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Effect of Emergency Department and Intensive Care Unit occupancy on admission decisions and outcomes for critically ill patients

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Abstract

Objectives—Intensive Care Unit (ICU) admission delays can negatively affect patient outcomes, but Emergency Department (ED) volume and boarding times may also affect these decisions and associated patient outcomes. We sought to investigate the effect of ED and ICU capacity strain on ICU admission decisions, and to examine the effect of ED boarding time of critically ill patients on in-hospital mortality.

Design—Retrospective cohort study

Setting—Single academic tertiary care hospital.

Patients—Adult critically ill ED patients for whom a consult for Medical ICU admission was requested, over a 21-month period.

Interventions—None.

Measurements and Main Results—Patient data, including severity of illness (Mortality Probability Model on admission (MPM₀-III)) and outcomes of mortality and persistent organ dysfunction (POD+D), as well as hourly census reports for the ED, for all ICUs and all adult

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wards were compiled. A total of 854 ED requests for ICU admission were logged, with 455 (53.3%) as “Accept” and 399 (46.7%) as “Deny” cases, with median ED boarding times 4.2 (IQR=2.8, 6.3) and 11.7 (3.2, 20.3) hours and similar rates of POD+D 41.5% and 44.6%, respectively. Those accepted were younger (mean±SD: 61±17 vs. 65±18 years) and more severely ill (median MPM₀-III score= 15.3% (7.0, 29.5) vs. 13.4 (6.3, 25.2)) than those denied admission. In the multivariable model, a full Medical ICU was the only hospital-level factor significantly associated with a lower probability of ICU acceptance (OR 0.55 (95% CI: 0.37, 0.81)). Using propensity score analysis to account for imbalances in baseline characteristics between those accepted or denied for ICU admission, longer ED boarding time post consult was associated with higher odds of POD+D (OR 1.77 (1.07, 2.95) per log₁₀ hour increase).

Conclusions—ICU admission decisions for critically ill ED patients are affected by Medical ICU bed availability, though higher ED volume and other ICU occupancy did not play a role. Prolonged ED boarding times were associated worse patient outcomes, suggesting a need for improved throughput and targeted care for patients awaiting ICU admission.

Keywords

Intensive Care Unit (ICU); Emergency Department (ED); Critically Ill; Triage; Admission decisions; Capacity strain

INTRODUCTION

The volume of Intensive Care Unit (ICU) admissions from the Emergency Department (ED) has significantly increased by almost fifty percent between 2001 and 2009.(1) This demand often exceeds available beds and resources in many hospitals around the country,(2) leading to more complex decision-making around ICU admission. In conjunction with clinical data and acute presentation, physicians may consider bed availability as part of their triage decisions, which can have profound implications for patient outcomes and utilization of ED and ICU resources.(3) High ICU bed availability may lead to admission of patients who are either too well or too ill to benefit, while low availability leads to difficult ICU triage decisions often resulting in the denial of patients who would otherwise be accepted to the ICU.(4, 5) The decision to deny patients admission to the ICU has been shown to be associated with increased hospital mortality in multiple studies.(4, 6-11)

The rise in ICU admissions has resulted in a 32% increase in ED length of stay (LOS) for critically ill patients over the same period.(12) These “boarding” delays are more striking for patients being treated in higher volume and/or metropolitan area EDs, with up to 87% of all patients having an admission delay of greater than two hours.(13) ED crowdedness and ICU capacity strain have been associated with longer ED and inpatient lengths of stay (LOS).(14) Studies have found that critically ill patients experiencing boarding times of greater than six hours have a higher risk of in-patient mortality.(15-17) However, studies focusing on ED critically ill populations have found conflicting results on the relationship between boarding and mortality.(18-20) Regardless, longer wait times for admission have been associated with higher cost, longer LOS, and lower adherence to best practices.(21, 22)

In this retrospective cohort study of critically ill Emergency Department patients, we sought to measure the effect of ED crowding and ICU occupancy on ICU admission decisions and to investigate the potential association of prolonged delays in admission on in-hospital morbidity and mortality, accounting for the ICU admission decision.

