics and gynecology	2 (1.6)	24 (2.9)	26 (2.7)	0.602
Psychiatry	0 (0)	3 (0.4)	3 (0.3)	1.000
Anesthetist	2 (1.6)	6 (0.7)	8 (0.8)	0.628
Number of total consulted departments, median (IQR)	1 (1,1)	1 (1,1)	1 (1,1)	0.017
Number of patients during that shift, median (IQR)	40 (33,45)	39 (30,45)	39 (30,45)	0.066
ED Disposition				<0.001
Admit to general ward	4 (3.2)	704 (84.2)	708	
Admit to COVID ward	106 (84.8)	4 (0.5)	110	
Admit to ICU	4 (3.2)	92 (11)	96	
Transfer	0 (0)	24 (2.9)	24	
Discharge	11 (8.8)	10 (1.2)	21	
Dead	0 (0)	2 (0.2)	2	
ED length of stay (hours)				0.015
<4	98 (78.4)	534 (63.9)	632	
4–8	26 (20.8)	280 (33.5)	306	
8–12	1 (0.8)	21 (2.5)	22	
>16	0 (0)	1 (0.1)	1	
EDLOS (hours), median (IQR)	2.6 (1.9,3.8)	3.2 (2.3,4.6)	3.2 (2.2,4.5)	<0.001
HLOS (days), median (IQR)	9.6 (4.9,14.8)	5.7 (2.1,12)	5.8 (1.9,12.1)	<0.001

Note: Data are presented as n (%) unless otherwise indicated.

Abbreviations: COVID-19, coronavirus disease-2019; IQR, interquartile range; BLS, basic life support; EMS, emergency medicine services; OPD, outpatient department; ED, emergency department; ESI, emergency severity index; COPD, chronic obstructive pulmonary disease; CT, computed tomography; IV, intravenous; HFNC, high flow nasal cannula; BiPAP, bi-level positive airway pressure; CVC, central venous catheter; ICU, intensive care unit; EDLOS, emergency department length of stay; HLOS, hospital length of stay.

Patients in the non-COVID-19 group were more likely to be admitted to the general ward (84.2% vs 3.2%, P < 0.001) and intensive care unit (ICU) than the COVID-19 group (11% vs 3.2%, P < 0.001). The EDLOS in the non-COVID-19 group was longer than the COVID-19 group (median [IQR] 3.2 hours [2.3, 4.6] vs 2.6 [1.9, 3.8], P < 0.001). On the other hand, patients in the non-COVID-19 group had a shorter HLOS (median [IQR] 5.7 days [2.1, 12] vs 9.6 [4.9, 14.8], P < 0.001).

EDLOS, Hospital Mortality, and Factors Affecting EDLOS in PUI

The median (IQR) EDLOS times in 7-day and 30-day mortality of all PUI were 3.1 hours (2.1,4.3, P = 0.231) and 3.2 hours (2.1,4.3, P = 0.653), respectively (Table 3). The median (IQR) HLOS durations among the PUI who died at 7 days and 30 days were 2 days (0.6,4.7) (P < 0.001) and 6.2 days (1.1,13) (P = 0.123), respectively (Table 3). The univariate logistic regression analysis showed that the factors for an increased likelihood of EDLOS longer than 4 hours were performing a blood test (OR 5.34, 95% CI 2.82–10.11), requesting a computed tomography scan (OR 3.3, 95% CI 2.13–5.1), requesting ultrasonography (OR 7.74, 95% CI 1.63–36.66), and orthopedic surgery consultation (OR 3.08, 95% CI 1.00–9.49) (Table 4). The factors that doubled the OR of longer ED stay included presenting with skin symptoms (OR 2.36, 95% CI 0.97–5.75), intercostal drainage insertion (OR 2.66, 95% CI 1.06–6.68), general surgery consultation (OR 2.3, 95% CI 1.47–3.62), and the number of consulted departments (OR 2.2, 95% CI 1.52–3.17). Multivariate logistic regression analysis revealed that consultation of three departments had the greatest adjusted OR (aOR) that was statistically significant (aOR 27.3, 95% CI 2.42–309.71, P = 0.007) (Table 5). Moreover, ESI level 3 (aOR 2.31, 95% CI 1.37–3.9), investigations >2 (aOR 2.62, 95% CI 1.62–4.25), nebulization (aOR 2.34, 95% CI 1.39–3.96), administration of intravenous fluid (aOR 2.62, 95% CI 1.59–4.33), performing ≥1 procedure (aOR 3.35, 95% CI 1.51–7.43), and discharged patients (aOR 2.13, 95% CI 1.02–4.48) were revealed to be significant factors identified in the multivariate logistic regression analysis.

