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ORIGINAL RESEARCH

Effect of Emergency Department Boarding on ICU Length of Stay and In-Hospital Mortality; A Retrospective Cohort Study

Mohamed M. Khamis[1], Moustafa Al Hariri[2], Nour Al Jalbout[3], Malak Khalifeh[4], Bachar Hamade[5,6]*

1. Department of Medicine, Mercy Hospital Saint Louis, MO, USA
2. Tamayuz Simulation Center, QU Health Sector, Qatar University, Doha, Qatar
3. Department of Emergency Medicine, Massachusetts General Hospital, Boston, MA, USA
4. Stony Brook Cancer Center, Stony Brook University Hospital, Stony Brook, NY, USA
5. Department of Intensive Care and Resuscitation, Anesthesia Institute, Center for Emergency Medicine, Emergency Services Institute, Cleveland Clinic Foundation, Cleveland, OH, USA
6. Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, Cleveland, OH, USA

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Abstract: **Introduction:** One of the main contributing factors of emergency department (ED) crowding is ED patient boarding. This study aimed to assess the factors influencing length of stay (LOS) in intensive care unit (ICU) and in-hospital mortality (IHM) among ICU-admitted ED boarded cases. **Methods:** A retrospective cohort study was conducted on adult patients at a tertiary care hospital in Lebanon who required ICU admission and stayed for 6+ hours in the ED during one year. The independent predictive factors of LOS in ICU and IHM were studied using multivariable logistic regression analysis. **Results:** Out of 583 patients (mean age 69.5 years; 61.6% male), 12.8% died in hospital. 25.5% had a prolonged ICU stay ($≥7 days) with a median LOS of 3 days. Prolonged ICU LOS was associated with previous cancer diagnosis (adjusted odds ratio (aOR)=1.66), prehospital bedridden status (>5 days, aOR=4.41), ED vasopressor use (aOR=1.86), extended ED boarding (aOR=1.03), IHM (aOR=3.37), and not being married (aOR=2.0). IHM was associated with abnormal Modified Shock Index at ED triage (aOR=7.35), ED mechanical ventilation use (aOR=6.07), ED triage Shock Index ≥1.3 (aOR=18.25), and long ICU stay (aOR=7.48). ED-triage Saturation of Peripheral Oxygen (SPO2) level was negatively associated with IHM (aOR=0.89). **Conclusion:** It seems that, ED boarding of ICU patients is associated with an increase in ICU LOS, which is associated with an increase in IHM. Hospitals should allocate resources to reduce ED boarding and improve outcomes for critically ill patients.

Keywords: Emergency Department; Boarding; Overcrowding; Intensive Care Units; Mortality; Length of Stay; Middle East

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1. Introduction

Emergency Department (ED) crowding is defined as the need for emergency services exceeding available resources for patient care in the ED, hospital, or both, and is an important growing concern reflective of pressured and malfunctioning healthcare systems (1). ED crowding is associated with an increased risk of medical errors, staff burnout, and disproportionate expenditure, all contributing to increased patient morbidity and mortality (2, 3). One of the main factors contributing to ED crowding is ED patient boarding.

The American College of Emergency Physicians defines ED boarders as patients who remain in the ED after they have been admitted or placed into observation status at the health care facility, but have not been transferred to an inpatient or observation unit (4). In the United States, there is a wide variability in the incidence of ED boarding among critically ill patients requiring intensive care unit (ICU) admissions, ranging from 2.1% to 87.6% (5). Several studies have shown that these patients, defined as ICU boarders, experience longer hospital lengths of stay (LOS) and develop worse outcomes compared to patients who get promptly admitted (6, 7). Boarding limits bed availability to many critical patients awaiting evaluation and treatment. Additionally, ICU boarders are at higher odds of in-hospital mortality (IHM) and end-organ dysfunction (8, 9), and their survival is closely linked to the early administration of critical care treatment in their respective units (10, 11). Several studies have shown that a prolonged ED stay of more than 6 hours for critically ill patients is associated with a 10% increase in IHM (5, 11).

Like other low-income countries, Lebanon is suffering from

*Corresponding Author: Bachar Hamade; Department of Intensive Care and Resuscitation, Cleveland Clinic, Cleveland, OH, USA. Email: hamadeb@ccf.org, Tel: 001-410-306-5624, ORCID: https://orcid.org/0000-0003-4685-9788.

an acute shortage of ICU and physical bed capacities (12, 13). As of August 2020, there were 300 ICU beds available for a population of 6.8 million, compared to other low-income countries that have an average of 425 beds per 100,000 persons (14). As a result, critically ill patients often board in EDs waiting for ICU beds. As the population ages and the complexity of medical conditions increases, the demand for critical care beds is outpacing the number of available beds, making ED ICU boarding more common (15).

