

Received: 2021.01.25

Accepted: 2021.03.30

Available online: 2021.04.14

Published: 2021.08.01

Factors Associated with Emergency Department Length of Stay in Critically Ill Patients: A Single-Center Retrospective Study

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

AE Zhiwei Yang
B Kun Song
F Hang Lin
D Changluo Li
CD Ning Ding

Department of Emergency Medicine, Changsha Central Hospital, University of South China, Changsha, Hunan, PR China

Corresponding Authors: Changluo Li, e-mail: 813205232@qq.com, Ning Ding, e-mail: doctordingning@csu.edu.cn, doctordingning@sina.com

Source of support: This research was supported by the Sanitation and Health Committee Foundation of Hunan Province, China (No. 20201088)

Background: Length of stay (LOS) in the emergency department (ED) should be measured and evaluated comprehensively as an important indicator of hospital emergency service. In this study, we aimed to analyze clinical characteristics of critically ill patients admitted to the ED and identify the factors associated with LOS.

Material/Methods: All patients with level 1 and level 2 of the Emergency Severity Index who were admitted to the ED from January 2018 to December 2019 were included in this retrospective study. The patients were divided into 2 groups: LOS ≥ 4 h and LOS < 4 h. Variables were comprehensively analyzed and compared between the 2 groups.


Results: A total of 19 616 patients, including 7269 patients in the LOS ≥ 4 h group and 12 347 patients in the LOS < 4 h group, were included. Advanced age, admission in winter and during the night shift, and diseases excluding nervous system diseases, cardiovascular diseases, and trauma were associated with higher risk of LOS. Nervous system diseases, cardiovascular diseases, trauma, and procedures including tracheal intubation, surgery, percutaneous coronary intervention, and thrombolysis were associated with lower risk of LOS.

Conclusions: Prolonged LOS in the ED was associated with increased age and admission in winter and during the night shift, while shortened LOS was associated with nervous system diseases, cardiovascular diseases, and trauma, as well as with procedures including tracheal intubation, surgery, percutaneous coronary intervention, and thrombolysis. Our findings can serve as a guide for ED physicians to individually evaluate patient condition and allocate medical resources more effectively.

Keywords: **Critical Illness • Emergency Medical Services • Length of Stay**

Abbreviations: **ESI** – Emergency Severity Index; **CPR** – cardiopulmonary resuscitation; **PCI** – percutaneous coronary intervention; **LOS** – length of stay; **ED** – Emergency Department; **IQR** – interquartile range; **OR** – odds ratio; **CI** – confidence interval

Full-text PDF: <https://www.medscimonit.com/abstract/index/idArt/931286>

 2362

 3

 2

 26



Background

Overcrowding in the hospital Emergency Department (ED), which can decrease the efficiency of ED staff and lead to patient management delays and poor clinical outcomes, is considered a public health problem worldwide [1,2]. The imbalance of a rapid increase in the number of patients, especially critically ill patients, and insufficient medical resources exacerbates the problem [3]. A multicenter retrospective research study including 995 379 ED patients concluded that ED crowding is associated with increased in-hospital mortality and prolonged length of stay (LOS) [4]. Conversely, prolonged LOS in the ED was detrimental to quality of treatment, especially in time-sensitive disorders, including trauma [5], heart failure [6], and acute coronary syndrome [7]. Previous studies revealed that factors linked with LOS in the ED include patient-specific factors such as age, triage level, and severity of disorder and hospital-specific factors such as hospital size and specialist consultation [8,9]. A maximum length of ED stay of 4 h was confirmed to be associated with improved quality of medical care in the ED as well as with patient satisfaction [10]. Another retrospective study clarified that an LOS in the ED longer than 4 h could make the ED crowded. As ED volume increased, some ED patients did not receive treatment in a proper and timely manner [11].

Therefore, LOS in the ED is an important indicator of hospital emergency service, which should be comprehensively measured and evaluated so that medical management and resources can be implemented and allocated more effectively. It is critical for physicians to identify the essential factors needed to assess, at an early stage, the likelihood of a longer LOS after admission. In our study, we aimed to analyze clinical characteristics of patients with critical illness admitted to the ED and identify the factors associated with LOS.

