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Delayed inter-hospital transfer of critically ill patients with surgical sepsis

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Abstract

Background: Suboptimal triage of critically ill patients with surgical sepsis may contribute to adverse outcomes. Patients transferred to a tertiary care center after spending 24 hours at an outside facility were compared with patients who had early triage to a tertiary care center with the null hypothesis that management parameters and outcomes would be similar between groups.

Methods: This prospective observational cohort study included 308 patients treated for surgical sepsis in a surgical intensive care unit at a tertiary care center. Patients transferred after spending more than 24 hours at an outside facility ($n=69$) were compared with patients who were directly admitted or transferred within 24 hours ($n=239$). Patient characteristics, management parameters, and outcomes were compared between groups. This study was registered at [ClinicalTrials.gov](https://clinicaltrials.gov) ().

Results: Average outside facility length of stay in the delayed transfer group was 43 hours. Delayed transfer patients had higher SOFA (7 vs. 5, $p=0.003$) and APACHE II scores (19 vs. 16, $p=0.007$) on admission. The interval between admission and source control was significantly longer in the delayed transfer group (12.1 vs. 1.0 hours, $p=0.009$). The incidence of nosocomial infection was significantly higher in the delayed transfer group (41% vs. 23%, $p=0.005$). Delayed transfer was independently associated with a 10-day increase in hospital length of stay. Delayed transfer patients were less likely to be discharged home (22% vs. 59%, $p<0.001$) and suffered two-fold higher in-hospital mortality (14.5% vs. 7.1%, $p=0.056$).

Conclusion: Patients with surgical sepsis who spent more than 24 hours at an outside facility prior to transfer had greater initial illness severity, longer intervals between admission and source control, and more nosocomial infections compared with patients who had early triage to a tertiary care center.

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Author contribution statement

TJL, QW, ZW, NL, FAM, AB, PAE, AMM, and SCB contributed to the literature review and study design. TJL, QW, ZW, and NL contributed to data collection and analysis. TJL, QW, ZW, NL, FAM, AB, PAE, AMM, and SCB interpreted the analysis. TJL drafted the manuscript. TJL, NL, FAM, AB, PAE, AMM, and SCB provided critical revisions to the manuscript.

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Keywords

Sepsis; source control; transfer; ICU; triage

Introduction

Sepsis is common, costly, and highly morbid. Hospitalization with sepsis has become more common than hospitalization with myocardial infarction, with annual costs exceeding \$20 billion in the United States alone (1, 2). In-hospital mortality ranges from 18–29% (3, 4). In the United States, Europe, and Asia, care provided for septic patients does not meet consensus standards in approximately two-thirds of all cases (5, 6). Initial patient triage represents one opportunity for improvement.

The setting in which septic patients are managed impacts outcomes. Delay in transfer from the emergency department to the ICU has been associated with increased mortality among medical and surgical populations (7-9). Patients transferred from one facility to another before undergoing emergency general surgery have increased morbidity and mortality, independent of comorbidities and operative complexity (10, 11). Initial diagnosis of sepsis on a hospital ward rather than intensive care unit (ICU) has been associated with delays in resuscitation and increased mortality (12). Inter-hospital transfer of septic patients has been associated with delays in antibiotic administration and intravenous fluid resuscitation, increased costs, and higher mortality (13, 14). To our knowledge, the impact of transferring patients with surgical sepsis from one facility to another has not been reported.

This prospective observational cohort study compared patients with surgical sepsis who initially presented to a tertiary care academic hospital or were expeditiously transferred after spending less than 24 hours at an outside facility versus patients with a delayed transfer from an outside facility after spending more than 24 hours at the referring facility. These cohorts were compared with the null hypothesis that management parameters and outcomes would be similar between groups.

Methods

Study design

This prospective observational cohort study included 308 patients with surgical sepsis treated at a tertiary care academic hospital in a 48-bed surgical intensive care unit. This study was registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (). Institutional Review Board approval was obtained (IRB201400611) prior to patient enrollment. Written informed consent was obtained from each study subject or their surrogate decision-maker.

