OBSERVATIONAL STUDY

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Patient and Hospital Characteristics Associated With the Interhospital Transfer of Adult Patients With Sepsis

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IMPORTANCE: The interhospital transfer (IHT) of patients with sepsis to higher-capability hospitals may improve outcomes. Little is known about patient and hospital factors associated with sepsis IHT.

OBJECTIVES: We evaluated patterns of hospitalization and IHT and determined patient and hospital factors associated with the IHT of adult patients with sepsis.

DESIGN: Retrospective cohort study.

SETTING AND PARTICIPANTS: A total of 349,938 adult patients with sepsis at 329 nonfederal hospitals in California, 2018–2019.

MAIN OUTCOMES AND MEASURES: We evaluated patterns of admission and outward IHT between low sepsis-, intermediate sepsis-, and high sepsis-capability hospitals. We estimated odds of IHT using generalized estimating equations logistic regression with bootstrap stepwise variable selection.

RESULTS: Among the cohort, 223,202 (66.4%) were initially hospitalized at high-capability hospitals and 10,870 (3.1%) underwent IHT. Nearly all transfers (98.2%) from low-capability hospitals were received at higher-capability hospitals. Younger age (< 65 yr) (adjusted odds ratio [aOR] 1.54; 95% CI, 1.40–1.69) and increasing organ dysfunction (aOR 1.22; 95% CI, 1.19–1.25) were associated with higher IHT odds, as were admission to low-capability (aOR 2.79; 95% CI, 2.33–3.35) or public hospitals (aOR 1.35; 95% CI, 1.09–1.66). Female sex (aOR 0.88; 95% CI, 0.84–0.91), Medicaid insurance (aOR 0.59; 95% CI, 0.53–0.66), home to admitting hospital distance less than or equal to 10 miles (aOR 0.92; 95% CI, 0.87–0.97) and do-not-resuscitate orders (aOR 0.48; 95% CI, 0.45–0.52) were associated with lower IHT odds, as was admission to a teaching hospital (aOR 0.83; 95% CI, 0.72–0.96).

CONCLUSIONS AND RELEVANCE: Most patients with sepsis are initially hospitalized at high-capability hospitals. The IHT rate for sepsis is low and more likely to originate from low-capability and public hospitals than from high-capability and for-profit hospitals. Transferred patients with sepsis are more likely to be younger, male, sicker, with private medical insurance, and less likely to have care limitation orders. Future studies should evaluate the comparative benefits of IHT from low-capability hospitals.

KEY WORDS: hospital capability; patient transfer; regionalization; rural hospitals; sepsis

Sepsis is a life-threatening multisystem inflammatory illness associated with organ dysfunction for which the incidence has doubled over the past decade (1–4). Further, sepsis is associated with greater than 50% of hospital deaths (5, 6), and costs the U.S. healthcare system $24 billion annually (7). Because hospitals differ in their capabilities for sepsis care, the interhospital transfer (IHT) of patients with sepsis to hospitals with capabilities that may not

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KEY POINTS

Question: What are the patterns of hospitalization and interhospital transfer (IHT) of adult patients with sepsis and what patient and hospital factors are associated with sepsis IHT?

Findings: Among 349,938 patients with sepsis in California in 2018–2019, 223,202 patients (66.4%) were initially hospitalized at high-capability hospitals and 10,870 patients (3.1%) underwent IHT. IHT was more likely among younger, sicker patients with sepsis with early respiratory or renal dysfunction, who have private medical insurance, no care limitations, and who are admitted to low-capability and nonteaching hospitals.

Meaning: Several key patient and hospital characteristics are associated with IHT for sepsis.

be locally available has the potential to improve sepsis outcomes (8–13).

However, the patterns and practices of IHT among patients with sepsis remain largely unstudied, and little is known about which patients are selected for transfer and why. As such, the transfer networks for sepsis remain implicit and based on informal transfer practices (13, 14), in contrast to the explicit transfer networks for other acute, time-sensitive conditions like trauma, stroke, and acute myocardial infarction (15–20).