Material and Methods

Study Design and Patients

Initially, all patients admitted to the ED from January 2018 to December 2019 were included in this retrospective study. Only patients with a critical illness of level 1 and level 2 according to the Emergency Severity Index (ESI), which has a 5-level triage system [12], were enrolled in the study. Exclusion criteria were the following: age <14 years, pregnancy, and patients with data missing. The included patients were divided into 2 groups: LOS \geq 4 h and LOS <4 h. Variables were comprehensively analyzed and compared between the 2 groups.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Changsha Central Hospital of University of South China (Changsha, China). All research was performed in accordance with the relevant guidelines and regulations. Owing to the retrospective nature of the study, informed consent was waived, which was also approved by the Ethics Committee of Changsha Central Hospital of University of South China.

Data Collection

The collected data included the baseline and clinical characteristics of the patients admitted to the ED. Patient characteristics included the following: sex, age, time of presenting (including month and day) to the ED, diagnosis after admission, treatments including tracheal intubation, mechanical ventilation, cardiopulmonary resuscitation (CPR), surgery, interventional therapy, and thrombolysis, clinical outcomes including hospitalization, observation in ED, discharge home, and transfers, and in-hospital mortality.

Definitions

Based on the climatic characteristics of southern in China, 4 seasons were classified as follows: winter (December to February), spring (March to May), summer (June to August), and autumn (September to November). Based on the schedule of the ED, 24 h were divided into 3 different shifts as follows: day shift (8: 00 AM to 4: 00 PM), afternoon shift (4: 00 PM to midnight), and night shift (midnight to 8: 00 AM).

Statistical Analysis

Statistical results were expressed in mean \pm standard deviation for normally distributed data, while for non-normally distributed data, interquartile range (IQR) and median were employed. Categorical data were expressed as a percentage and number. The *t* test or rank-sum test was used for comparisons between the LOS \geq 4 h and LOS <4 h groups. Chi-square or Fisher's exact test was applied for categorical data.

Significant factors associated with LOS \geq 4 h ($P < 0.05$) identified by univariate logistic regression analysis were then examined by multivariate logistic regression analysis. Analytical results were described as odds ratio (OR) with a 95% confidence interval (CI). Statistical analysis was performed using SPSS (version 26) and statistical significance was considered at a two-sided *P* value <0.05.

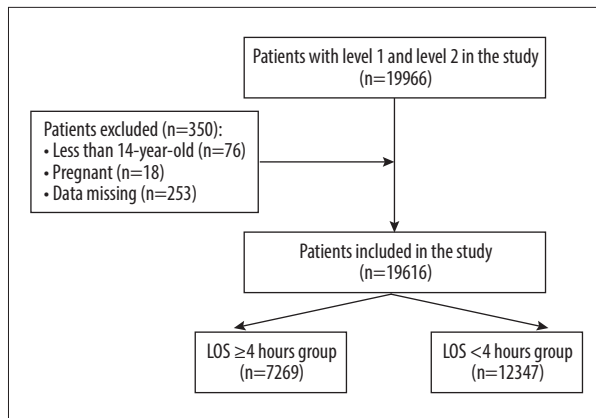


Figure 1. Flow chart of patient enrollment and study design.
LOS – length of stay.

Results

General Characteristics of Patients

At first, a total of 19 966 patients admitted to the ED were enrolled in this study. Based on the exclusion criteria, 350 patients were excluded and 19 616 patients with critical illness were finally included (**Figure 1**). The distribution of subgroups based on LOS is shown in **Figure 2**. The LOS proportions were <2 h (38.1%), 2 to 4 h (24.9%), 4 to 6 h (9.4%), 6 to 8 h (4.4%), 8 to 10 h (3.1%), and ≥10 h (20.1%). The mean patient age was 60.5 years and the in-hospital mortality was 1.9%. Male patients and elderly patients (≥60 years) accounted for 62.9% and 56.2% of patients, respectively. The proportion of ESI level 1 and level 2 were 11.7% and 88.3%, respectively. The mean time of LOS was 2.7 h. The top 5 disease categories ranked as follows: nervous system (25.6%), respiratory system (21.0%), cardiovascular system (14.3%), digestive system (11.6%), and trauma (9%). The incidence of tracheal intubation, mechanical ventilation, and CPR were 5.2%, 5%, and 2.4%, respectively. Surgery, PCI, and thrombolysis were performed in 377 (1.9%), 615 (3.1%), and 273 (1.4%) patients, respectively. More than 60% of patients were hospitalized (**Table 1**).