METHODS

Study Setting & Population

This is a single institution study, taking place at an academic, urban, tertiary care center with a 14-bed closed Medical ICU, operating at a 91% average occupancy. The unit is staffed with a maximum 2:1 patient-to-nurse ratio for most patients, with physician coverage by an in-house pulmonary and critical care medicine (PCCM) boarded physician during the dayshift and early evening hours, and nighttime staffing provided by the same attending on-call and an in-house PCCM fellow, in addition to the housestaff teams. Other ICUs include Surgical, Cardiac, Cardiothoracic, and Neurosurgical ICUs, all of which can serve as overflow units for patient admissions to the Medical ICU when there is no bed availability. The ED contains a 5-bed area designated for high acuity patients upon arrival and for ongoing management of patients who clinically deteriorate in other locations of the ED; this area is staffed by an emergency medicine (EM)-trained attending physician as well as upper-level EM residents, with a typical nursing to patient ratio of 1:3. The patient cohort includes all adult ED patients (age 18 years and older) for whom Medical ICU admission was requested from October 01, 2013 to June 30, 2015.

Consults for ICU admission are initiated by ED physicians, followed by an in-person evaluation by the Medical ICU team to determine ICU admission decisions; the final decision of “accept” or “decline” for admission is made by the ICU attending physician. After the decision is made, the patients “board” in the ED until a bed is available in the target ICU or wards. For patients accepted to the ICU, the ED physicians remain the primary team with support from the ICU team on an as-needed basis until physical transfer to the destination ICU. For patients declined for ICU admission, ED physicians admit to an inpatient Medicine service, who then take over the care while the patient awaiting an inpatient bed assignment. A critical care consult service, staffed by a PCCM attending and fellow, is available to aid in the management of patients not admitted to the ICU and those patients admitted to another ICU as overflow when the Medical ICU is full.

Study Design & Measurements

This is a retrospective cohort study of critically ill ED patients who were considered for ICU admission. Data about the patient cohort were captured from the Medical ICU consult logs, which were matched with electronic health records (EHR) clinical data, operational metrics, and hourly census queried through the institution’s Data Warehouse. Consult log format and associated data abstraction tool is included in Appendix Table A1. Electronic data capture was validated and further expanded with standardized EHR chart abstraction by trained reviewers.

The study's primary objectives were to 1) identify predictors of ICU admission decisions (accept vs. deny), specifically examining the effect of ED and ICU volume on these decisions, and 2) measure the effect of post-consult ED boarding time on patient outcome of in-hospital mortality or morbidity, captured by the presence of persistent organ dysfunction or death at 28 days.⁽²³⁾ This composite outcome is defined as in-hospital mortality, discharge to hospice facility, or persistent use of vasopressors, dialysis, or mechanical ventilation by hospital day 28,⁽²³⁾ adjusting for ICU admission, boarding time, and other patient/hospital-related predictors.

Patient-related characteristics included age, gender, race/ethnicity, insurance, pre-hospital location (nursing facility/hospital vs. home), severity of illness calculation at the time of Medical ICU consult, using the Mortality Probability Model III scores on admission (MPM₀-III),⁽²⁴⁾ timing of consult (day vs. nightshift), primary admission diagnosis grouped into categories by the Society for Critical Care Medicine Diagnosis Model,^[25] and code status/goals of care (full code/no care limitations vs. any care limitations such as a do-not-resuscitate/do-not-intubate code status) at the time of ICU, upon admission to the ICU if applicable, and at the time of hospital discharge. Hospital-related predictors included continuous measurements of ED and inpatient census. These involve ED census counts at time of consult, specifically the number of ED patients being actively managed by the ED team as well as the number of patients being treated in the high-intensity/high-acuity section of the ED. Inpatient census measurements, as a percentage of total capacity, were obtained from hourly records of Medical ICU, other ICUs, and overall hospital occupancy, matched to the hour of the patients' consult times. The high-intensity ED beds and the Medical ICU were both defined as categorical variables (full vs. one or more beds available), as both units operate at > 90% occupancy on average. Additional patient-related predictors related to throughput included ED length of stay pre-consult, ED boarding time from time of consult until ED departure to inpatient admission (ICU or wards), admission to another ICU as overflow when no Medical ICU beds were available, and ICU/hospital length of stay.

This project was approved by the institutional review board at the study site under expedited review procedure, with a waiver of informed consent.

Statistical Methods

Predictors of ICU admission decision—Individuals were classified according to their ICU admission decision, accept or deny. T-testing, Chi-square testing, analysis of variance (ANOVA), and/or non-parametric testing was used to test for differences between baseline characteristics and ICU admission decision, as appropriate. Multivariable logistic regression was utilized to determine the odds of receiving an ICU “accept” admission decision by patient- and hospital-related characteristics, with particular attention to factors related to census and patient volume.