Nonetheless, the formal, organized transfer of patients from lower-capability to higher-capability hospitals in a regionalized system of care remains an appealing concept (21–23). We previously described the development of the Sepsis-Related Capability (SRC) score, an index derived from six hospital resource use characteristics (bed size, annual volumes of sepsis, major diagnostic procedures, renal replacement therapy, mechanical ventilation, and major therapeutic procedures) that categorized hospitals into high, intermediate, and low capabilities (12). This initial study of patients with sepsis directly admitted into nonfederal hospitals in New York, Massachusetts, and Florida demonstrated that sicker patients with sepsis were primarily concentrated at high sepsis-capability hospitals, that IHT rates for sepsis were very low, and that mortality among patients with sepsis with multiple organ dysfunction who were directly admitted at high-capability hospitals was worse compared with low-capability hospitals (12). However, the mechanisms underlying the concentration of sicker patients with sepsis at high-capability hospitals and the drivers of IHT decisions for patients with sepsis remain unclear.

To improve the quality and safety of sepsis IHT and to implement the best care model for patients with sepsis presenting to less capable hospitals, rigorous comparative studies of IHT are needed. To facilitate such studies, it is imperative to have a broad understanding of patterns and practices of sepsis IHT. The objectives of the current study were to extend analyses of the hospital SRC score to a new state database and: 1) quantify patterns of initial hospitalization for sepsis based on hospital sepsis capability, 2) determine rates and patterns of IHT based on capability, and 3) identify patient and hospital factors associated with higher or lower odds of IHT.

MATERIALS AND METHODS

We performed a retrospective cohort study of adult (≥ 18 yr) sepsis hospitalizations using the 2018 and 2019 California State Inpatient (SID) and Emergency Department Databases, a family of databases developed as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality (24). The California SID was chosen due to its rural/urban diversity, and the availability and consistency of relevant variables. The Human Research Protection Office at Washington University in St. Louis deemed this study exempt due to its use of deidentified administrative data (number 202106079).

We defined sepsis as sepsis diagnosis complicated by organ dysfunction and identified patients with a principal (DX1) or other (DX2-25) *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnostic code for infection and an additional ICD-10 code for acute organ dysfunction, or patients assigned ICD-10 principal or other diagnosis codes for severe sepsis without septic shock (R6520) and severe sepsis with septic shock (R6521) (1, 3). We excluded patients hospitalized at nonacute care facilities (rehabilitation, psychiatry, or drug and alcohol dependency centers) or long-term acute care facilities (25) and “transfer-in” patients whose admission source was designated as another acute care hospital, using previously described methods (26). We then divided the study population into transferred (transferred-out) and nontransferred cohorts.

Patient and Hospital Characteristics

Patient characteristics included demographic information (age, gender, race, and primary insurance payer [Medicare, Medicaid, private, other]), and clinical variables, (Elixhauser Comorbidity Index (27), hospital length of stay, do-not-resuscitate [DNR] status within the first 24 hours of admission, sepsis type [community-acquired vs. nosocomial], number and categories of organ dysfunction, including early respiratory and renal dysfunction). Community-acquired sepsis was defined as a principal diagnosis (DX1) of sepsis, or any higher-order diagnoses (DX2-DX25) that was designated as present at admission. We defined early respiratory dysfunction as new mechanical ventilation for acute respiratory failure and captured patients with acute respiratory failure (J96.0 and all subcodes, J96.2 and all subcodes, J80) plus a mechanical ventilation code (5A1935Z, 5A1945Z, 5A1955Z) on procedure days 0, 1, or 2. We defined early renal dysfunction as new dialysis for acute renal failure and thus identified patients with ICD-10 acute renal failure code (N17 and all subcodes) plus a dialysis procedure code (5A1D and all subcodes) on hospital days 0, 1, or 2. Among transferred patients, the acute renal failure and acute respiratory failure codes had to be from the index admission, whereas the dialysis procedure and mechanical ventilation procedure codes can be from days 0,1, or 2 on the index or subsequent admission. We also calculated home distances for all patients (between patients' residential and index hospital ZIP codes) and travel distances for transferred patients (between sending and receiving hospital ZIP codes). Distances were determined as arc distances between appropriate zip code centroids (28).