Subject screening and enrollment is illustrated in Supplemental Figure 1. Inclusion criteria were admission to a surgical intensive care unit, age 18 years or greater, and diagnosis of sepsis with subsequent initiation of a computerized clinical decision support-directed sepsis management protocol (15, 16). The protocol maps patient physiology to clinical interventions, making recommendations for intravenous fluid infusions, vasopressor initiation and titration, and antibiotic therapy. These recommendations were supplemented

with protocols for daily spontaneous breathing trials, evaluation and management of delirium, blood product transfusions, and nutritional support.

Subject recruitment, management, and data collection

Study protocols have been previously described (15). Briefly, patients were identified by a modified version of the MEWS (17) early-detection protocol which screened for sepsis with body temperature, heart rate, respiratory rate, blood pressure, and level of consciousness. For transfer patients, this screening tool was used on arrival at the receiving center, calibrated for high sensitivity to ensure that all patients who may have sepsis would undergo subsequent diagnostic evaluation. Patients who screened positive were then assessed by study investigators and the clinical ICU team using all available clinical and microbiological data for the presence of sepsis using 2001 consensus Sepsis-2 definitions and criteria (18-20). Patients diagnosed with sepsis were started on an early goal-directed therapy computerized clinical decision-support protocol (16). Data regarding demographics and the diagnosis and treatment of sepsis were prospectively collected for all patients and maintained in the REDCap™ platform (21). Non-infectious complications included acute respiratory distress syndrome, abdominal compartment syndrome, cardiac arrest, extremity compartment syndrome, heparin-induced thrombocytopenia, new-onset atrial fibrillation, pulmonary embolism, rhabdomyolysis, stroke, upper gastrointestinal bleeding, or any other non-infectious complication identified by study investigators and the clinical ICU team.

The receiving hospital is the sole tertiary care center for a greater than 90-mile radius catchment area, including over 1.5 million people. For transferred patients, data regarding sepsis onset were collected from transfer notes and communications with referring providers at the time of referral to establish initial clinical findings, organ dysfunction, type of infection, written reports regarding microbiologic specimens, treatment, and a timeline for the sequence of events leading to transfer using 2001 consensus Sepsis-2 definitions and criteria with clinical adjudication by study investigators and the clinical ICU team (18-20). In all cases, transfers were initiated by a phone call from the referring center to the tertiary care center with a conversation between the referring provider and the accepting provider. Patients transferred after spending more than 24 hours at the referring center were compared with patients who were directly admitted or transferred after less than 24 hours at the referring facility. Patients transferred after spending less than 24 hours at the referring facility were grouped with patients who were directly admitted because these patients had similar phenotypes and this analytic approach allowed for comparison of two groups rather than three groups, decreasing the family-wise error rate of multiple comparisons.

Statistical analysis

Statistical analysis was performed in SAS (v.9.4, Cary, NC). To describe patient characteristics, management parameters, and outcomes, discrete variables were compared by Fisher's Exact test and reported as n (%). Continuous variables were tested for normality with the Shapiro-Wilk test. Normally distributed variables were compared by one-way analysis of variance and reported as mean $\pm$ standard deviation. Non-normally distributed variables were compared by the Kruskal Wallis test and reported as median with interquartile range. To interpret our results, it is important to note that two lists of values can

have the same median value but have skewed distributions that are significantly different. In this study, significance was set at $\alpha=0.05$. Therefore, when the non-parametric Kruskal Wallis tests demonstrated a <5% chance that differences between distributions were due to chance, this was considered statistically significant, even if the median value was the same in each group. Because historical data regarding the impact of transferring septic patients from one facility to another are lacking, this was an exploratory study performed without a power analysis.

To assess the ability of transfer status to predict hospital length of stay and SOFA score at the time of discharge, univariable linear regression was performed using transfer status and other factors which were different between groups as input variables, including global indicators of illness severity like SOFA and APACHE II scores. To determine whether transfer status was an independent predictor of hospital length of stay and SOFA score at discharge, all input variables that were statistically significant on univariable regression were included in a multivariable linear regression model predicting hospital length of stay and SOFA score at discharge, excluding variables that were collinear (Pearson's correlation coefficient $p<0.05$). Input variables were reported as coefficient estimates with 95% confidence intervals. Model significance was assessed by the F-test with $\alpha=0.05$, such that an F-test $p<0.05$ indicates that a significant proportion of variance in the outcome is explained by the model.