While there is a strong association between ED boarding of critically ill patients requiring ICU admissions and IHM, there is heterogeneity in the literature about the association between ED boarding of critically ill patients and prolonged ICU LOS. Several studies have shown that ED boarding is associated with increased LOS in ICU (11, 16, 17); however, others have found no association (18). Prolonged LOS in ICU is associated with increased mortality, cost, and risk of nosocomial infections (19, 20). This is of high importance in the Middle East, where there is a paucity of literature on ED boarding and critical illness, and where healthcare systems are under marked financial constraints. Therefore, this study aimed to evaluate the factors associated with LOS in ICU and IHM among critically ill patients boarding in the ED.

2. Methods

2.1. Study design and setting

This is a retrospective cohort study of all adult patients ≥18years old who presented to the ED of the American University of Beirut Medical Center (AUBMC), a large academic tertiary care hospital in Beirut, Lebanon, requiring ICU admission and boarded in the ED for more than 6hours from November2018 to October2019. The independent predictive factors of LOS in ICU and IHM were analyzed and reported using multivariate regression analysis. The ED contains 36beds, while the hospital has a total of 376inpatient beds.

This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The study was approved by the Institutional Review Board (IRB) of the American University of Beirut with IRB protocol ID BIO-2020-0173 in April 2020 and the need to obtain consent from participants was waived since many of them may have passed away before the initiation of the study. The study commenced after the IRB approval.

2.2. Participants

Inclusion criteria were: (1) adult patients (≥18 years) who presented to the ED; (2) patients who required ICU admission as determined by the treating physician; and (3) patients who stayed in the ED for 6 or more hours before ICU admission. Patients who were transferred to other institutions before ICU admission; patients who left against medical advice before ICU admission; patients who died in the ED before ICU admission; patients who were transferred to other institutions, and patients with incomplete medical records were excluded.

2.3. Data gathering

Patient data were extracted electronically from the Epic electronic health record (EHR) system and entered into a Health Insurance Portability and Accountability Act-compliant web-based application (www.project-redcap.org) by study team members.

Independent variables including demographic information, presenting vital signs, clinical presentation, laboratory workup, medication administered at home and in the ED, and ED LOS were collected. From the presenting vital signs, we calculated the shock index (SI) by dividing the heart rate by the systolic blood pressure, and the modified shock index (MSI) by dividing the heart rate by the mean arterial pressure. Patient data extraction and validation were conducted by a multidisciplinary team consisting of American board-certified Emergency Medicine physicians (including one with additional American board certification in Critical Care Medicine), data management specialists, and an Emergency Medicine resident. Prior to full data collection, we conducted a pilot phase with 10 participants to test our extraction protocol, refine inclusion/exclusion criteria application, and validate the REDCap data entry process. The team developed standardized protocols for data extraction and categorization during this phase.

Multiple quality control measures were implemented throughout the study. The research team held weekly meetings to review challenging cases and discuss any inconsistencies in data extraction. Random entry validation was performed regularly during these meetings to ensure accuracy and consistency. Additionally, during the final data management phase, values at the extremes of distributions were individually verified against the original electronic health records. This multi-layered validation approach, combining clinical and methodological expertise, ensured data integrity throughout the collection and analysis process. The rate of missing data was very low due to the structured data entry requirements of the Epic system and comprehensive documentation practices at our institution. In our statistical analysis, we used complete case analysis where missing data were kept as missing without imputation. This approach was chosen to preserve data integrity, avoid introducing potential bias from imputation methods, maintain transparency and reproducibility, and ensure consistency with clinical decision-making processes where healthcare providers make decisions based on available information.

Epic's integrated architecture provides exceptional data capture capabilities through its various modules: Hyperspace logs clinical events to the millisecond, while the Transfer Center tool records precise bed-ready times. This allowed for systematic extraction of clinical, administrative, and demographic variables with high completeness, minimizing documentation errors and misclassification bias.

2.4. Definitions

- We defined ED boarding as >6 hours elapsed from placement of the ICU admission order to physical transfer, a threshold supported by prior studies linking this duration to increased mortality (5, 11).
- Moitra et al. (20) demonstrated increasing long-term IHM beyond 7 days. Swoboda and Lipsett (21) prospectively studied patients with ICU LOS of ≥7 days and validated this threshold through 20-year survival data. Also, ¬this threshold was selected to balance clinical relevance (mortality risk) and operational precision (Electronic Health Record-validated timestamps).

2.5. Outcomes

Our primary outcome measure was LOS in ICU, categorized as prolonged if ≥7 days and our secondary outcome was IHM.

2.6. Statistical analysis

Continuous variables were presented as means ± standard deviations or median and interquartile range, and categorical variables were presented as frequencies and percentages. In the bivariate analysis, Student's t-test and Pearson's Chi-square test were used to assess the significance of the statistical association between independent variables and outcomes. Both tests were interpreted at a predetermined significance level (p ≤0.05).