Predictors of Persistent Organ Dysfunction and/or Death (POD+D)—To find factors associated with POD+D, we applied propensity score methods to adjust for baseline characteristic imbalances in ICU admission decisions. Propensity score analysis is a well-documented method used in observational studies when investigators have no control over

treatment assignment, where treatment in our analysis is admission to the ICU, in order to reduce bias and balance covariates.(25, 26) The propensity score is defined as the probability of being admitted to the ICU, conditional on measured baseline characteristics. To determine the baseline characteristics that predict ICU admission, a stepwise logistic regression model was performed using a p-value of 0.2 for covariate selection. All predictors from the triage decision model listed in Table 1 were included as candidate predictors for the propensity score model. After non-automated stepwise regression, variables with low common support and high bias were dropped from the model, to achieve the best balancing (Appendix Table A2).

Using this model, we calculated the conditional probability that each individual would be accepted or declined for ICU admission, or the propensity score. Individuals were stratified into quintiles based on this score which created 5 groups of individuals who were similar with respect to their baseline characteristics, as this has been shown to reduce bias by 90%. (27) We further examined this group by presenting the percentages by quintile category (Appendix Figures A1-3), and the groups are more balanced in the quintiles than before stratification. The standardized differences of the mean and percent change in bias for the model variables pre- and post-propensity score adjustment indicated that baseline covariate balance was achieved (Appendix Table A2).

Multivariable logistic regression was performed to determine risk factors associated with POD+D adjusting for quintile propensity score, with the main variable of interest being ED boarding time. Goodness of fit was assessed using the Hosmer-Lemeshow (H-L) test.(28)

In a sensitivity analyses we tested for interaction between boarding time and nursing home origin, as frail patients may be more sensitive to prolonged waits for ICU admission.(29, 30) We additionally tested for interaction between boarding time and severity of illness, as higher acuity patients may be more negatively affected by prolonged wait times.

All analyses were conducted using Stata 14.1 (StataCorp LP, College Station, TX).

RESULTS

Baseline characteristics

A total of 854 consults for ICU admission were requested by the ED team during the study period with complete data, representing 43.7% of all the ICU consults received. Of all the ED consults, 455 patients (53.3%) were accepted for ICU admission with 57 patients (12.5%) requiring overflow admission to another ICU due to Medical ICU being at full capacity. Appendix Table A3 describes the characteristics of the patient cohort, stratified by final ICU admission decision status. A larger proportion of patients accepted for ICU admission were younger (mean 61 vs. 65 years of age) originated from non-nursing facility pre-hospital locations (12.5% vs. 24.8%), and had higher MPM₀-III scores at time of consult (median 0.15 (IQR 0.07, 0.30) vs. 0.13 (0.06, 0.25)). Pulmonary system diagnoses accounted for the majority of reasons for admission (accept cases 41.5% vs. denied cases 30.8%, $p < 0.05$). There were no significant differences between the groups in patient volume for ED, other ICUs, or hospital ward censuses at the time of consult. However, Medical ICU

was more often at full capacity at the time of ICU consults resulting in a “deny” admission decision compared to an “accept” decision (32.8 vs. 25.7, $p<0.05$).

Predictors of ICU admission decision

The Medical ICU being at capacity was the only hospital-related factor significantly associated with a lower probability of being accepted to the ICU, OR (95% CI) = 0.55 (0.37, 0.81) (Table 1). Patient-related factors associated with a lower odds of receiving an ICU “accept” decision were older age (27% lower odds of acceptance, per 10-year increase), and nursing home origin (OR = 0.45 (0.29, 0.68)). Higher severity of illness (MPM₀-III score) and having no care limitations at time of consult (code status: full) were associated with higher odds of acceptance (OR = 1.79 (1.05, 3.03) and 3.80 (1.93, 7.46), respectively). (See Table 1.)