Results

Patient characteristics

Patient characteristics at the time of tertiary care center admission with a diagnosis of sepsis are summarized in Table 1. There were 69 delayed transfer patients and 239 direct admit/early transfer patients. Patients transferred after more than 24 hours at an outside facility had older age (64 vs. 60 years, $p=0.012$) and higher Charlson comorbidity index (3 [interquartile range 2–6] vs. 3 [interquartile range 1–4] $p=0.008$). The most common etiology of sepsis was an intra-abdominal infection, occurring in 92 (39%) of all direct admit/early transfer patients and 31 (45%) of all delayed transfer patients, followed by pneumonia, occurring in 45 (19%) of all direct admit/early transfer patients and 6 (9%) of all delayed transfer patients, and necrotizing soft tissue infection, occurring in 34 (14%) of all direct admit/early transfer patients and 11 (16%) of all delayed transfer patients. Other less common etiologies of sepsis were surgical site infection, bloodstream infection, urinary tract infection, empyema, and endocarditis.

The average length of stay at an outside facility in the delayed transfer group was approximately 43 hours. In the direct admit/early transfer group, 60 patients (25%) were transferred from an outside facility, and median outside facility length of stay was approximately 1 hour. Although vital signs were similar between groups, delayed transfer patients had greater acute illness severity, manifest as lower Glasgow Coma Scale scores (11 vs. 15, $p=0.014$), higher SOFA scores (7 vs. 5, $p=0.003$), higher CNS SOFA scores (2 vs. 1, $p=0.017$), higher liver SOFA scores (0 [interquartile range 0–1] vs. 0 [interquartile range 0–0], $p=0.005$), and higher APACHE II scores (19 vs. 16, $p=0.007$). Cardiovascular, respiratory, and renal SOFA scores were similar between groups.

Management parameters

Management parameters are summarized in Table 2. Nearly two-thirds of all patients in both groups underwent a source control procedure. Eight patients (12%) in the delayed transfer group had a source control procedure at a referring facility. Four underwent laparotomy for control of intra-abdominal sepsis, three underwent soft tissue debridement for necrotizing soft tissue infection, and one underwent percutaneous drainage of an intra-abdominal abscess. The interval between tertiary care center admission and source control was significantly longer in the delayed transfer group (12.1 vs. 1.0 hours, $p=0.009$). The delayed transfer group had a greater proportion of patients who underwent a source control procedure more than six hours after sepsis onset (35% vs. 17%, $p=0.002$). The timing of initial antibiotic administration was similar between groups. Within 24 hours of arrival at the tertiary care center, the incidence of vasopressor administration was similar between groups (38% vs. 28%, $p=0.135$), total crystalloid intravenous fluid administration was lower in the delayed transfer group (3.1 L vs. 4.0 L, $p=0.048$), and urine output was similar between groups (1.5 L vs. 1.7 L, $p=0.071$).

Outcomes

Outcomes are summarized in Table 3. The incidence of nosocomial infection was significantly higher in the delayed transfer group (41% vs. 23%, $p=0.005$). Non-infectious complications were similar between groups. Consistent with the observation that a greater proportion of delayed transfer patients had pre-existing end-stage renal disease on dialysis, a greater proportion of the delayed transfer group received dialysis during admission (25% vs. 8%, $p<0.001$). The delayed transfer group had longer hospital length of stay at the tertiary care center (24 vs. 15 days, $p<0.001$) and ICU-length of stay (14 vs. 6 days, $p<0.001$), though ICU-free days were similar between groups. Discharge SOFA score was higher in the delayed transfer group (4 vs. 2, $p=0.013$). The in-hospital mortality rate was two-fold higher in the delayed transfer group (14.5% vs. 7.1%, $p=0.056$). Delayed transfer patients were less likely to be discharged home (22% vs. 59%, $p<0.001$), a phenomenon which may be partially attributable to the observation that delayed transfer patients were significantly more likely to be transferred to another hospital, including the original referring facility (13.0% vs. 0.4%, $p<0.001$).