A multivariable analysis was performed using logistic regression to assess the association between independent variables and outcomes. A forward conditional selection procedure was conducted by fitting significantly associated variables with the outcome at the bivariate level in addition to those considered clinically meaningful. All statistical analyses were performed using SPSS 24 (Statistical Package for Social Sciences).

We performed multicollinearity tests using SPSS, evaluating the tolerance and Variance Inflation Factor (VIF) values for all predictor variables considered in the logistic regression models for two outcomes: LOS in ICU and IHM.

To validate the results of our regression models, we generated receiver operating characteristic (ROC) curves and calibration plots for the variables included in the ICU LOS and IHM regression models. To address multiple comparisons, False Discovery Rate (FDR) adjusted q-values were calculated and reported alongside p-values to control the expected proportion of false-positive findings.

3. Results

3.1. Baseline characteristics of studied patients

A total of 42,475 patients presented to the Emergency Department (ED) during the study period. Of these, 11,684 were admitted to the hospital, including 1,518 patients who required ICU admission. After excluding patients who were transferred to other institutions, had canceled ICU admission requests, or had missing outcome data, 583 ICU-admitted ED boarders met the inclusion criteria and were included in the final analysis. The patient selection process is summarized in Figure 1. The mean age of the participants was 69.5 ± 15.1 (range: 19.2 – 98.6) years, with 61.6% being males. On average, the participants boarded in the ED for more than 16 hours. Detailed patient characteristics are presented in Table 1.

3.2. Predictive factors of LOS in ICU

25.5% of participants were in the long ICU stay category. Table 1 compares the baseline characteristics of studied cases between cases with and without prolonged LOS in ICV (≥ 7 days). Patients with long ICU stay had lower systolic blood pressure (108.1 ± 27.7 vs. 119.5 ± 25.5, p<0.001), mean arterial pressure (76.3 ± 19.8 vs. 83.6 ± 17.0, p<0.001), SpO2 (93.7 ± 12.0 vs. 95.6 ± 8.4, p=0.033) measured at ED triage on presentation, and had higher SI (0.8 ± 0.3 vs. 0.7 ± 0.3, p=0.005) and modified SI (1.1 ± 0.5 vs. 1.0 ± 0.5, p=0.002) values at ED presentation. The participants with long ICU stay were more likely to be placed on mechanical ventilation (MV) (12.8% vs. 3.9%, p<0.001), receive more vasopressors (37.6% vs. 16.4%, p<0.001), and had more central venous catheters (CVCs) inserted (8.1 vs. 2.3, p=0.003) in the ED compared to the short ICU stay participants. The long ICU stay participants had longer ED boarding times (14 hours [9, 27] vs. 10 hours [8, 18], p<0.001) and had a higher rate of IHM (26.8% vs. 8.1%, p<0.001) compared to the short ICU stay group.

The independent predictive factors of LOS in ICU based on logistic regression analysis were prehospital bedridden status (>5 days, (adjusted odds ratio (aOR)=4.41, 95% CI [1.57, 12.35], p=0.0015), malignancy diagnosis (aOR= 1.656, 95% CI [1.04, 2.65], p=0.035), receiving vasopressors in the ED (aOR= 1.860, 95% CI [1.12, 3.1], p=0.017), longer duration of ED boarding (aOR= 1.028, 95% CI [1.01, 1.04], p<0.001), and IHM (aOR=3.366, 95% CI [1.48, 5.03], p=0.001). Participants who were married (aOR= 0.298, 95% CI [0.30, 0.82], p=0.006) had shorter ICU stays (Table 2).

3.3. Predictive factors of IHM

Overall, 12.8% of ED boarders died during their hospital stay. Table 1 compares the baseline characteristics of studied cases between survived and non-survived patients. Non-survived patients had higher rates of malignancy diagnosis, (52% vs. 22.5%, p<0.001) and had significantly different presenting vital signs (lower systolic blood pressure (SBP), mean arterial pressure (MAP), and SpO2) compared to survivors. More patients who died had abnormal triage values of SI ≥1.3 (37% vs. 0.4%, p<0.001) and MSI values (74% vs. 17.1%, p<0.001) compared to the patients who survived their hospital stay.

Patients who died were placed more frequently on MV (21.3% vs. 3.9%, p<0.001), received more vasopressors (73.3% vs. 14.2%, p<0.001), and had more CVCs inserted (69.3% vs. 10.2%, p<0.001) in the ED compared to in-hospital survivors.