Table 3 Comparison of EDLOS and 7-Day and 30-Day Hospital Mortality of All PUI

Variables	7-day mortality (n = 47)	Survival >7 days (n = 868)	Total (n = 915)	P value
EDLOS (hours), median (IQR)	3.1 (2.1,4.3)	3.2 (2.3,4.6)	3.2 (2.2,4.5)	0.231
EDLOS (hours)				0.711
< 4	30 (63.8)	568 (65.4)	598 (65.4)	
4–8	17 (36.2)	279 (32.1)	296 (32.3)	
8–12	0 (0)	20 (2.3)	20 (2.2)	
>16	0 (0)	1 (0.1)	1 (0.1)	
HLOS (days), median (IQR)	2 (0.6,4.7)	6.9 (3.1,13.2)	5.8 (1.9,12.1)	<0.001
	30-day mortality (n = 78)	**Survival >30 days (n = 837)**	**Total (n = 915)**	**P value**
EDLOS (hours), median (IQR)	3.2 (2.1,4.3)	3.1 (2.3,4.6)	3.2 (2.2,4.5)	0.653
EDLOS (hours)				0.932
<4	51 (65.4)	547 (65.4)	598 (65.4)	
4–8	26 (33.3)	270 (32.3)	296 (32.3)	
8–12	1 (1.3)	19 (2.3)	20 (2.2)	
>16	0 (0)	1 (0.1)	1 (0.1)	
HLOS (days), median (IQR)	6.2 (1.1,13)	6.4 (3,12.3)	5.8 (1.9,12.1)	0.123

Note: Data are presented as n (%) unless otherwise indicated.
Abbreviations: EDLOS, emergency department length of stay; IQR, interquartile range; HLOS, hospital length of stay.

Table 4 Univariate Logistic Regression Analysis of Factors Affecting EDLOS in Patients Under Investigation (PUI) and Treatment Outcomes

Variables	Odds ratio	95% CI	P value
Gender: Male	1.25	0.96–1.62	0.091
Age > 65 years	1.13	0.86–1.48	0.394
Mode of arrival			
Walk in	1	1	0.042
BLS	0.61	0.36–1.04	0.068
EMS	0.68	0.36–1.31	0.252
OPD	1.69	0.93–3.06	0.086
Work shift			
8:00–16:00	1	1	<0.001
16:01–24:00	0.56	0.41–0.75	<0.001
00:01–07:59	0.5	0.34–0.74	<0.001
ESI triage			
ESI 1 (Resuscitated)	1	1	0.015
ESI 2 (Emergent)	1.56	1.13–2.14	0.006
ESI 3 (Urgency)	1.82	1.18–2.8	0.007
ESI 4 (Less urgency)	0.67	0.07–6.13	0.726
Presenting symptoms			
Respiratory symptoms	0.56	0.42–0.75	<0.001
Cardiovascular symptoms	1.16	0.63–2.15	0.639
GI symptoms	1.86	1.22–2.84	0.004
Neurologic symptoms	1.29	0.83–2.02	0.253
Skin symptoms	2.36	0.97–5.75	0.059
Others	1.45	0.91–2.3	0.119
Comorbidities			
Asthma	0.95	0.53–1.69	0.85
COPD	0.81	0.49–1.35	0.417
Hypertension	0.95	0.73–1.23	0.678
Diabetes mellitus	0.88	0.66–1.17	0.369
Coronary heart disease	0.99	0.68–1.43	0.939
Liver disease	1.02	0.54–1.93	0.96
Chronic kidney disease	0.98	0.71–1.36	0.903
Malignancy	1.23	0.89–1.69	0.208
Cerebrovascular disease	1.27	0.9–1.81	0.175
Dementia	1.23	0.57–2.67	0.592
Investigation			
Uninvestigated	0.09	0.01–0.69	0.02
Laboratory (blood)	5.34	2.82–10.11	<0.001
Plain film X-ray	1.92	0.97–3.81	0.06
CT scan	3.3	2.13–5.1	<0.001
Ultrasonography	7.74	1.63–36.66	0.01
ED Treatment			
Nebulization	0.89	0.62–1.27	0.515
Intravenous fluid	1.48	1.14–1.92	0.003
IV antibiotics	1.33	1.02–1.73	0.034