Comparison of Variables Between LOS ≥ 4 H and LOS < 4 H Groups

The clinical characteristics of the 7269 patients in the LOS ≥ 4 h group and the 12 347 patients in the LOS < 4 h group are shown in **Table 2**. There were significant differences in sex between the 2 groups ($P=0.038$). Patients in the LOS ≥ 4 h group were older ($P<0.001$). Comparing 6 subgroups of age, the LOS ≥ 4 h group had more patients in the 4 subgroups ≥60 years. The number of patients in the LOS ≥ 4 h group admitted in winter (December to February) and spring (March to May) was significantly higher than patients in the LOS < 4 h group admitted during those seasons. Moreover, significant differences

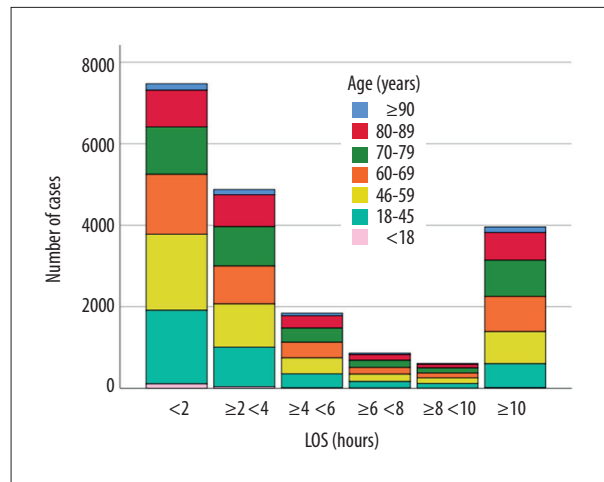


Figure 2. Distribution of subgroups based on length of stay.
LOS – length of stay.

were found between the 2 groups in admissions by all seasons (all $P<0.001$). The proportion of patients in the LOS ≥ 4 h group admitted to the ED during the night shift (midnight to 8: 00 AM) was significantly higher than those in the LOS < 4 h group (20.8% vs 15.1%, $P<0.001$), while the LOS ≥ 4 h group admissions were lower at the other times (day and afternoon shifts). Comparing the top 5 disease categories at presentation between the 2 groups, patients with respiratory diseases (32.1%) and digestive diseases (13.8%) were more likely to have longer stays in the ED, while those with nervous system diseases (31.7%), cardiovascular diseases (16.4%), and trauma (11.7%) had shorter stays in the ED (all $P<0.001$). The proportion of patients with tracheal intubation (3.0%), mechanical ventilation (3.4%), CPR (1.1%), surgery (0.2%), interventional therapy (1.8%), and thrombolysis (0.2%) was significantly lower in the LOS ≥ 4 h group than in the LOS < 4 h group (all $P<0.001$). More patients were hospitalized (75.4%) or discharged home (16.6%) in the LOS ≥ 4 h group than in the LOS < 4 h group (both $P<0.001$). The in-hospital mortality rates of the LOS ≥ 4 h and LOS < 4 h groups were 1.1% and 2.5%, respectively ($P<0.001$).

Univariate and Multivariate Analyses for Factors Associated with LOS

Factors associated with LOS were determined by univariate and multivariate logistic regression analyses, as shown in **Table 3**. Age >60 years, admission in winter and during the night shift, and diseases excluding nervous system diseases, cardiovascular diseases, and trauma were associated with the higher risk of LOS. Nervous system diseases, cardiovascular diseases, trauma, and procedures including tracheal intubation, surgery, PCI, and thrombolysis were associated with the lower risk of LOS. In age subgroups, the OR increased with increasing age, and the OR in the group over 90 years old was the

Table 1. General characteristics of total patients.