Non-survivors had longer LOS in ICU (8 [2, 16] vs. 3 days [2, 6], p<0.001) and in-hospital LOS (9 [3, 20] vs. 4 [2, 8], p<0.001). A higher number of patients who died stayed more than 7 days in the ICU (53.3% vs. 21.5%, p<0.001).
The independent predictive factors of IHM based on logistic regression analysis were receiving vasopressors in the ED (aOR= 5.824, 95% CI [2.54, 13.35], p<0.001), abnormal ED triage modified SI level (aOR= 7.346, 95% CI [3.04, 17.75], p<0.001), receiving MV in the ED (aOR= 6.072, 95% CI [2.01, 18.36], p=0.001), an ED triage SI >1.3 (aOR= 18.253, 95% CI [2.57, 129.68], p=0.004), and long ICU stay (aOR=7.478, 95% CI [3.02, 18.5], p<0.001). High SPO2 levels at triage (aOR= 0.887, 95% CI [0.84, 0.94], p<0.001) were associated with survival during hospital stay (Table 2).

3.4. Evaluation of the models' characteristics

None of the variables showed significant collinearity, indicated by tolerance values >0.2 and VIF values <5. Additionally, Collinearity Diagnostics showed no variables with coefficients above 0.5 when Condition Index was greater than 30, confirming minimal multicollinearity (Table 3).
To validate the results of the regression model, the ROC curve for the combined variables in the model was constructed and showed an area under the curve (AUC) of 0.74, indicating a moderate ability to discriminate between patients with a long ICU stay (≥7 days) and those with shorter stays (Figure S1). Moreover, the calibration plot for the model demonstrated that the predicted probabilities closely matched the observed outcomes, indicating good calibration (Figure S1).
For the IHM regression model, the ROC curve for the combined variables was constructed, revealing an area under the curve (AUC) of 0.963 (Figure S1). This indicates a high capability to distinguish between patients who experienced in-hospital mortality and those who did not. Additionally, the calibration plot demonstrated that the predicted probabilities were closely aligned with the observed outcomes, showcasing excellent calibration (Figure S1).

4. Discussion

In this study, longer ED boarding times among critically ill ED patients were associated with prolonged ICU LOS, and prolonged ICU LOS was associated with increased IHM. ED boarding is an indicator of hospital crowding leading to a scarcity of beds in the ICU. Previous reports in the literature indicated that the longer patients stay in hospital departments before ICU admission, the lower their chances of survival (22, 23). However, these studies did not specifically investigate ED boarding, as they included patients admitted from various hospital wards into the ICU (24).
The ≥7-day ICU stay threshold used in our study aligns with established definitions in the literature and enables early identification of high-risk ICU patients in resource-constrained settings (20). Our findings regarding the association between prolonged ICU LOS and in-hospital mortality are consistent with previous studies, which have shown increased mortality among patients with extended ICU admissions. Few studies have assessed ICU LOS and IHM among ED boarders in the Middle East and North Africa (MENA) region. Our study provides important insights for this financially and economically strained region (8, 24, 25). Our study thus provides valuable insights, particularly relevant to a financially and economically strained region.
Key factors associated with prolonged ICU LOS included prior cancer diagnosis and vasopressor use in the ED, both of which also increased the odds of IHM. This aligns with prior reports that cancer patients often have prolonged ICU stays and higher mortality risks (26, 27), though confounding and referral bias may influence these findings. Patients with cancer represent a particularly vulnerable subgroup, inherently prone to complications, thus potentially biasing our findings. Additionally, referral bias at our tertiary-care hospital, which receives complex oncology cases, may further influence our results. Vasopressor use is a well-established indicator of illness severity (28, 29), and sicker patients are more likely to require them. Moteijunaite et al. similarly reported increased IHM among ICU patients receiving vasopressors (29).
Our results also confirm that Prehospital bedridden status and prolonged ED boarding increase the risk of extended hospital and ICU stays, as shown in prior literature (5, 11, 30, 31). Bedridden or immobile patients before ICU admission are significantly more likely to experience prolonged ICU stays due to their limited ability to recover, ambulate, or wean from mechanical support (5, 11, 30). Prolonged boarding can also increase healthcare costs, decrease patient satisfaction, and raise the risk of medical errors and adverse events (5, 30). On the other hand, being married was associated with a shorter ICU stay, possibly due to social support and improved recovery (32).
In our cohort, 12.8% of ED boarders died during their hospital stay. This percentage is higher than the mortality rate reported in multiple studies on ED boarding (2.8 – 4.5) (33-36) and less than the rate reported in critically injured patients by Plurad et al. (14.5) (28). This may reflect our hospital's status as a tertiary referral center for complex cases.
Factors contributing to higher IHM included an abnormal Modified Shock Index (MSI), mechanical ventilation, and vasopressor use in the ED, all markers of illness severity. Abnormal MSI was associated with a sevenfold increase in IHM, consistent with previous findings (37), though MSI's predictive value may vary by patient acuity (33). Early mechanical ventilation was also associated with higher IHM, likely reflecting greater disease severity (38). Similarly, a high SI at triage was linked to increased mortality, in line with prior reports (39).
Due to the retrospective observational design, causality cannot be inferred. Associations observed likely reflect underlying clinical conditions and patient complexity. Further prospective studies are needed to definitively characterize these relationships.
Actionable recommendations include developing structured

ED-to-ICU admission protocols, prioritizing critically ill patients using objective severity indices such as MSI and SI at ED triage, and implementing dedicated transition teams to expedite transfers. Expanding critical care capacity, flexible staffing, and targeted training for early recognition and intervention may reduce boarding times and adverse outcomes. Policymakers should invest in sustainable critical care infrastructure and streamline insurance approval processes to address barriers to timely ICU admission. These strategies may be broadly applicable in other low-resource settings, but multicenter studies are needed to validate and refine these recommendations.