Transfer status was an independent predictor of hospital length of stay

Univariable and multivariable predictors of hospital length of stay are summarized in Table 4. On univariable linear regression, delayed transfer was associated with longer length of stay. Other factors associated with longer length of hospital stay on univariable analysis were lower GCS, higher SOFA score, higher CNS SOFA score, higher liver SOFA score, and higher APACHE II score. After excluding collinear variables, delayed transfer, CNS SOFA score, and liver SOFA score were included in the multivariable model. Delayed transfer was independently associated with a 10-day increase in hospital length of stay. The multivariable model F-test demonstrated that the model was statistically significant ($p<0.001$), i.e. a significant proportion of variance in hospital length of stay was explained by the model.

Transfer status was not an independent predictor of persistent organ dysfunction at hospital discharge

Univariable and multivariable predictors of discharge SOFA score are summarized in Table 5. On univariable linear regression, delayed transfer was associated with higher discharge SOFA score. Other factors associated with higher discharge SOFA score on univariable analysis were older age, lower GCS at sepsis onset, and higher SOFA score, CNS SOFA score, liver SOFA score, and APACHE II score at sepsis onset. After excluding collinear variables, delayed transfer, age, CNS SOFA score, and liver SOFA score were included in the multivariable model. When adjusting for age, CNS SOFA score, and liver SOFA score, delayed transfer did not significantly contribute to the model, and therefore was not independently associated with discharge SOFA score. All other input variables contributed significantly to the multivariable model. The multivariable model F-test demonstrated that the model was statistically significant ($p < 0.001$), i.e. a significant proportion of variance in discharge SOFA score was explained by the model.

Discussion

In this study, patients with surgical sepsis who spent more than 24 hours at an outside facility prior to transfer to a tertiary care center were older, had more comorbidities, had greater initial illness severity, experienced longer delays in achieving source control, required longer hospital lengths of stay, suffered more nosocomial infections, and were less likely to be discharged home compared with patients who were directly admitted to a tertiary care center or were transferred expeditiously. The authors speculate that the interval between admission and source control was longer in the delayed transfer group because the process of gathering information from caregivers and outside facility records was not conducive to the expeditious performance of procedural interventions compared with patients who received all of their care at the tertiary center, who represented 75% of the direct admit/early transfer group. Because the delayed transfer group had greater illness severity on arrival, these findings may also suggest that patients with surgical sepsis who progress to severe sepsis or septic shock may be best served at a tertiary care center. The multivariable analysis suggested that delayed transfer was independently associated with longer hospital length of stay when adjusting for other factors that were different between groups. Delayed transfer patients had persistently higher SOFA score at discharge, suggesting that prolonged illness contributed to longer ICU and hospital length of stay in this group.

Although previous studies have not investigated the impact of transferring patients with surgical sepsis from one facility to another, analyses of similar patient populations have had similar results. Longer delays in transfer from the emergency department to the ICU and longer delays in inter-hospital transfer of non-surgical patients with sepsis have been associated with increased mortality (7-9, 14). An initial diagnosis of sepsis on a hospital ward has been associated with delayed intravenous fluid resuscitation and increased mortality (12). Several phenomena may contribute. ICUs are staffed with providers who have expertise in managing life-threatening conditions and equipped with the resources to do so. Staffing the ICU with faculty who have critical care training has been associated with decreased mortality for septic shock patients (22). Lower provider-to-patient ratios may have

important implications for initiation of antibiotic therapy and performance of source control. Tertiary care centers often benefit from the immediate availability of specialists with expertise in managing critically ill patients and obtaining source control by minimally invasive and image-guided percutaneous techniques. Our institution fits this description as the sole tertiary care center for a greater than 90-mile radius, with the ability to perform extra-corporeal membrane oxygenation and other resource-intensive measures that require the immediate availability of highly skilled specialists and intensivists. Delayed inter-facility transfer may be particularly harmful for patients with surgical sources of sepsis (23, 24).