Hospital characteristics included urban versus rural location, ownership, teaching status, and the hospital capability category (low, intermediate, and high) based on tertiles of the SRC score—a previously described index derived from six hospital characteristics (bed capacity, annual volumes of sepsis, major diagnostic procedures, renal replacement therapy, mechanical ventilation, and major therapeutic procedures) (12).

Statistical Analysis

We identified patient and hospital characteristics that could potentially influence the probability of interhospital transfer based on literature review and clinical experience and evaluated their relationships with the outcome variable using directed acyclic graphs. We used means with standard deviations and frequencies with percentages for the descriptive statistics for continuous and categorical variables respectively. Comparisons of characteristics of transferred and nontransferred patients were performed using standardized differences (29). A standardized difference of greater than 10% suggests a covariate imbalance. We calculated hospital transfer rates for sepsis by dividing the number of patients with sepsis transferred out of each hospital by the hospital's total sepsis cases.

Next, we evaluated multicollinearity among the variables using Spearman rank correlation and Variance Inflation Factor. To identify patient and hospital characteristics that are predictive of the odds of IHT, the resulting variables were entered into a bootstrap stepwise variable selection process (30). We generated 100 bootstrap samples from the original data and ran a stepwise generalized estimating equation (GEE) logistic regression in each bootstrap sample with thresholds of p value equal to 0.2 for both variable entry and variable elimination. We used GEE to account for the potential clustering of patients within hospitals. Variables that were clinically relevant or present in at least 80% of 100 runs were chosen to construct the multivariable logistic regression model. We estimated two GEE models: The first model included age, sex, race, primary payer, home distance, DNR status, number of organ dysfunctions, hospital capability category, profit status, and teaching status. In the second model, the number of organ dysfunctions was replaced with early respiratory dysfunction and early renal dysfunction. We also ran a sensitivity model that included all variables to ensure that the estimates were not biased by the variable selection processes. Exchangeable correlation structure was used for all GEE models.

Unadjusted and adjusted odds ratios (aOR) with 95% CIs, and corresponding p values were reported for IHT. All hypothesis tests were two-sided with a significance alpha level of 0.05. All analyses were performed with SAS Enterprise Guide, Version 7.15 (SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of Transferred and Nontransferred Patients With Sepsis

Over a 2-year study period, we identified 349,938 index adult sepsis hospitalizations among whom 10,870 patients (3.1%) were transferred (**Fig. 1**). Among the study cohort, 47.5% were female patients, and 92.4% had community-acquired sepsis. The most prevalent organ dysfunctions were related to the cardiovascular (65.2%), renal (56.1%), and respiratory (41.6%) systems. Approximately 40% had a single organ dysfunction. A majority (65.6%) had Medicare as their primary payer, and 17.6% had DNR orders within 24 hours of admission (**Table 1**). Compared with nontransferred patients, transferred patients were more likely to be younger, with multiple organ dysfunction, especially early renal and early respiratory dysfunction, more likely to have private insurance, but less likely to have DNR status. The median (interquartile range [IQR]) hospital length of stay for transferred patients at the index hospital was 4 days (2–10).

Characteristics of Patients With Sepsis According to Admitting Hospital Capability Category

Patient characteristics according to the admitting hospital capability category are outlined in **Supplemental Table 1** (http://links.lww.com/CCX/B276). About two-thirds (66.4%) of the cohort of patients with sepsis were directly admitted into high-capability hospitals. Compared with low-capability hospitals, high-capability hospitals admitted a higher proportion of Black and a lower proportion of White patients with sepsis and a lower proportion of patients with community-acquired sepsis. Patients admitted into high-capability hospitals were also more likely to have three or more organ dysfunctions and higher median home distances from the admitting hospital.