This study has significant implications for low-income countries and healthcare systems in the MENA region facing similar challenges such as limited resources and increasing demand for critical care beds. Our findings can be used to develop strategies that enhance patient outcomes and resource allocation in resource-limited settings.

In summary, prolonged ED boarding of critically ill patients is associated with longer ICU stays and increased in-hospital mortality. Addressing ED boarding is essential to improve outcomes and optimize resource utilization in low-resource healthcare settings. Future research should focus on validating these findings across diverse environments.

5. Limitations

This study's retrospective cohort design limits causal inference. Associations between interventions (e.g., vasopressor use, mechanical ventilation) and outcomes (prolonged ICU stay, mortality) may reflect underlying illness severity rather than direct effects; prospective studies are needed to clarify causality.

Conducted at a single tertiary center—the largest in the country—our findings may have limited generalizability. As a referral hub for critically ill patients, our hospital's resources and care pathways may differ from those in other settings, particularly community or non-tertiary hospitals, highlighting the need for multicenter validation.

The definition of ED boarding time varies across studies. We adopted a 6-hour threshold based on prior literature, but this variability may affect comparability.

Selection bias is possible, as we excluded patients transferred elsewhere or leaving against medical advice, often for financial reasons. These patients may differ in clinical risk and socioeconomic status, affecting generalizability.

Despite using precise Epic timestamps and rigorous data validation, information bias remains possible due to documentation inconsistencies. Residual confounding may persist, as unmeasured factors—such as socioeconomic status, health literacy, insurance coverage, and access to care—could influence both ED boarding time and outcomes.

6. Conclusions

It seems that, ED boarding of ICU patients is associated with an increase in ICU LOS, which is associated with an increase in IHM. Hospitals should allocate resources to reduce ED boarding and improve outcomes for critically ill patients.

7. Declarations

7.1. Acknowledgments

None.

7.2. Authors' contributions

Study Conception and Design: Bachar Hamade, Mohamed M. Khamis, Moustafa Al Hariri, Nour Al Jalbout.
Data Acquisition: Mohamed M. Khamis.
Statistical Analysis: Moustafa Al Hariri, Malak Khalifa.
Data Interpretation: Bachar Hamade, Mohamed M. Khamis, Moustafa Al Hariri, Nour Al Jalbout.
Manuscript Drafting: All authors.
Article Revision: Bachar Hamade, Mohamed M. Khamis, Moustafa Al Hariri, Nour Al Jalbout. All authors have reviewed the final manuscript for important intellectual content and approved it for publication.

7.3. Conflict of interest

The authors declare no conflicts of interest.

7.4. Data availability

Bachar Hamade has full access to all study data and ensures its accuracy, integrity, and fidelity to the study's findings. Data are available upon reasonable request.

7.5. Funding

This study did not receive any funding.

7.6. Prior Presentations

The results of this manuscript were not previously presented at any conference.

7.7. Ethical Compliance

The study was approved by the Institutional Review Board (IRB) of the American University of Beirut with IRB protocol ID BIO-2020-0173. The IRB at AUB waived the requirement of the consent process for enrolling the records of patients in this study since many of the patients have passed away or have been lost to follow up. The study complies with the principles of the Declaration of Helsinki for ethical standards in human research.