Characteristic		Characteristic	
Number of patients	19616	Digestive system diseases	2270 (11.6)
Sex (n, %)		Trauma	1756 (9.0)
Male	12330 (62.9)	Tuberculosis	726 (3.7)
Female	7286 (37.1)	Acute poisoning	616 (3.1)
ESI level (n, %)		Urinary system diseases	334 (1.7)
Level 1	2292 (11.7)	Endocrine system diseases	291 (1.5)
Level 2	17324 (88.3)	Respiratory and cardiac arrest	226 (1.2)
Age (years)	60.5±18.9	Tumor diseases	223 (1.1)
<18 (n, %)	179 (0.9)	Blood system diseases	161 (0.8)
18-45	3981 (20.3)	Other diseases	1058 (5.4)
46-59	4424 (22.6)	Procedures (n, %)	
60-69	3928 (20.0)	Tracheal intubation	1027 (5.2)
70-79	3671 (18.7)	Mechanical ventilation	990 (5.0)
80-89	2890 (14.7)	Invasive ventilation	903 (4.6)
≥90	543 (2.8)	Noninvasive ventilation	87 (0.4)
Admission season (n, %)		CPR	466 (2.4)
Winter (Dec-Feb)	5072 (25.9)	Surgery	377 (1.9)
Spring (Mar-May)	4755 (24.2)	Interventional therapy	819 (4.2)
Summer (Jun-Aug)	4753 (24.2)	PCI	615 (3.1)
Fall (Sep-Nov)	5036 (25.7)	Others	204 (1.0)
Admission time (n, %)		Thrombolysis	273 (1.4)
Midnight-8: 00 AM	3376 (17.2)	Clinical outcomes (n, %)	
8: 00 AM-4: 00 PM	7940 (40.5)	Hospitalization	13514 (68.9)
4: 00 PM-Midnight	8300 (42.3)	Observation in ED	3310 (16.9)
Diagnosis (n, %)		Discharged home	2070 (10.6)
Nervous system diseases	5029 (25.6)	Transferred	339 (1.7)
Respiratory diseases	4120 (21.0)	In-hospital mortality (n, %)	382 (1.9)
Cardiovascular diseases	2806 (14.3)	LOS in ED (h)	2.7 (1.4-7.1)

ESI – Emergency Severity Index; CPR – cardiopulmonary resuscitation; PCI – percutaneous coronary intervention; LOS – length of stay; ED – emergency department.

highest (OR 2.320, 95% CI 1.426-3.776). For time of admission, patients admitted in the winter (December to February) and during the night shift (midnight to 8: 00 AM) were more likely to stay longer in the ED (OR 1.602, 95% CI 1.459-1.759 and OR 1.642, 95% CI 1.493-1.806, respectively). Three categories of diseases were negatively associated with LOS, including cardiovascular diseases (OR 0.188, 95% CI 0.104-0.341), nervous system diseases (OR 0.612, 95% CI 0.544-0.689), and trauma (OR 0.541, 95% CI 0.456-0.640). Patients with tracheal

intubation (OR 0.564, 95% CI 0.329-0.967), surgery (OR 0.097, 95% CI 0.054-0.174), PCI (OR 0.046, 95% CI 0.028-0.077), and thrombolysis (OR 0.170, 95% CI 0.103-0.281) had a significantly lower risk of longer LOS.

Table 2. Comparison of variables between LOS \geq 4 h and LOS <4 h groups.

Variable	LOS \geq 4 h (n, %)	LOS <4 h (n, %)	P value
Number of patients	7269 (37.1)	12347 (62.9)	
Sex (n, %)			0.038*
Male	4679 (64.4)	7651 (62.0)	
Female	2590 (35.6)	4696 (38.0)	
Age, years (n, %)	63.1 \pm 18.1	59.0 \pm 19.1	<0.001*
<18	30 (0.4)	149 (1.2)	<0.001*
18-45	1208 (16.6)	2773 (22.5)	<0.001*
46-59	1499 (20.6)	2925 (23.7)	0.034*
60-69	1527 (21.0)	2401 (19.4)	0.008*
70-79	1541 (21.2)	2130 (17.3)	0.045*
80-89	1207 (16.6)	1683 (13.6)	0.193
\geq 90	257 (3.5)	286 (2.3)	<0.001*
Admission by season (n,%)			
Winter (Dec-Feb)	2154 (29.6)	2918 (23.6)	<0.001*
Spring (Mar-May)	1922 (26.4)	2833 (22.9)	<0.001*
Summer (Jun-Aug)	1569 (21.6)	3184 (25.8)	<0.001*
Fall (Sep-Nov)	1624 (22.3)	3412 (27.6)	<0.001*
Admission time (n, %)			
Midnight-8: 00 AM	1514 (20.8)	1862 (15.1)	<0.001*
8: 00 AM-4: 00 PM	2784 (38.3)	5153 (41.7)	0.031*
4: 00 PM-Midnight	2968 (40.8)	5332 (43.2)	0.040*
Diagnosis (n, %)			
Respiratory diseases	2336 (32.1)	1784 (14.4)	<0.001*
Nervous system diseases	1112 (15.3)	3917 (31.7)	<0.001*
Cardiovascular diseases	775 (10.7)	2031 (16.4)	<0.001*
Digestive system diseases	1000 (13.8)	1270 (10.3)	<0.001*
Trauma	307 (4.2)	1449 (11.7)	<0.001*
Endocrine system diseases	141 (1.9)	150 (1.2)	<0.001*
Blood system diseases	100 (1.4)	61 (0.5)	<0.001*
Acute poisoning	175 (2.4)	441 (3.6)	<0.001*
Tumor diseases	152 (2.1)	71 (0.6)	<0.001*
Tuberculosis	529 (7.3)	197 (1.6)	<0.001*
Respiratory and cardiac arrest	17 (0.2)	209 (1.7)	<0.001*
Other	415 (5.7)	643 (5.2)	0.133