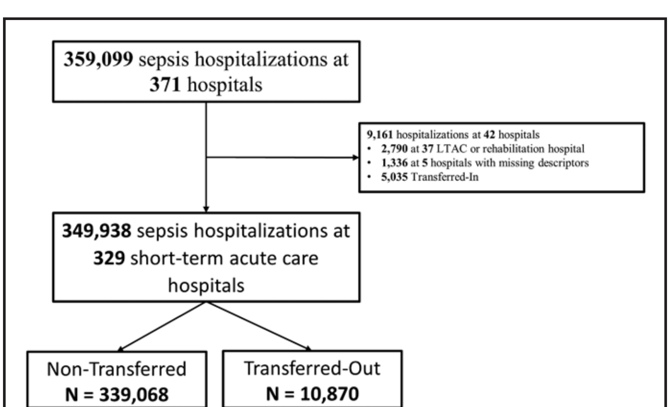

Figure 1. Derivation of the sepsis study cohort. LTAC = long-term acute care.

Distribution and Patterns of Interhospital Transfer Between Hospital Capability Categories

The median (IQR) hospital-level transfer rate for sepsis was 3.3% (1.8–5.6), with low variability in IHT rates (variance, 5.3%; 95% CI, 4.6–6.0). The distribution of transfer rates across hospitals is illustrated in **Figure 2**. On average, 6.6% of patients with sepsis at low-capability hospitals, 3.7% of patients at intermediate-capability hospitals, and 2.4% at high-capability hospitals were transferred. The interhospital sepsis transfer patterns are illustrated in **Figure 3**. Among patients with sepsis transferred to low-capability hospitals, approximately three-quarters (73.8%) were transferred to high-capability hospitals, whereas a quarter (24.4%) were transferred to intermediate-capability hospitals (**Fig. 3*A***). Similarly, 73% of patients with sepsis transferred out of intermediate-capability hospitals were transferred into high-capability hospitals, whereas 23.3% were transferred into other intermediate-capability hospitals. Among patients with sepsis received in transfer at high-capability hospitals, nearly half (48.1%) were transferred from other high-capability hospitals. Sepsis transfers into low-capability hospitals were minimal (**Fig. 3*B***).

Predictors of Interhospital Transfer

The predictors of IHT among patients with sepsis are outlined in **Table 2** and **Figure 4**. Compared with patients with sepsis 80 years and older, the odds of IHT were higher for the 18–64 (aOR 1.54; 95% CI, 1.40–1.69) and 65–79 age groups (aOR 1.44 [1.35–1.53]). Female patients were less likely to be transferred than male patients (aOR 1.54 [1.40–1.69]), and patients with public insurance were less likely to be transferred than patients with private insurance (aOR Medicare, 0.69 [0.62–0.76]; Medicaid, 0.59 [0.53–0.66]).

The odds of IHT increased by 22% for each additional organ dysfunction (aOR 1.22 [1.19–1.25]), which in models with specific organ systems was driven by early renal (aOR 2.42 [2.20–2.67]) and early respiratory