7.8. Using artificial intelligence chatbots

During the preparation of this work the authors used Grammarly's AI in order to check and correct grammatical errors during the manuscript writing process. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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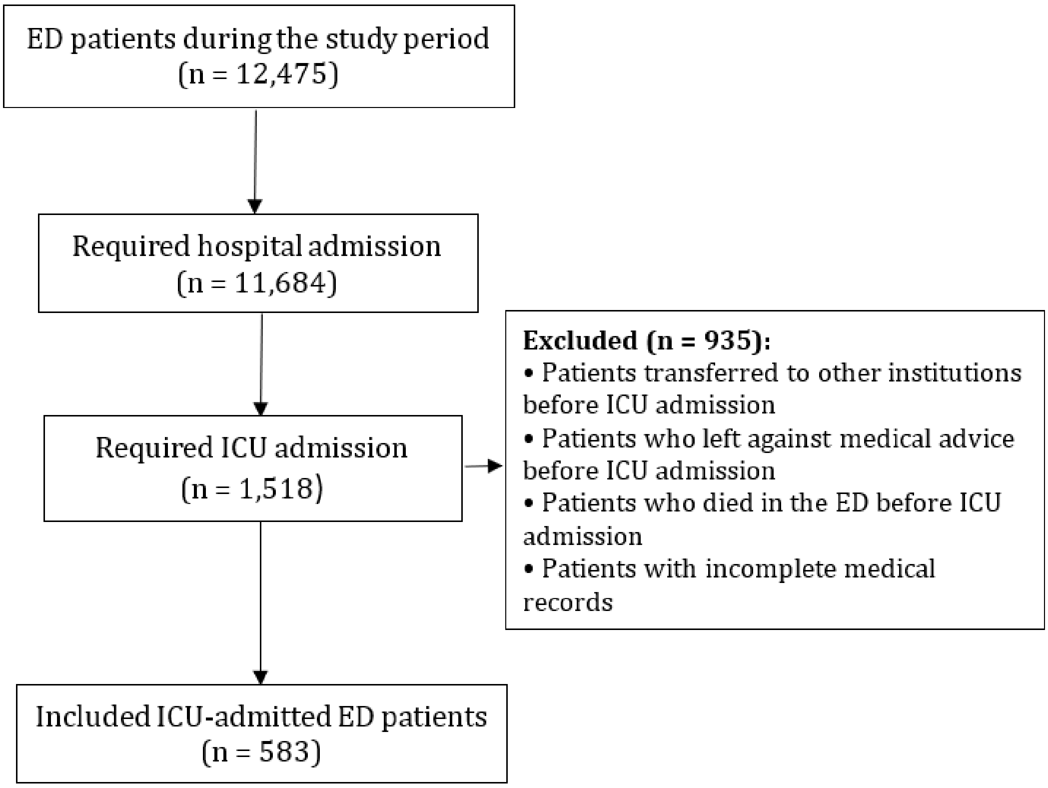

Figure 1: Flow diagram of patient selection for the study cohort. ICU: intensive care unit; ED: emergency department.

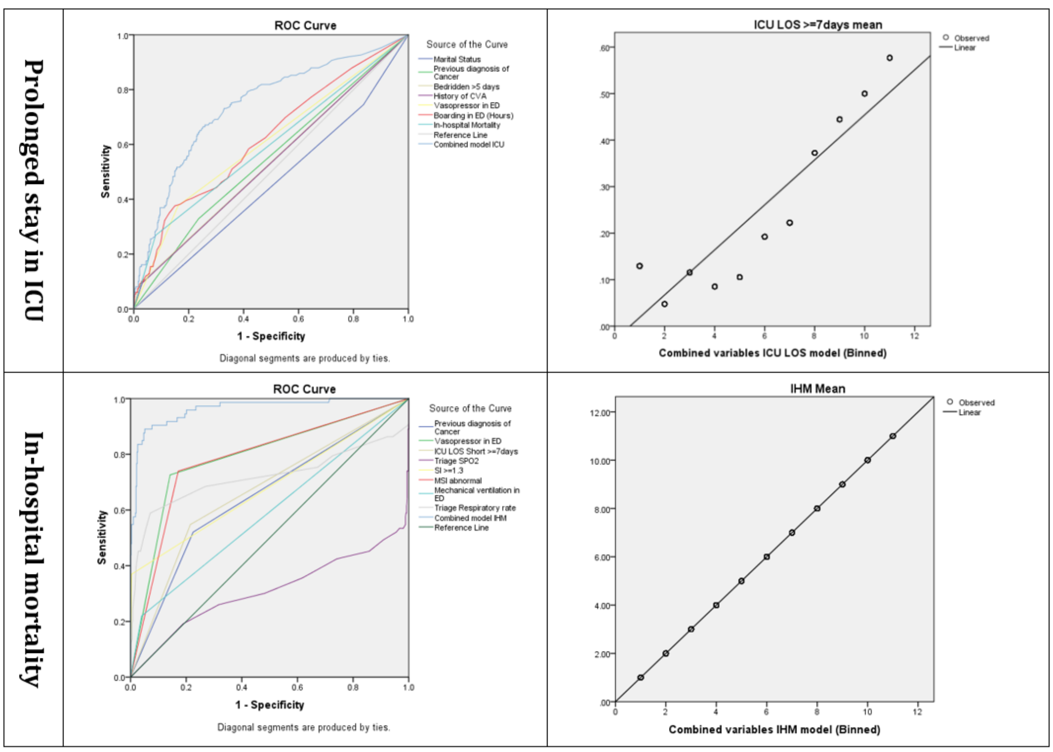

Figure S 1: Receiver operating characteristic (ROC) curve analysis of the variables included in the prolonged intensive care unit (ICU) stay (area under the curve (AUC) = 0.74) and in-hospital mortality (AUC = 0.963) regression model (left column). Calibration plot of the variables included in regression models (right column). LOS: Length of stay; IHM: In-hospital mortality; CVA: Cerebrovascular Accident; ED: emergency department; SpO: Oxygen Saturation; MSI: Modified Shock Index.