(*Continued*)

Table 4 (Continued).

Variables	Odds ratio	95% CI	P value
Type of oxygen therapy			
None	1.17	0.9–1.51	0.252
Oxygen cannula	1.49	1.04–2.13	0.031
Oxygen mask with bag	0.82	0.43–1.57	0.551
HFNC	1.56	0.85–2.86	0.151
BiPAP	0.9	0.56–1.46	0.677
Endotracheal intubation	0.85	0.58–1.24	0.395
Procedures			
CVC insertion	1.9	0.27–13.56	0.521
Intercostal drainage	2.66	1.06–6.68	0.037
Cardiopulmonary resuscitation	0.63	0.17–2.34	0.489
Consulted department			
General Medicine	1.03	0.69–1.54	0.875
General surgery	2.3	1.47–3.62	<0.001
Neurological surgery	1.7	0.65–4.45	0.278
Orthopedic surgery	3.08	1–9.49	0.05
Ophthalmology	0.95	0.09–10.49	0.965
Otolaryngology	1.23	0.52–2.86	0.639
Obstetrics and gynecology	1.67	0.78–3.55	0.183
Psychiatry	0.95	0.09–10.49	0.965
Anesthetist	0.63	0.13–3.14	0.573
Number of consulted departments	2.2	1.52–3.17	<0.001
Number of patients	1.02	1.01–1.04	<0.001
ED disposition			
Admitted to general ward	1	1	0.008
Admitted to COVID ward	0.45	0.27–0.72	0.001
Admitted to ICU	0.62	0.38–0.99	0.046
Transferred	1.03	0.48–2.21	0.941
Discharged	1.08	0.59–1.99	0.799
Dead	0.56	0.06–5.42	0.618

Abbreviations: EDLOS, emergency department length of stay; CI, confidence interval; BLS, basic life support; EMS emergency medical services; OPD, outpatient department; ESI, emergency severity index; GI, gastrointestinal; COPD, chronic obstructive pulmonary disease; CT, computed tomography; ED, emergency department; IV, intravenous; HFNC, high flow nasal cannula; BiPAP, bi-level positive airway pressure ventilator; CVC, central venous catheter; COVID, coronavirus disease.

Table 5 Multivariate Logistic Regression Analysis of Factors Affecting EDLOS in PUI and Treatment Outcomes

	Crude OR (95% CI)	aOR (95% CI)	P value
Work shift			
16:01–0.24:00	0.56 (0.41–0.75)	0.57 (0.41–0.79)	< 0.001
00:01–07:59	0.5 (0.34–0.74)	0.6 (0.38–0.94)	0.026
ESI triage			
ESI 2 (Emergent)	1.56 (1.13–2.14)	1.77 (1.23–2.55)	0.002
ESI 3 (Urgent)	1.82 (1.18–2.8)	2.31 (1.37–3.9)	0.002
ESI 4 (Less urgent)	0.67 (0.07–6.13)	1.89 (0.19–19.17)	0.588

(*Continued*)

Table 5 (Continued).