TABLE 1.
Patient Characteristics by Interhospital Transfer Status

	Overall, *n* = 349,938	Transferred, *n* = 10,870	Nontransferred, *n* = 339,068	Comparison
Age, yr, mean (SD)	67.7 (15.7)	64.8 (15.6)	67.8 (15.7)	0.19
Female, *n* (%)	166,087 (47.5)	4,701 (43.2)	161,386 (47.6)	0.09
Race, *n* (%)				0.07
White	184,599 (52.8)	5,672 (52.2)	178,927 (52.8)	
Black	31,656 (9.00)	1,174 (10.8)	30,482 (9.00)	
Hispanic	80,125 (22.9)	2,473 (22.8)	77,652 (22.9)	
Other	51,180 (14.6)	1,462 (13.4)	49,718 (14.7)	
Comorbidity Index, mean (SD)	6.49 (2.91)	6.48 (2.91)	6.54 (2.84)	0.02
Severe sepsis code R6520, *n* (%)	214,778 (61.4)	7,088 (65.2)	207,690 (61.3)	0.08
Community sepsis	323,507 (92.4)	9,844 (90.6)	313,663 (92.5)	0.07
Organ dysfunction, *n* (%)				
Cardiovascular	228,077 (65.2)	7,527 (69.2)	220,550 (65.0)	0.09
Respiratory	145,427 (41.6)	5,376 (49.5)	140,051 (41.3)	0.16
Neurologic	55,700 (15.9)	1,720 (15.8)	53,980 (15.9)	0.00
Hematologic	56,971 (16.3)	2,077 (19.1)	54,894 (16.2)	0.08
Hepatic	19,038 (5.40)	919 (8.50)	18,119 (5.30)	0.12
Renal	196,327 (56.1)	6,373 (58.6)	189,954 (56.0)	0.05
Number of organ dysfunction, *n* (%)[a]				0.20
Any 1	137,238 (39.2)	3,428 (31.5)	133,810 (39.5)	
Any 2	115,457 (33.0)	3,584 (33.0)	111,873 (33.0)	
Any 3	64,400 (18.4)	2,431 (22.4)	61,969 (18.3)	
Any 4+	32,843 (9.40)	1,427 (13.1)	31,416 (9.30)	
Early mechanical ventilation	43,298 (12.4)	2,885 (26.5)	40,413 (11.9)	0.23
Early dialysis	7,432 (2.10)	728 (6.70)	6,704 (2.00)	0.38
Do-not-resuscitate	61,705 (17.6)	891 (8.20)	60,814 (17.9)	0.29
Primary payer (%)				0.18
Medicare	61,100 (17.5)	6,397 (58.9)	223,180 (65.8)	
Medicaid	229,577 (65.6)	1,998 (18.4)	59,102 (17.4)	
Private insurance	8,388 (2.40)	2,240 (20.6)	48,550 (14.3)	
Other	50,790 (14.5)	232 (2.10)	8,156 (2.40)	
Home distance (miles)	5.5 (2.80–11.4)	5.0 (2.30–11.5)	5.5 (2.80–11.4)	$p = 0.06$
Hospital LOS 1, d, median (IQR)[a]	5 (3–10)	4 (2–10)	5 (3–10)	$p < 0.001$
Hospital LOS 2, d, median (IQR)[b]	NA	7 (4, 14)	NA	
Travel distance (miles)[c]	NA	13.2 (6.8, 29.0)	NA	

IQR = interquartile range, LOS = length of stay.

[a]Values from index hospitalization for transferred patients.

[b]Values from the index and subsequent hospitalization for transferred patients.

[c]Values for transferred patients only.

Comparisons represent standardized differences except where otherwise stated.