Table 1: Comparing the baseline characteristics between cases with and without length of stay (LOS) in intensive care unit (ICU) ≥ 7 days as well as survived and non-survived cases

Characteristics	Overall (N=583)	LOS ≥ 7 days		P	FDR	In-hospital mortality		P	FDR
		No(N=434)	Yes(N=149)			No(N=508)	Yes(N=75)		
Age (years)									
Mean ± SD	69.5 ± 15.1	69.1 ± 14.8	70.7 ± 16.0	0.264	0.337	69.4 ± 15.0	70.5 ± 15.5	0.568	0.654
Gender									
Male	359 (61.6)	267 (61.5)	92 (61.7)	0.961	0.961	311 (61.2)	48 (64.0)	0.644	0.673
Married									
Number (%)	474 (81.3)	363 (83.6)	111 (74.5)	0.014	0.024	413 (81.3)	61 (81.3)	0.994	0.994
BMI									
Mean ± SD	28.4 ± 6.9	28.7+6.4	27.5+7.9	0.081	0.116	28.5+7.0	27.2+5.6	0.118	0.160
Confounding factors									
Cancer	153 (26.3)	104 (24.0)	49 (32.9)	0.034	0.052	114 (22.5)	39 (52.0)	<0.001	<0.001
Bedridden ≥5	22 (3.8)	9 (2.1)	13 (8.7)	<0.001	<0.001	17 (3.3)	5 (6.7)	0.185	0.237
CVA	27 (4.7)	13 (3.0)	14 (9.4)	0.002	0.003	22 (4.4)	5 (6.8)	0.373	0.451
Vital signs									
SBP (mmHg)	116.6 ± 26.5	119.5 ± 25.5	108.1 ± 27.7	<0.001	<0.001	123.1 ± 18.7	72.5 ± 29.3	<0.001	<0.001
DBP (mmHg)	64.3 ± 16.0	65.6 ± 15.1	60.4 ± 17.8	<0.001	0.001	67.5 ± 12.7	42.8 ± 19.1	<0.001	<0.001
MAP (mmHg)	81.7 ± 18.0	83.6 ± 17.0	76.3 ± 19.8	<0.001	<0.001	86.0 ± 12.7	52.7 ± 21.4	<0.001	<0.001
Temperature (oC)	36.7 ± 0.7	36.7 ± 0.6	36.8 ± 0.9	0.511	0.619	36.7 ± 0.3	37.0 ± 1.7	0.002	0.003
Respiratory rate (/min)	18.5 ± 3.9	18.5 ± 3.6	18.7 ± 4.6	0.555	0.638	18.0 ± 2.4	21.7 ± 8.1	<0.001	<0.001
SpO (%)	95.1 ± 9.5	95.6 ± 8.4	93.7 ± 12.0	0.033	0.052	96.9 ± 3.3	83.2 ± 21.6	<0.001	<0.001
Shock Index ≥1.3	29 (5.0)	21 (4.9)	8 (5.4)	0.806	0.883	2 (0.4)	27 (37.0)	<0.001	<0.001
MSI abnormal	141 (24.3)	98 (22.7)	43 (28.9)	0.13	0.175	87 (17.1)	54 (74.0)	<0.001	<0.001
ED Interventions and Outcomes									
Mechanical ventilation	36 (6.2)	17 (3.9)	19 (12.8)	<0.001	<0.001	20 (3.9)	16 (21.3)	<0.001	<0.001
Vasopressors	127 (21.8)	71 (16.4)	56 (37.6)	<0.001	<0.001	72 (14.2)	55 (73.3)	<0.001	<0.001
CVC placement	104 (17.8)	57 (13.1)	47 (31.5)	<0.001	<0.001	52 (10.2)	52 (69.3)	<0.001	<0.001
ED boarding (hours)	11 [8,20]	10 [8,18]	14 [9,27]	<0.001	<0.001	10.5 [8,19]	13 [8,24]	0.109	0.157
ICU LOS (days)	3 [2,7]	–	–	–	–	3 [2,6]	8 [2,16]	<0.001	<0.001
Hospital LOS (days)	5 [2,10]	3 [2,5]	15 [10,26.5]	<0.001	<0.001	4 [2,8]	9 [3,20]	<0.001	<0.001
In-hospital mortality	75 (12.9)	35 (8.1)	40 (26.8)	<0.001	<0.001	–	–	–	–

Data are presented as mean ± standard deviation (SD), number (%), or median [interquartile range]. BMI: Body Mass Index; CVA: Cerebrovascular Accident; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MAP: Mean Arterial Pressure; SpO: Oxygen Saturation; MSI: Modified Shock Index; CVC: Central Venous Catheter; LOS: Length of Stay; ICU: Intensive Care Unit; ED: Emergency Department; IQR: Interquartile Range; FDR: False Discovery Rate.