Predictors of POD+D

Results from the multivariable logistic regression adjusted for ICU triage decision propensity score indicate that longer ED boarding time post consult is associated with an increased probability of POD+D (OR = 1.79 (1.09, 2.96) per log₁₀ hour increase). (See Figure.) Nursing home origin and MPM₀-III mortality score were also associated with a higher odds of POD+D, OR (95% CI) = 9.43 (1.30, 68.13) and 8.03 (4.89, 13.17), respectively. (See Table 2). Outcomes between those admitted to the Medical ICU and those admitted to another ICU as overflow were not significantly different (36.8 vs. 63.2%, $p=0.442$). In a sensitivity analysis, no interaction was seen between boarding times and nursing home origin or severity of illness in the sensitivity analyses (data not shown).

DISCUSSION

In this retrospective cohort analysis, we found a significant effect of Medical ICU bed availability on ICU admission decisions for critically ill ED patients, even after adjustment for patient characteristics. This is consistent with other studies that have identified ICU bed availability as affecting triage and goals of care decisions.(5, 9, 11, 31, 32) Furthermore, in examination of delays in admission, we determined that longer boarding times were associated with worse outcomes for critically ill ED patients, after adjustment for the ICU admission decision.

Our study further adds to this body of work by investigating the effect of concurrent high volume in other areas of the hospital. Unlike the census of the medical ICU, the census in the other ICUs did not seem to affect ICU admission decisions (Table 1). Our cohort only contained a minority of patients who were admitted to other ICUs in times of high Medical ICU occupancy, with no difference in outcomes when compared to those directly admitted to a Medical ICU. Other studies investigating the safety of overflow have found possible harm boarding surgical patients in non-surgical ICUs,(33) though not seen in a medical ICU patient population.(34) While our findings are limited due to the low subgroup numbers, it may be that these patients also are receiving the same quality and level of care that they would experience in a Medical ICU. This illustrates a potential opportunity to have improved coordination and collaboration between ICUs to facilitate overflow to offload the

ED during times of MICU capacity strain, without compromising quality of care.(35) We did not detect an effect of ED volume, both overall and in the high-intensity section of the ED, on the ICU team's admission decision. As our measures for ED crowdedness were snapshots at the time of ICU consult, the ICU team may not have been aware of the demand for the high-intensity resources of the ED. Critically ill patients remaining in the ED often consume limited ED resources for both other acute patients as well as less urgent patients, necessitating efficient throughput of ICU-bound ED patients for optimal patient care for all other ED patients.(36)

A major strength of our study is the use of propensity score analysis. Multiple studies have demonstrated higher mortality in patients denied ICU admission,(4, 8-10) and others have reported that a significant number of patients are declined ICU admission due to perceived lack of benefit by the triaging physician.(9, 11, 31, 37) Our use of propensity score analysis helps to account for the selection bias associated with decision-making around ICU admission, such as the rejection of patients deemed too ill to benefit.(38) Additionally, studies may underestimate the effects of ICU refusal decisions when the primary outcome is strictly limited to in-hospital mortality. By weighing the accept decision in the model and using a composite outcome of mortality and 28-day morbidity, we can better elucidate the effect of boarding on negative patient outcomes.

Our model also documents the effect of severity of illness, diagnosis, and surrogates for frailty (nursing home origin) on ICU decisions, similar to other studies.(9, 11, 31, 39-41) Not surprisingly, we also found that these factors were significantly associated with mortality and morbidity (POD+D). However, we did not see an increased effect of ED boarding on POD+D for more frail or more severely ill patients, which may be related to inadequate numbers to detect this effect. Patients who were denied ICU admission also experienced longer ED boarding times, perhaps in part related to the re-triage process and limited step-down unit/ward bed availability at time of request, elements not available in our study data.(42) These are areas for further investigation as identification of those patient groups who are most susceptible to the deleterious effects of boarding can allow for targeted interventions and deployment of limited resources to those of greatest need during periods of boarding.

Limitations in our study are in part related to the observational study design and likely insufficient EHR documentation for more granular information on our patients. Our cohort identification utilized an internal log of consults for Medical ICU admission; additional patients may have been considered for ICU admission without a formal consult, though less likely as this log is used to track staff workload and ICU demand longitudinally at our institution. In discussion with ED providers at our institution, it is possible that the ED providers decided not to request ICU consult after their determination that a patient may not benefit from ICU services; unfortunately this earlier stage of decision-making was not captured in the EHR ED provider notes.