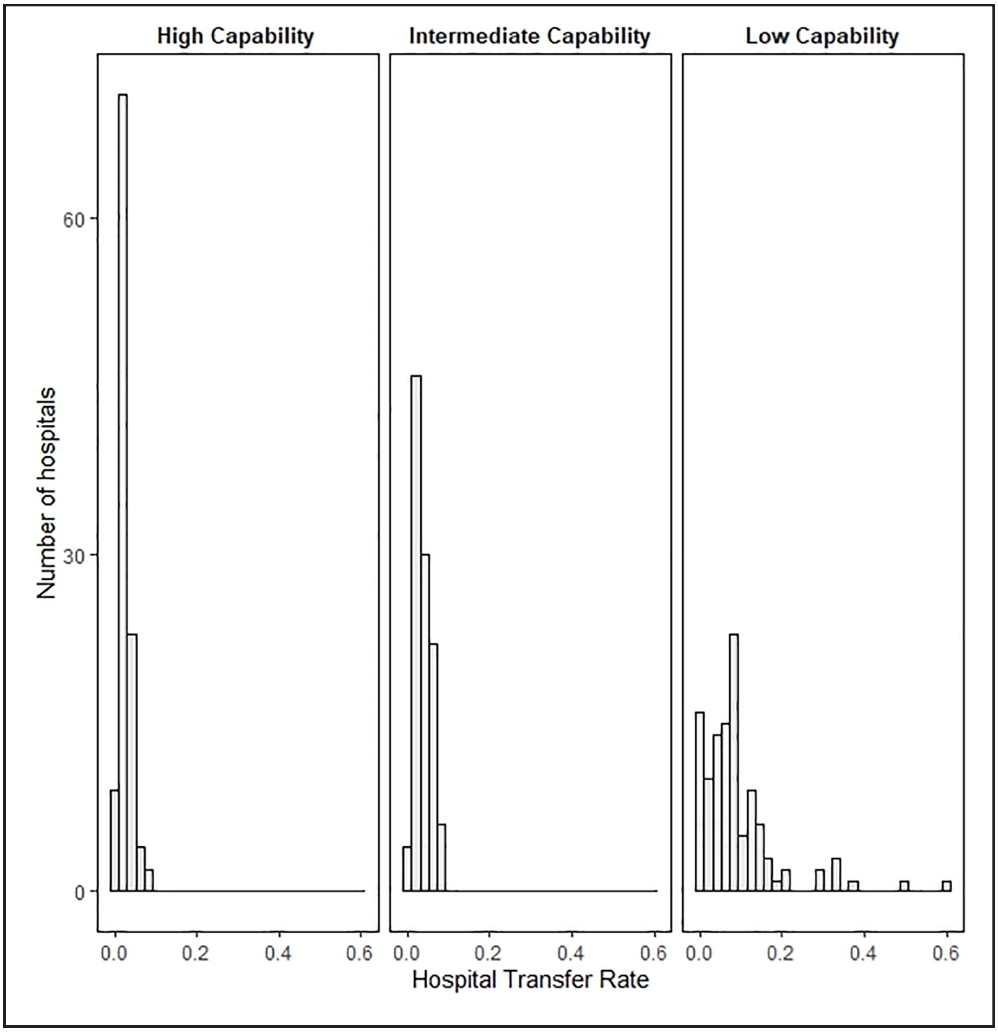

Figure 2. Distribution of hospital transfer rates for sepsis. The distributions of hospital transfer rates at the hospital level, for high-capability, intermediate-capability hospitals, and low-capability hospitals.

dysfunction (aOR 2.35 [2.20–2.50]). Conversely, the odds of transfer were 50% lower among patients with sepsis with DNR orders (aOR 0.48 [0.45–0.52]) and for patients who resided closer to the hospital of admission (aOR < 10 miles vs. > 10 miles, 0.92 [0.87–0.97]).

Compared with private for-profit hospitals, public hospitals were 35% more likely to transfer their patients with sepsis (aOR 1.35 [1.09–1.66]). Likewise, the odds of transfer were higher for patients admitted into intermediate-capability hospitals (aOR 1.54 [1.34–1.78]) and low-capability hospitals (aOR 2.79 [2.33–3.35]), compared with high-capability hospitals. The odds of transfer were lower at teaching compared with nonteaching hospitals (aOR 0.83, [0.72–0.96]). The sensitivity analysis model yielded comparable results (**Supplemental Table 2**, http://links.lww.com/CCX/B276). Model characteristics and the proportion of bootstrap samples in which each predictor variable was retained are outlined in **Supplemental Table 3** (http://links.lww.com/CCX/B276).

DISCUSSION

In this study of adult sepsis hospitalizations in California over a 2-year period, two-thirds of the cohort of patients with sepsis were directly admitted into high-capability hospitals. Low-capability hospitals accounted for less than 10% of direct sepsis hospitalizations but accounted for the largest proportion of transferred patients, almost exclusively to higher-capability hospitals. Younger age and increasing organ dysfunction, especially early renal and respiratory dysfunction were associated with higher odds of transfer, whereas female sex, public medical insurance, DNR order, and shorter distance from patient's residence to hospital were associated with lower odds of transfer. At the hospital level, admission to public, nonteaching, or low-capability hospitals was associated with higher odds of sepsis IHT.