Table 2: Independent predictive factors of long stay in intensive care unit (ICU) and in-hospital mortality (IHM) based on logistic regression models

Variables	Long ICU stay (≥7 days) a	P-value	In-hospital mortality b	P-value
	aOR (95% CI)		aOR (95% CI)	
Being married	0.498 (0.30, 0.82)	0.006	—	—
Previous diagnosis of Cancer	1.656 (1.04, 2.65)	0.035	2.343 (1.01, 5.46)	0.048
Bedridden >5 days	4.405 (1.57, 12.35)	0.005	—	—
History of CVA	3.117 (1.33, 7.29)	0.009	—	—
Vasopressors in ED	1.860 (1.12, 3.1)	0.017	5.824 (2.54, 13.35)	<0.001
Boarding in ED (Hours)	1.028 (1.01, 1.04)	<0.001	—	—
In-hospital mortality	3.366 (1.48, 5.03)	0.001	—	—
Triage SPO2	—	—	0.887 (0.84, 0.94)	<0.001
MSI abnormal	—	—	7.346 (3.04, 17.75)	<0.001
Mechanical ventilation in ED	—	—	6.072 (2.01, 18.36)	0.001
Triage Respiratory rate	—	—	1.177 (1.07, 1.3)	0.001
Shock Index ≥1.3	—	—	18.253 (2.57, 129.68)	0.004
ICU LOS ≥7 days	—	—	7.478 (3.02, 18.5)	<0.001

Data are presented with 95% confidence interval (CI); aOR: adjusted Odds Ratio; CVA: Cerebrovascular accident; LOS: length of stay; ED: emergency department; SpO: Oxygen Saturation; MSI: Modified Shock Index.
aModel's characteristics: 98.6% of the data included in the model, Omnibus<0.001, R20.790, and Hosmer 0.990.
Accounting for Boarding in ED (Ref No), IHM, being Married (Ref Unmarried), Diagnosis of cancer (Ref No), bedridden for >5 days (Ref No), history of CVA (Ref No), Triage SBP, Triage DBP, Triage MAP, Triage SPO2, MSI abnormal (ref No), mechanical ventilation (Ref No), Vasopressor in ED (Ref No), and Central venous catheter in ED (Ref No).
b Model's characteristics: 99.5% of the data included in the model, Omnibus<0.001, R20.731, and Hosmer 0.557.
Accounting for Boarding in ED (Ref No), SI≥1.3 (Ref No), being Married (Ref Unmarried), Diagnosis of cancer (Ref No), triage SPO2, MSI abnormal (Ref No), mechanical ventilation (Ref No), Vasopressor in ED (Ref No), Triage Temperature, Triage Respiratory rate, and ICU LOS ≥7days (Ref ICU LOS <7days).

Table 3: Tolerance and variance of inflated factors (VIF) analyses of the intensive care unit (ICU) stay and in-hospital mortality (IHM)

Predictor variables	Collinearity (LOS)		Collinearity (IHM)		Comment
	Tolerance	VIF	Tolerance	VIF	
Being married	0.956	1.046	0.945	1.059	Tested for both outcomes
Previous diagnosis of Cancer	0.909	1.100	0.916	1.092	Tested for both outcomes
Bedridden >5 days	0.945	1.058	N/A	N/A	Only tested for ICU LOS
History of CVA	0.953	1.049	N/A	N/A	Only tested for ICU LOS
Vasopressors in ED	0.295	3.389	0.792	1.263	Tested for both outcomes
Boarding in ED (Hours)	0.912	1.096	0.897	1.115	Tested for both outcomes
IHM	0.378	2.646	N/A	N/A	Only tested for ICU LOS
Triage SBP	0.411	2.432	N/A	N/A	Only tested for ICU LOS
Triage DPB	0.513	1.949	N/A	N/A	Only tested for ICU LOS
Triage SPO2	0.741	1.349	0.789	1.267	Tested for both outcomes
MSI abnormal	0.781	1.281	0.804	1.244	Tested for both outcomes
Mechanical ventilation in ED	0.874	1.144	0.898	1.113	Tested for both outcomes
Central venous catheter in ED	0.282	3.549	N/A	N/A	Only tested for ICU LOS
Triage Temperature	N/A	N/A	0.910	1.099	Only tested for IHM
Triage Respiratory rate	N/A	N/A	0.832	1.202	Only tested for IHM
Shock Index ≥1.3	N/A	N/A	0.624	1.603	Only tested for IHM
ICU LOS ≥7 days	N/A	N/A	0.870	1.149	Only tested for IHM

VIF: Variance Inflation Factor; LOS: Length of Stay; IHM: In-Hospital Mortality; ICU: Intensive Care Unit; ED: Emergency Department; CVA: Cerebrovascular Accident; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SPO2: Saturation of Peripheral Oxygen; MSI: Modified Shock Index; N/A: Not Applicable.