Table 2 continued. Comparison of variables between LOS ≥ 4 h and LOS < 4 h groups.

Variable	LOS ≥ 4 h (n, %)	LOS < 4 h (n, %)	P value
Procedures			
Tracheal intubation	216 (3.0)	811 (6.6)	$< 0.001^*$
Mechanical ventilation	245 (3.4)	745 (6.0)	$< 0.001^*$
Invasive ventilation	199 (2.8)	704 (5.7)	$< 0.001^*$
Noninvasive ventilation	46 (0.6)	41 (0.3)	0.002*
CPR	81 (1.1)	385 (3.1)	$< 0.001^*$
Surgery	12 (0.2)	365 (3.0)	$< 0.001^*$
Interventional therapy	131 (1.8)	688 (5.6)	$< 0.001^*$
PCI	16 (0.2)	599 (4.9)	$< 0.001^*$
Other	115 (1.6)	89 (0.7)	$< 0.001^*$
Thrombolysis	17 (0.2)	256 (2.1)	$< 0.001^*$
Clinical outcomes			
Hospitalization	5484 (75.4)	8030 (65.0)	$< 0.001^*$
Observation in ED	318 (4.4)	2992 (24.2)	$< 0.001^*$
Discharged home	1209 (16.6)	861 (7.0)	$< 0.001^*$
Transferred	179 (2.5)	160 (1.3)	$< 0.001^*$
In-hospital mortality	78 (1.1)	304 (2.5)	$< 0.001^*$

LOS – length of stay; CPR – cardiopulmonary resuscitation; PCI – percutaneous coronary intervention; ED – Emergency Department. (* $P < 0.05$).

Discussion

In this retrospective cohort study of critically ill patients admitted to the ED in 2018 and 2019, patient clinical characteristics were analyzed and factors associated with LOS were identified. Prolonged LOS was associated with increased age and admission in winter and during the night shift, whereas shortened LOS was associated with nervous system diseases, cardiovascular diseases, and trauma as well as with procedures including tracheal intubation, surgery, PCI, and thrombolysis.

Our study showed that with increasing age, the risk of prolonged LOS increased, and the group of patients aged 90 years or older had the highest risk. A study with 5025 elderly patients in the ED indicated that prolonged LOS is best predicted by several indicators, which include being aged 90 years or older [13]. Another study revealed that of 16 791 ED presentations made by older patients, 4192 experienced a longer LOS, and increased age was associated with an increasing LOS in the ED [14]. Elderly patients are likely to stay in the ED longer because of poor communication with physicians, multiple chronic disorders, an atypical presentation with delayed

symptoms, and unstable vital signs. Compared with younger patients, older patients admitted in the ED have multiple and complex presenting symptoms and conditions, which lead to more diagnostic tests and procedures as well as consultation services [15].

In the present study, patients admitted in winter and during the night shift had a higher risk of staying longer in the ED. One study investigated the relationship between the relative risk of ED visitation and seasonal temperature and concluded that in cold weather, the total number of patients in the hospital declined by 15%, but ED visits increased by 4% [16]. A study of 17 298 ED visits for respiratory infection indicated that significantly fewer visits were recorded in warm months than in cold months (OR 0.23; 95% CI 0.29-0.18; $P < 0.001$) [17]. Increasing evidence indicates that winter is associated with the higher risk of morbidity in many disorders, including stroke, acute coronary syndrome, heart failure, and asthma [6,18-21], which also contributes to more ED visits and a longer LOS in the ED. Moreover, many studies have focused on the relationship between admission time and clinical outcomes. A retrospective cohort study in acute aortic dissection demonstrated

Table 3. Univariate and multivariate analyses for factors associated with LOS.