The rates of sepsis IHT in California are similar to findings in a prior study of sepsis hospitalizations at nonfederal hospitals in New York, Florida, and Massachusetts (12). The proportion of patients with sepsis transferred out of low-capability hospitals (66%) is also consistent with prior literature where 60% of patients with sepsis presenting to rural hospitals in Iowa underwent IHT (31). The low IHT rate is potentially explained by the patterns of hospitalization whereby most patients with sepsis in the California cohort who were generally sicker, with higher proportions of multiple organ dysfunction, were directly admitted into high-capability hospitals. These hospitalization patterns were also observed in

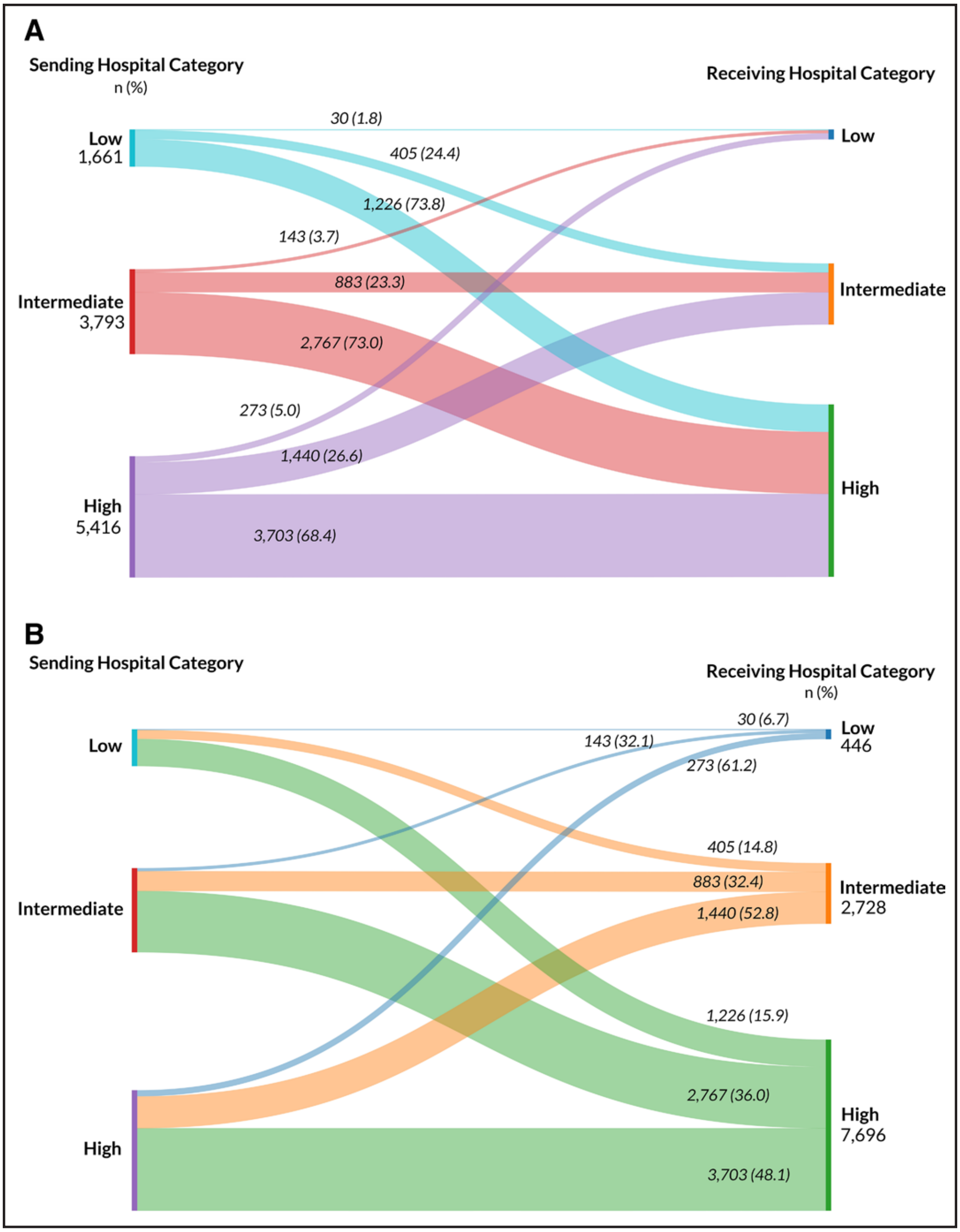

Figure 3. Patterns of interhospital transfer of patients with sepsis by hospital capability. The patterns of interhospital transfer between hospitals of different capability categories are stratified by (**A**) proportions transferred out and (**B**) proportions received in transfer.