	Crude OR (95% CI)	aOR (95% CI)	P value
Respiratory symptoms	0.56 (0.42–0.75)	0.69 (0.49–0.96)	0.028
Cerebrovascular disease	1.27 (0.9–1.81)	1.32 (0.91–1.92)	0.146
Investigations >2	3.12 (2.03–4.8)	2.62 (1.62–4.25)	<0.001
ED treatment			
Nebulization	2.26 (1.41–3.63)	2.34 (1.39–3.96)	0.001
Intravenous fluid	2.6 (1.65–4.08)	2.62 (1.59–4.33)	<0.001
IV antibiotics	1.85 (1.08–3.18)	1.87 (1.01–3.47)	0.046
Others	2.32 (0.99–5.4)	2.82 (1.11–7.15)	0.029
Procedures ≥ 1	1.82 (0.91–3.65)	3.35 (1.51–7.43)	0.003
Number of consulted departments			
1	1.62 (0.69–3.81)	2.23 (0.78–6.35)	0.132
2	3.92 (1.48–10.36)	4.39 (1.37–14.1)	0.013
3	19.71 (2.02–192.7)	27.4 (2.42–309.71)	0.007
4	3.29 (0.18–59.6)	1.16 (0.05–24.68)	0.924
Number of patients ≥40	1.7 (1.31–2.21)	1.37 (1–1.87)	0.049
Disposition			
Admitted to COVID ward	0.45 (0.27–0.72)	0.55 (0.33–0.92)	0.024
Admitted to ICU	0.62 (0.38–0.99)	0.68 (0.4–1.17)	0.167
Transferred	1.03 (0.48–2.21)	1.22 (0.53–2.82)	0.639
Discharged	1.08 (0.59–1.99)	2.13 (1.02–4.48)	0.045
Dead	0.56 (0.06–5.42)	0.79 (0.06–10.34)	0.857

Abbreviations: EDLOS, emergency department length of stay; PUI, patients under investigation; OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; ESI, emergency severity index; ED, emergency department; IV, intravenous; COVID, coronavirus disease; ICU, intensive care unit.

Discussion

The primary outcome of the present study revealed no association between 7-day and 30-day hospital mortality of PUI for COVID-19 and EDLOS. The multivariate logistic regression analysis that was conducted for the secondary outcome analysis revealed that the following factors significantly influenced EDLOS in PUI: three departments consulted, performing one procedure, investigations >2, administration of intravenous fluid, nebulization, ESI level 3, and discharged patients.

The definition of prolonged EDLOS varies across studies and ranges from 4 to 12 hours. An internationally recognized performance indicator to assess the quality of emergency care in western countries is EDLOS <6 hours for critically ill patients admitted to the ICU from the ED.[18] The median EDLOS durations of patients who died at 7 days and 30 days in all PUI found in our study were 3.1 hours and 3.2 hours, respectively, without statistical significance. To our knowledge, limited data is available on the association of EDLOS in PUI and hospital mortality. In contrast to our data, one retrospective observation study demonstrated an increased EDLOS for patients who were triaged as life threatening or critical patients and managed in isolation for COVID 19 infection prevention and control precautions. The median (IQR) EDLOS was 4.3 (3.5,6.3) hours for the isolation group and 3.4 (2.1–4.9) hours for the non-isolation group, which was a difference of 54 minutes ($P < 0.001$) in the median EDLOS times. Isolation was independently associated with a 23% increase in EDLOS ($P = 0.002$) and doubled the odds of an ED stay of more than four hours (aOR 2.2 [1.4–3.4], $P = 0.001$).[19] Several previous studies discussed only the general ED population that was not specific to PUI. Strong evidence of a connection between EDLOS and mortality risk in general ED patients was not found in an earlier study conducted by Boudi et al.[20] Nevertheless, other negative outcomes of prolonged EDLOS were reported that included prolonged HLOS,[21] increased risks of undesirable event, and missed a relevant home medication.[22] During the

pandemic era, the EDLOS was significantly shorter than normal due to a variation in patient flow, the lockdown, and hospital setup with better availability of resources and ED protocols.[23] Also, in a study that showed no negative effect of prolonged EDLOS on patient mortality, the ED had sufficient capability to perform appropriate resuscitation protocols and had fewer incidences of overcrowding. Data during the pandemic era possibly resulted in shorter EDLOS due to early admission; therefore, we stratified the severity of illness based on the triage system and adjusted the causal model accordingly. The present investigation was carried out during the early phases of the COVID-19 pandemic. In this unique circumstance, the short EDLOS possibly represented hospital policies that included the hospital management system and the flow of hospital patient care, which might not be applicable in regular or normal practice.