Variable	Unadjusted results		Multivariate results	
	OR (95% CI)	P value	OR (95% CI)	P value
Sex, Male	1.109 (1.044-1.178)	0.001	0.991 (0.924-1.063)	0.802
Age, years		<0.001		0.002*
<18	Ref		Ref	
18-45	2.164 (1.453-3.221)	<0.001	1.678 (1.066-2.641)	0.025*
46-59	2.545 (1.711-3.786)	<0.001	1.798 (1.143-2.829)	0.011*
60-69	3.159 (2.123-4.700)	<0.001	1.955 (1.241-3.079)	0.004*
70-79	3.593 (2.414-5.348)	<0.001	1.880 (1.192-2.964)	0.007*
80-89	3.562 (2.390-5.309)	<0.001	1.963 (1.243-3.099)	0.004*
≥90	4.463 (2.912-6.839)	<0.001	2.320 (1.426-3.776)	0.001*
Admission season		<0.001		<0.001*
Winter (Dec-Feb)	1.551 (1.430-1.682)	<0.001	1.602 (1.459-1.759)	<0.001*
Spring (Mar-May)	1.452 (1.312-1.548)	<0.001	1.412 (1.283-1.553)	<0.001*
Summer (Jun-Aug)	1.035 (0.951-1.127)	0.421	0.998 (0.906-1.099)	0.964
Fall (Sep-Nov)	Ref		Ref	
Admission time				
Midnight-8: 00 AM	1.461 (1.347-1.585)	<0.001	1.642 (1.493-1.806)	<0.001*
8: 00 AM-4: 00 PM	0.972 (0.911-1.036)	0.381	0.850 (0.789-0.915)	<0.001*
4: 00 PM-Midnight	Ref		Ref	
Diagnosis				
Respiratory and cardiac arrest	Ref		Ref	
Nervous system diseases	0.753 (0.677-0.838)	<0.001	0.612 (0.544-0.689)	<0.001*
Respiratory diseases	3.484 (3.142-3.864)	<0.001	2.647 (2.356-2.975)	<0.001*
Digestive system diseases	2.071 (1.841-2.328)	<0.001	1.746 (1.531-1.991)	<0.001*
Trauma	0.557 (0.480-0.646)	<0.001	0.541 (0.456-0.640)	<0.001*
Cardiovascular diseases	0.214 (0.129-0.353)	<0.001	0.188 (0.104-0.341)	<0.001*
Endocrine system diseases	2.462 (1.928-3.145)	<0.001	2.325 (1.770-3.053)	<0.001*
Blood system diseases	4.480 (3.222-6.230)	<0.001	4.080 (2.825-5.894)	<0.001*
Acute poisoning	1.011 (0.833-1.227)	0.912	1.358 (1.082-1.704)	0.008*
Tumor diseases	5.777 (4.305-7.753)	<0.001	4.840 (3.505-6.684)	<0.001*
Tuberculosis	7.040 (5.860-8.459)	<0.001	4.986 (4.102-6.061)	<0.001*
Other	1.692 (1.458-1.964)	<0.001	1.786 (1.508-2.115)	<0.001*
Procedures				
Tracheal intubation	0.436 (0.374-0.508)	<0.001	0.564 (0.329-0.967)	0.038*
Mechanical ventilation				

Table 3 continued. Univariate and multivariate analyses for factors associated with LOS.

Variable	Unadjusted results		Multivariate results	
	OR (95% CI)	P value	OR (95% CI)	P value
Invasive ventilator	0.467 (0.398-0.548)	<0.001	1.015 (0.566-1.820)	0.960
Noninvasive ventilator	1.853 (1.215-2.826)	0.004	0.818 (0.523-1.279)	0.379
None	Ref		Ref	
CPR	0.350 (0.275-0.446)	<0.001	0.874 (0.578-1.323)	0.525
Surgery	0.054 (0.031-0.097)	<0.001	0.097 (0.054-0.174)	<0.001*
Interventional therapy				
PCI	0.044 (0.027-0.072)	<0.001	0.046 (0.028-0.077)	<0.001*
Other	2.111 (1.598-2.788)	<0.001	1.912 (1.359-2.690)	<0.001*
None	Ref		Ref	
Thrombolysis	0.111 (0.068-0.181)	<0.001	0.170 (0.103-0.281)	<0.001*