Furthermore, detailed information is rarely found in the EHR for the clinical reasoning behind ICU admission decisions of "accept" vs. "decline", such as whether a patient was declined admission due to hospital-related factors such as bed availability or patient-related

factors such as perceived benefit. We utilized physician consult logs which are composed in real-time and can be more detailed in clinical justification for triage decisions, but still include a great deal of variability in documentation. Further limitations include inability to test for interactions between many of the patient-related variables due to small sample sizes in each of the subgroups, undermining the propensity score analysis. Our severity of illness measure was also collected only at time of consult; our dataset did not contain a dynamic measure of clinical severity, nor detailed accounting of the hospital course, to better predict POD+D risk. We also recognize that patient goals of care are often revisited during the patient's hospital course; while chart documentation was limited and variable regarding goals of care discussions which may have occurred pre-consult or pre-ICU admission which would likely impact ICU admission decisions and patient outcomes, we include objective measures of code status (the EHR order/documentation) at consult, ICU admission, and hospital discharge as descriptive variables, differences between which indicate an area for further research. We were limited in our investigation of secondary outcomes related to resource utilization—while we describe hospital LOS for patients accepted vs. declined for ICU admission, we did not have data on cost, transfers, readmissions, or other similar metrics. However, this is an area for further study as delays in care may have a deleterious effect on occupancy and burden on the health care system.⁽⁴³⁾ Despite focusing on clinical condition at the time of ICU consult, we still detected a significant effect of ED boarding, supporting our concerns that early delays in throughput can be detrimental to downstream patient outcomes.

Additionally, we were limited in that our measures of ED crowdedness were taken at the time of ICU consult and did not represent the dynamic changes that take place during the entire patient length of stay in the ED. Depending on the staffing and structure of the institution, higher volume during ED boarding times may reduce the available resources and provider attention the critically ill patient receives, thus adding to the risk of poor outcomes during the hospitalization, as seen in trauma and stroke.^(44, 45) Furthermore, this study reflects a single institution's ICU admission decision-making process and a ED-led model of care for boarding critically ill patients and may not be as applicable to institutions with ICU or ED intensivist-led teams who care for these waiting patients.⁽⁴⁶⁾ However, the consideration of concurrent measures of ED, Medical ICU, and other ICU occupancy is generalizable to all institutions, and highlights the necessity of more interdisciplinary efforts to improve throughput of critically ill ED patients.⁽⁴⁷⁾

Overall, our study demonstrates that critically ill ED patients have lower odds of being accepted for ICU admission in times of capacity strain in their target ICU, despite bed availability in other units. For all these patients, longer ED boarding times have an independent negative effect on inpatient mortality and morbidity, suggesting a need for development of interventions to optimize care for these waiting patients and improved hospital-wide flow.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure. Predicted probability of Persistent Organ Dysfunction + Death (POD+D) by Emergency Department (ED) boarding time (hours)

In this cohort of critically ill ED patients for whom Medical Intensive Care Unit admission consult was completed, between 10/2013 and 06/2015, ED boarding time post-consult is associated with an increase in the odds of dying or having significant morbidity during the hospitalization. The POD+D model was adjusted for age, gender, race, insurance, nursing home/facility pre-hospital origin, interaction between age and nursing home origin, MPM₀-III score, nightshift timing of consult, critical care diagnosis category, hospital LOS, and ICU admission decision/propensity score quintile.

Table 1

Predictors of “Accepted” Intensive Care Unit (ICU) admission decision for critically ill Emergency Department patients for whom Medical ICU admission consult was requested: Results from a multivariate regression model