Several strategies may facilitate direct admission to a tertiary care center or early transfer from outside facilities. Pre-hospital triage systems can be designed to identify patients who are likely to benefit from direct admission to a tertiary care center within their catchment area. When these mechanisms fail, inter-facility transfer systems should facilitate direct conversations between providers and place the patient at high priority for early ground or air transportation (13, 14, 25). Dedicating hospital beds for transfer purposes can ensure bed availability at receiving hospitals (26). Scalea et al. (25) found that creation of a critical care resuscitation unit to expedite transfer of critically ill surgical patients to a quaternary care center was associated with shorter intervals between initial referral and arrival and transfer to the operating room. Finally, public and professional educational initiatives informing patients and providers of the importance of early identification and management of sepsis may promote early identification of patients who are likely to benefit from early admission to a tertiary care center.

This study was limited by using data from a single institution, which limits generalizability to other practice settings. Extensive exclusion criteria were applied to reduce heterogeneity and confounding variables as much as possible. Some potentially important data were unavailable (e.g. the ability of referring centers to provide ventilator support, data regarding the structure, process, and personnel of the referring facilities, final culture and sensitivity data from referring facilities, and the proportion of patients who had been recently discharged from our facility before readmission, representing fragmentation of care). When designing this study, historical data regarding inter-hospital transfer for surgical sepsis were lacking, and so this exploratory study was performed without a power analysis. The cohort selection strategy also introduces selection bias. Sepsis-3 definitions emerged during the study period; because patients classified by sepsis-3 definitions may have greater illness severity than patients classified by sepsis-2 definitions, our results may underestimate morbidity and mortality compared with studies using sepsis-3 definitions. Finally, multivariable regression models cannot control for all potentially confounding factors, and therefore cannot establish causality. Future investigations should include more patients from multiple institutions to ensure adequate power and generalizability, and assess the efficacy of initiatives promoting early admission of patients with surgical sepsis to centers with the personnel and resources necessary to provide optimal care.

Conclusions

Patients with surgical sepsis who spent more than 24 hours at an outside facility prior to transfer to a tertiary care center had greater initial illness severity, longer intervals between

admission and source control, more nosocomial infections, and longer hospital length of stay compared with patients who were directly admitted to a tertiary care center or were transferred expeditiously. Future investigations should assess the efficacy of initiatives promoting early admission of critically ill patients with surgical sepsis to centers with the personnel and resources necessary to provide optimal care, including early source control.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1:

Summary of patient characteristics on admission to a tertiary care center with a diagnosis of sepsis.

Patient characteristics	Direct admit/early transfer (n=239)	Delayed transfer (n=69)	<i>p</i>
Age (years)	60 (49, 69)	64 (56, 72)	*0.012
Male	131 (54.8%)	39 (56.5%)	0.801
Sepsis Severity			0.168
Sepsis	78 (32.6%)	15 (21.7%)	
Severe Sepsis	107 (44.8%)	33 (47.8%)	
Septic shock	54 (22.6%)	21 (30.4%)	
Heart rate	107 (94, 119)	108 (95, 117)	0.7971
Respiratory rate	20 (16, 23)	20 (15, 25)	0.890
Mechanically ventilated	121 (50.6%)	41 (59.4%)	0.220
Temperature (°C)	99.5 (98.2, 101.1)	99.3 (97.7, 100.3)	0.135
Glasgow Coma Scale score	15 (10, 15)	11 (9, 15)	*0.014
SOFA score	5 (3, 8)	7 (5, 11)	*0.003
CNS SOFA score	1 (0, 2)	2 (0, 3)	*0.017
Respiratory SOFA score	1 (0, 3)	2 (0, 3)	0.431
Cardiovascular SOFA score	1 (1, 3)	1 (1, 3)	0.343
Liver SOFA score	0 (0, 0)	0 (0, 1)	*0.005
Renal SOFA score	1 (0, 2)	1 (0, 3)	0.314
Coagulation SOFA score	0 (0, 1)	0 (0, 1)	0.168
APACHE II score	16 (11, 23)	19 (14, 26)	*0.007
Charlson comorbidity index	3 (1, 4)	3 (2, 6)	*0.008
History of TIA	8 (3.3)	4 (5.8)	0.373
History of stroke	9 (3.8)	11 (15.9)	*0.001
With residual deficit	5 (2.1)	4 (5.8)	0.391
Without residual deficit	5 (2.1)	5 (7.2)	*0.035
Smoker within 1 year	84 (35.1%)	24 (34.8%)	0.883
Severe COPD	23 (9.6%)	9 (13.0%)	0.452
Congestive heart failure	7 (2.9%)	3 (4.3%)	0.564
Heart attack within 6 months	3 (1.3%)	1 (1.4%)	0.902
Previous coronary angioplasty	36 (15.1%)	11 (15.9%)	0.900
Previous intervention for PVD	20 (8.4%)	14 (20.3%)	*0.006
Diabetes	66 (27.6%)	25 (36.2%)	0.187
Acute renal failure	18 (7.5%)	8 (11.6%)	0.287
On dialysis	7 (2.9%)	6 (8.7%)	*0.041
Body mass index	31.7 (9.4)	30.6 (9.8)	0.252
Chronic steroid use	15 (6.3%)	5 (7.2%)	0.812
Disseminated cancer	7 (2.9%)	4 (5.8%)	0.257