LOS – length of stay; OR – odds ratio; CI – confidential interval; CPR – cardiopulmonary resuscitation; PCI – percutaneous coronary intervention (* $P < 0.05$).

that nighttime admission was associated with a higher risk of longer stays in the intensive care unit and in-hospital mortality [22]. A recent study identified that ED patients who presented during the evening (OR 4.25, 95% CI 1.742-10.417) or nighttime (OR 14.93, 95% CI 4.22-52.63) were significantly more likely to have a prolonged LOS than those with a morning presentation [23]. A possible explanation could be that it was necessary for night shift arrivals to wait until the daytime to be hospitalized or discharged, leading to increased LOS in the ED. Additionally, consultations with specialists and some special imaging or laboratory tests for diagnosis and therapy are less available at night than during the day [24].

In the present study, among the most common categories of disorders presenting in the ED, nervous system diseases, cardiovascular diseases, and trauma were negatively associated with LOS. Moreover, tracheal intubation, surgery, PCI, and thrombolysis showed the same relationship with LOS. Our hospital is a tertiary hospital as well as a stroke, chest pain, and trauma center. For several years, effective and convenient emergency medicine processes have been constructed for time-sensitive disorders including stroke, acute coronary syndrome, acute heart failure, and trauma. For those patients, multidiscipline consultation and management are implemented quickly as are hospitalizations and transfers, which could explain why patients with mechanical intubation, surgery, PCI, and thrombolysis had a comparatively lower risk of prolonged LOS. In a study on stroke, evidence showed that endovascular stroke therapy and thrombolysis were inversely associated with the LOS in the ED [25]. In a mature trauma center with standardized activation protocols, trauma activation and subsequent

management and procedures, including surgery, could mitigate the negative effects of prolonged LOS in the ED [26].

Overall, factors associated with LOS in the ED in a large sample of critically ill patients were analyzed. Our findings can serve as a guide for ED physicians to individually evaluate patients' condition and allocate medical resources more effectively. There were several limitations in our study. First, it was a single-center retrospective study, so caution should be exercised when applying the results to other centers with different situations and policies. Second, only categories of diseases were included and analyzed in this study, with subgroups of diseases not divided and compared, which to a certain extent might have affected our results. Third, because of some missing data, not all factors associated with LOS in the ED of patients were mentioned in this study, including marital status, medical insurance, socioeconomic status, and educational background. Further research with more clinical variables should be considered.

Conclusions

Prolonged LOS in the ED was associated with increased age and admission in winter and during the night shift, while shortened LOS was linked with nervous system diseases, cardiovascular diseases, and trauma as well as with procedures including tracheal intubation, surgery, PCI, and thrombolysis. Our findings can serve as a guide for ED physicians to individually evaluate patients' conditions and allocate medical resources more effectively.

Ethics Statement

Ethics approval was provided by the Medical Ethics Committee of Changsha Central Hospital.

Availability of Data and Materials

Datasets used and/or analyzed in the present study are availed by the corresponding author on reasonable request.

References:

1. Prather J, Alexander B, Halstrom J, et al. Factors affecting Emergency Department visits, readmissions, and reoperations within 30 days of ankle fracture surgery – an institutional retrospective study. *Injury*. 2020;51(11):2698-702
2. Oh HC, Chow WL, Gao Y, et al. Factors associated with inappropriate attendances at the emergency department of a tertiary hospital in Singapore. *Singapore Med J*. 2020;61(2):75-80
3. Tangkulpanich P, Yuksen C, Kongchok W, Jenpanitpong C. Clinical predictors of emergency department revisits within 48 hours of discharge: A case control study. *Arch Acad Emerg Med*. 2021;9(1):e1
4. Sun BC, Hsia RY, Weiss RE, et al. Effect of emergency department crowding on outcomes of admitted patients. *Ann Emerg Med*. 2013;61(6):605-11.e6
5. Hymel G, Leskovan JJ, Thomas Z, et al. Emergency department boarding of non-trauma patients adversely affects trauma patient length of stay. *Cureus*. 2020;12(9):e10354
6. Sricharoen P, Phinyo P, Patumanond J, et al. Clinical predictors influencing the length of stay in emergency department patients presenting with acute heart failure. *Medicina (Kaunas)*. 2020;56(9):434
7. Chen H-C, Lee W-C, Chen Y-L, et al. The impacts of prolonged emergency department length of stay on clinical outcomes of patients with ST-segment elevation myocardial infarction after reperfusion. *Intern Emerg Med*. 2015;11(1):107-14
8. Strada A, Bolognesi N, Manzoli L, et al. Diagnostic anticipation to reduce emergency department length of stay: A retrospective cohort study in Ferrara University hospital, Italy. *BMC Health Serv Res*. 2020;20(1):624
9. Chen CH, Hsieh JG, Cheng SL, et al. Early short-term prediction of emergency department length of stay using natural language processing for low-acuity outpatients. *Am J Emerg Med*. 2020;38(11):2368-73
10. Dadeh AA, Phunyanantakorn P. Factors affecting length of stay in the emergency department in patients who presented with abdominal pain. *Emerg Med Int*. 2020;2020:5406516
11. Fee C, Weber EJ, Maak CA, Bacchetti P. Effect of emergency department crowding on time to antibiotics in patients admitted with community-acquired pneumonia. *Ann Emerg Med*. 2007;50(5):501-9, 509.e1
12. Mistry B, Stewart De Ramirez S, Kelen G, et al. Accuracy and reliability of emergency department triage using the Emergency Severity Index: An international multicenter assessment. *Ann Emerg Med*. 2018;71(5):581-7.e3
13. Curiati PK, Gil-Junior LA, Morinaga CV, et al. Predicting hospital admission and prolonged length of stay in older adults in the emergency department: The PRO-AGE Scoring System. *Ann Emerg Med*. 2020;76(3):255-65
14. Sweeny A, Keijzers G, O'Dwyer J, et al. Predictors of a long length of stay in the emergency department for older people. *Intern Med J*. 2020;50(5):572-81
15. Jusmanova K, Rice C, Bourke R, et al. Impact of a specialist service in the emergency department on admission, length of stay and readmission of patients presenting with falls, syncope and dizziness. *QJM*. 2020;114(1):32-38
16. Davis R, Markle E, Windoloski S, et al. A comparison of the effect of weather and climate on emergency department visitation in Roanoke and Charlottesville, Virginia. *Environ Res*. 2020;191:110065
17. Ferrero F, Abrutzky R, Ossorio MF, Torres F. Effects of contamination and climate in the Pediatric Emergency Department visits for acute respiratory infection in the City of Buenos Aires. *Arch Argent Pediatr*. 2019;117(6):368-74
18. Chen X, Shang W, Huang X, et al. The effect of winter temperature on patients with ischemic stroke. *Med Sci Monit*. 2019;25:3839-45
19. Shibuya J, Kobayashi N, Asai K, et al. Comparison of coronary culprit lesion morphology determined by optical coherence tomography and relation to outcomes in patients diagnosed with acute coronary syndrome during winter-vs-other seasons. *Am J Cardiol*. 2019;124(1):31-38
20. Beard JD, Beck C, Graham R, et al. Winter temperature inversions and emergency department visits for asthma in Salt Lake County, Utah, 2003-2008. *Environ Health Perspect*. 2012;120(10):1385-90
21. Christiaens H, Charpentier S, Houze-Cerfon CH, Balen F. Winter virus season impact on acute dyspnoea in the emergency department. *Clin Respir J*. 2019;13(11):722-27
22. Zhou Y, Yang G, He H, Pan X, et al. Association between admission time and in-hospital mortality in acute aortic dissection patients: A retrospective cohort study. *Heart Lung*. 2020;49(5):651-59
23. Ahmed AA, Ibro SA, Melkamu G, et al. Length of stay in the emergency department and its associated factors at Jimma Medical Center, southwest Ethiopia. *Open Access Emerg Med*. 2020;12:227-35
24. Sariyer G, Ataman MG, Kiziloglu I. Analyzing main and interaction effects of length of stay determinants in emergency departments. *Int J Health Policy Manag*. 2020;9(5):198-205
25. Minaeian A, Patel A, Essa B, et al. Emergency department length of stay and outcome after ischemic stroke. *J Stroke Cerebrovasc Dis*. 2017;26(10):2167-73
26. Siletz A, Jin K, Cohen M, et al. Emergency department length of stay in critical nonoperative trauma. *J Surg Res*. 2017;214:102-8

Conflicts of Interest

None.