Predictors	OR	95% CI	
<i>Patient-Related</i>			
Age (per 10-year increase) ***	0.73	0.64	0.85
Gender, Male (ref: Female)	1.02	0.74	1.42
Race/Ethnicity (ref: Caucasian)			
<i>African American</i>	0.79	0.51	1.23
<i>Hispanic</i>	0.86	0.54	1.36
<i>Asian/Native American/Other</i>	0.80	0.43	1.48
<i>Unknown</i>	0.70	0.28	1.74
Insurance (ref: Medicare/Private Payor)			
<i>Medicaid</i>	0.71	0.46	1.09
<i>Other/Unknown</i>	0.21	0.11	0.40
Nursing Home/Facility Pre-Hospital Origin ***	0.45	0.29	0.68
MPM ₀ -III score (per log10 % increase) ***	1.79	1.05	3.03
Revised Charlson Score (per 1 point increase)	1.03	0.97	1.09
Code status at time of consult (FULL CODE/No care limitations) ***	3.80	1.93	7.46
Critical Care Diagnosis Category (ref: Pulmonary)			
<i>Sepsis/septic shock</i>	1.12	0.59	2.11
<i>Cardiac system</i>	0.68	0.37	1.25
<i>Gastrointestinal disorders</i>	0.98	0.54	1.75
<i>Endocrine (including electrolyte derangements)</i>	0.64	0.28	1.45
<i>Other</i>	0.73	0.40	1.31
<i>None</i> ***	0.11	0.06	0.17
ED LOS pre-ICU consult (log10 hours)	0.85	0.56	1.29
<i>Hospital-Related</i>			
ED High Intensity Section at Full Capacity (Y vs. N)	0.99	0.70	1.42
Active ED Patient Volume (Quartiles) (ref: Q1, low)			
<i>Q2-Q3 (medium)</i>	0.97	0.64	1.47
<i>Q4 (high)</i>	0.91	0.56	1.48
Medical ICU at Full Capacity (Y vs. N) **	0.55	0.37	0.81
Other ICU Patient Volume, percent capacity (Quartiles) (ref: Q1, low)			
<i>Q2-Q3 (medium)</i>	0.83	0.55	1.24
<i>Q4 (high)</i>	0.92	0.50	1.69
Adult Inpatient Volume, percent capacity (Quartiles) (ref: Q1, low)			
<i>Q2-Q3 (medium)</i>	1.47	0.69	3.13

Predictors	OR	95% CI	
<i>Q4 (high)</i>	1.59	0.71	3.59

p<0.001,

**
p<0.01,

*
p<0.05

$R^2=0.200$; AIC = 944.175; Hosmer Lemeshow goodness of fit p = 0.597

Abbreviations: *ED*=Emergency Department; *ICU*=Intensive Care Unit; *OR*=Odds ratio; *95% CI*=95% Confidence Interval; *MPM0-III*=Mortality Probability Model on Admission (severity of illness); *AIC*= Akaike information criterion

Table 2

Predictors of Persistent Organ Dysfunction + Death (POD+D) for critically ill Emergency Department patients, for whom a Medical Intensive Care Unit admission consult was completed, adjusted for propensity score (ICU admission): Results from the multivariate regression model

Predictors	OR	95% CI	
<i>Patient-Related</i>			
Age (per 10-year increase)	0.98	0.83	1.17
Gender, Male (ref: Female)	1.15	0.82	1.61
Race/Ethnicity (ref: Caucasian)			
<i>African American</i>	1.41	0.91	2.19
<i>Hispanic</i>	1.27	0.80	2.02
<i>Asian/Native American/Other</i>	1.24	0.68	2.25
<i>Unknown</i>	0.93	0.35	2.49
Insurance (ref: Medicare/Private Payor)			
<i>Medicaid</i>	0.71	0.45	1.13
<i>Other/Unknown</i>	1.41	0.74	2.67
Nursing Home/Facility Pre-Hospital Origin **	9.43	1.30	68.13
Age *Nursing Home Origin (Interaction)	0.83	0.63	1.10
MPM ₀ -III score (per log10 % increase) ***	8.03	4.89	13.17
Critical Care Diagnosis Category (ref: Pulmonary)			
<i>Sepsis/septic shock</i>	0.95	0.53	1.69
<i>Cardiac system</i>	1.54	0.84	2.83
<i>Gastrointestinal disorders</i> *	0.47	0.24	0.88
<i>Endocrine (including electrolyte derangements)</i>	0.69	0.28	1.70
<i>Other</i>	0.70	0.39	1.26
<i>None</i> **	0.40	0.24	0.67
Nightshift timing of ICU consult	1.41	1.00	1.98
Hospital LOS, days (log10)	0.78	0.53	1.13
<i>Hospital-Related</i>			
ED Boarding time post-ICU consult (log10 hours) **	1.79	1.09	2.96

p<0.001,

**
p<0.01,

*
p<0.05

R²=0.211; AIC = 918.362; Hosmer Lemeshow goodness of fit p = 0.853

Abbreviations: *ED*=Emergency Department; *ICU*=Intensive Care Unit; *OR*=Odds ratio; *95% CI*=95% Confidence Interval; *MPM₀-III*=Mortality Probability Model on Admission (severity of illness); *LOS*=Length of stay; *AIC*= Akaike information criterion