SOFA: sequential organ failure assessment, TIA: transient ischemia attack, CNS: central nervous system, COPD: chronic obstructive pulmonary disease, PVD: peripheral vascular disease. Data are presented as median (25th percentile, 75th percentile), mean (standard deviation), or n (%).

*
 $p < 0.05$ was considered statistically significant.

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Table 2:

Summary of management parameters for septic patients with early versus delayed admission to a tertiary care center.

Management parameters	Direct admit/early transfer (n=239)	Delayed transfer (n=69)	<i>p</i>
Hours from admission ^a to source control	1.0 (−4.8, 6.9)	12.1 (−3.0, 33.7)	*0.009
Hours from admission ^a to antibiotics	0.2 (−2.3, 3.5)	−0.6 (−2.4, 1.8)	0.138
Hours from admission ^a to culture	0.0 (−0.7, 5.1)	−0.2 (−1.0, 1.6)	0.078
Underwent a source control procedure	149 (62.3%)	42 (60.9%)	0.793
Multiple source control procedures	32 (13.4%)	9 (13.0%)	0.941
Source control procedure at OSH	0 (0.0%)	8 (11.6%)	*0.007
Resuscitation within 24h of arrival ^a			
Vasopressor administration	66 (27.6%)	26 (37.7%)	0.135
Volume of crystalloid IVF (L)	4.0 (2.4, 5.7)	3.1 (2.0, 4.8)	*0.048
Total urine output (L)	1.7 (1.1, 2.6)	1.5 (0.9, 2.6)	0.071

^a Admission to or arrival at a tertiary care center. OSH: outside hospital, IVF: intravenous fluid. Data are presented as median (25th percentile, 75th percentile), mean (standard deviation), or n (%).

* $p < 0.05$ was considered statistically significant.

Table 3:

Summary of outcomes for septic patients with early versus delayed admission to a tertiary care center.

Outcomes	Direct admit/early transfer (n=239)	Delayed transfer (n=69)	p
Nosocomial infection	55 (23.0%)	28 (40.6%)	*0.005
Non-infectious complication	64 (26.8%)	24 (34.8%)	0.166
Received dialysis	20 (8.4%)	17 (24.6%)	*<0.001
Days on dialysis	5 (3, 17)	10 (1, 25)	0.848
Discharged on dialysis	6 (2.5%)	6 (8.7%)	0.610
Hospital length of stay (days)	15 (8, 23)	24 (12, 40)	*<0.001
ICU length of stay (days)	6 (3, 14)	14 (6, 24)	*<0.001
ICU-free days	5 (2, 10)	5 (1, 16)	0.787
Days on mechanical ventilation	4 (1, 9)	5 (2, 13)	0.139
Discharge SOFA score	2 (0, 4)	4 (1, 5)	*0.013
CNS SOFA score	0 (0, 0)	0 (0, 0)	0.242
Respiratory SOFA score	0 (0, 0)	0 (0, 0)	0.152
Cardiovascular SOFA score	0 (0, 1)	0 (0, 1)	*0.012
Liver SOFA score	0 (0, 0)	0 (0, 0)	0.914
Renal SOFA score	0 (0, 4)	3 (0, 4)	0.055
Coagulation SOFA score	0 (0, 0)	0 (0, 0)	0.5279
Discharge disposition			
Inpatient mortality	17 (7.1%)	10 (14.5%)	0.056
Another hospital	1 (0.4%)	9 (13.0%)	*<0.001
Home	140 (58.6%)	15 (21.7%)	*<0.001
Hospice	5 (2.1%)	2 (2.9%)	0.692
Long term care facility	31 (13%)	15 (21.7%)	0.072
Subacute rehabilitation facility	13 (5.4%)	4 (5.8%)	0.909
Skilled nursing facility	30 (12.6%)	14 (20.3%)	0.106