One frequent and significant component of ED practice that can cause delays in patient flow is interdepartmental consultation. Consultations can be for a variety of purposes that include admission, opinion only, special treatments, transfer of care, and outpatient referrals.[24] The present study revealed that consultation of three departments had the greatest aOR that was statistically significant (aOR 27.3, 95% CI 2.42–309.71, P = 0.007). In our study, the median (IQR) age of all PUI was in the elderly age group (72.6 years [59.9,82.3]). Prolonged EDLOS was also linked to age >65 years. Older patients were more likely to be under-triaged because of non-specific symptoms or vital signs compared to younger patients, which could result in extended EDLOS.[25] Due to multiple chronic diseases, exceptional physiology resulting in atypical presentations with delayed symptoms, unreliable vital signs in response to disease, and unpredictable physical examination results, elderly patients were likely to stay in the ED longer. Elderly patients needed more investigations, imaging studies, and consulting services.[26] Our data collection represents the early stages of the first wave of COVID-19 that hit Thailand. During that time, the medical teams were instructed to wear complete personal protective equipment prior to any contact with PUI. Due to the strict hygiene protocol, N95 masks were constantly worn during the pandemic. The time needed for "donning" and "doffing" possibly delayed patient care especially when multiple department consultations were needed.

Emerging trends in emergency medicine indicate that telemedicine is a promising tool for streamlining emergency care. The development of telemedicine was one of the most significant shifts in emergency treatment during the COVID-19 epidemic. There are advantages and challenges in telehealth methods that are being implemented in emergency care.[27] The use of remote consultation may facilitate decreasing EDLOS in PUI with specific disorders, but may have some limitations in evaluating clinical signs and symptoms in severe and critically ill patients. Telehealth methods need to be investigated further to confirm their validity.

In the study setting of this current research, the ESI triage system was used to categorize the severity of the patients. We found that ESI level 3 triage presented with an aOR of 2.31 for an EDLOS longer than four hours. In concordance with a previous study that compared patients assigned to higher acuity scores during the initial triage, patients with lower acuity ratings were more likely to experience a longer EDLOS.[28] Prolonged EDLOS in patients with lower acuity scores may be explained by a variety of factors, such as a deteriorating clinical condition while the patient is in the ED, diagnostic uncertainty that requires additional diagnostic testing and specialist consultations, and lowering the priority of patients assigned to higher severity scores.[29]

The study period of the present study was conducted during the initial stage of a pandemic. The short EDLOS may reflect only the hospital policy that included the hospital management system and the flow of hospital care during a special event; therefore, it may not apply in normal or routine practice.

Limitations

Our study has some limitations. This was a single-center study, and our results may not be generalizable to other institutions. Furthermore, this study was retrospective in nature that resulted in selection bias due to the exclusion of patients with incomplete data. Furthermore, other possible confounders such terminal illness, duration of mechanical ventilation, and referral after admission were not taken into account in this study, which may have had an impact on the primary results.

Conclusion

Significant factors associated with prolonged EDLOS in PUI included consultation of three departments, ESI level 3, investigations >2, emergency department treatment, ED procedures, and discharged patients. The median durations of EDLOS and HLOS were 3.2 hours and 5.7 days, respectively. The EDLOS had no significant association with short-term

mortality. The emergency department workflow for patients who present with ESI level 3, which requires multiple resources, needs to be optimized. A specific multidepartment consultation protocol would reduce ED stay with a positive impact on ED workflow. Future research should focus on the long-term outcomes of PUI with various EDLOS and assess the impact of particular healthcare system components on EDLOS and patient outcomes.

Data Sharing Statement

The retrospective data used to support the findings of this study are available from the corresponding author upon request.

Acknowledgments

The authors are grateful to Ms. Kingkarn Waiyanak for article searches and retrieval, Ms. Jirawan Jayuphan, Epidemiology Unit, Faculty of Medicine, Prince of Songkla University for statistical assistance, and Glenn K. Shingledecker for his help in editing the manuscript.

Author Contributions

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

Funding

The Faculty of Medicine funded this research.

Disclosure

The authors report no conflicts of interest in this work.

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