ICU: intensive care unit, SOFA: sequential organ failure assessment. Data are presented as mean (standard deviation), median (25th percentile, 75th percentile), or n (%).

*
p<0.05 was considered statistically significant.

Table 4:

Univariable and multivariable predictors of longer hospital length of stay.

Factor	Univariable		Multivariable	
	Coefficient	<i>p</i>	Coefficient	<i>p</i>
Delayed transfer	11.5 (6.7,16.3)	*<0.001	10.0 (5.1, 14.9)	*<0.001
Age	0.1 (−0.1, 0.2)	0.396	-	-
Glasgow Coma Scale score ^a	−0.8 (−1.4, −0.3)	*0.004	-	-
SOFA score ^b	0.9 (0.4, 1.4)	*0.001	-	-
CNS SOFA score	2.4 (1.0, 3.8)	*0.001	1.9 (0.5, 3.2)	*0.008
Liver SOFA score	3.7 (0.8, 6.7)	*0.013	2.5 (−0.3, 5.4)	0.086
APACHE II score ^a	0.5 (0.2–0.7)	*<0.001	-	-
History of stroke	8.2 (−0.2, 16.6)	0.056	-	-
Previous intervention for PVD	−0.4 (−7.0, 6.3)	0.913	-	-
On dialysis	2.2 (−8.2, 12.6)	0.678	-	-

SOFA: sequential organ failure assessment, CNS: central nervous system, PVD: peripheral vascular disease. Coefficient estimates are presented with 95% confidence intervals.

^aExcluded from the multivariable model for collinearity with SOFA score and CNS SOFA score.

^bExcluded from the multivariable model for collinearity with CNS SOFA score and APACHE II score. Multivariable model F-test $p<0.001$.

* $p<0.05$ was considered statistically significant.

Table 5:

Univariable and multivariable predictors of higher SOFA score at the time of discharge.

Factor	Univariable		Multivariable	
	Coefficient	<i>p</i>	Coefficient	<i>p</i>
Delayed transfer	1.1 (0.0, 2.1)	*0.046	0.3 (−0.7, 1.3)	0.580
Age	0.0 (0.0, 0.1)	*0.007	0.0 (0.0, 0.1)	*0.041
Glasgow Coma Scale score ^a	−0.3 (−0.4, −0.2)	*<0.001	-	-
SOFA score ^b	0.4 (0.3, 0.5)	*<0.001	-	-
CNS SOFA score	0.7 (0.4, 1.0)	*<0.001	0.5 (0.2, 0.8)	*<0.001
Liver SOFA score	1.6 (1.0, 2.1)	*<0.001	1.4 (0.8, 2.0)	*<0.001
APACHE II score ^a	0.2 (0.1, 0.2)	*<0.001	-	-
History of stroke	0.8 (−0.9, 2.6)	0.348	-	-
Previous intervention for PVD	1.1 (−0.3, 2.5)	0.127	-	-
On dialysis	1.8 (−0.3, 4.0)	0.089	-	-

SOFA: sequential organ failure assessment, CNS: central nervous system, PVD: peripheral vascular disease. Coefficient estimates are presented with 95% confidence intervals.

^aExcluded from the multivariable model for collinearity with SOFA score and CNS SOFA score.

^bExcluded from the multivariable model for collinearity with CNS SOFA score and APACHE II score. Multivariable model F-test $p<0.001$.

* $p<0.05$ was considered statistically significant.