the prior study of patients with sepsis in New York, Florida, and Massachusetts (12). The concentration of sicker patients at high-capability hospitals supports the hypothesis that sepsis care may already be regionalized to an extent. Our finding is that patients directly admitted to high-capability hospitals (that are more likely to be in urban densely populated areas) are more geographically distant from their places of residence than patients admitted to low-capability hospitals (more likely to be in rural less densely populated areas) sheds some light on the potential mechanism of de facto regionalization. Financial factors, transportation factors, perceived quality, and convenient access to care impact patients' hospital choices for care (32, 33). Thus these patients may have bypassed closer hospitals by choice, or through selective referral by emergency medical services, or may have been transferred directly to the admitting hospital emergency department (ED) from a local hospital ED, a hypothesis that requires further study.

Our study also sheds light on the patterns of sepsis transfer. Low-capability hospitals accounted for the largest proportion of transferred patients relative to the number of direct sepsis hospitalizations. Although nearly all sepsis IHTs out of low-capability hospitals appeared to be appropriate in higher-capability hospitals, a sizeable proportion of transfers out of intermediate and high-capability hospitals were received into hospitals of similar or lower-capability categories. Although these findings cannot be meaningfully interpreted without data on the indications for transfer, transfers out of low-capability hospitals may represent patients in

TABLE 2.
Predictors of Interhospital Transfer Among Patients With Sepsis

Predictors	Model 1	Model 2
Age category		
80+	Reference	Reference
65–79	1.44 (1.35–1.53)	1.36 (1.28–1.44)
18–64	1.54 (1.40–1.69)	1.39 (1.26–1.52)
Female sex	0.88 (0.84–0.91)	0.89 (0.85–0.92)
Race category		
White	Reference	Reference
Black	1.11(1.01–1.22)	1.07 (0.98–1.17)
Hispanic	0.93 (0.87–0.99)	0.92 (0.87–0.98)
Other	0.94 (0.88–1.02)	0.93 (0.86–1.00)
Primary payer		
Private insurance	Reference	Reference
Medicare	0.69 (0.62–0.76)	0.68 (0.62–0.75)
Medicaid	0.59 (0.53–0.66)	0.58 (0.52–0.65)
Other	0.59 (0.50–0.70)	0.58 (0.49–0.69)
Home distance (< 10 miles)	0.92 (0.87–0.97)	0.92 (0.86–0.97)
Do-not-resuscitate status	0.48 (0.45–0.52)	0.50 (0.46–0.53)
Elixhauser comorbidity score	[b]	[b]
Number of organ dysfunction	1.22 (1.19–1.25)	[a]
Early respiratory dysfunction	[a]	2.35 (2.20–2.50)
Early renal dysfunction	[a]	2.42 (2.20–2.67)
Sending hospital capability		
High	Reference	Reference
Intermediate	1.54 (1.34–1.78)	1.60 (1.39–1.84)
Low	2.79 (2.33–3.35)	3.11 (2.62–3.68)
Hospital profit status		
For-profit	Reference	Reference
Government, nonfederal	1.35 (1.09–1.66)	1.30 (1.05–1.62)
Nonprofit	0.96 (0.81–1.14)	1.00 (0.84–1.18)
Hospital teaching status		
Nonteaching	Reference	[b]
Teaching	0.83 (0.72–0.96)	[b]
Hospital location		
Rural	[b]	[b]
Urban	[b]	[b]

[a]Not included in model.
[b]Excluded from model based on bootstrap parameters.
All values are odds ratios with 95% CIs.

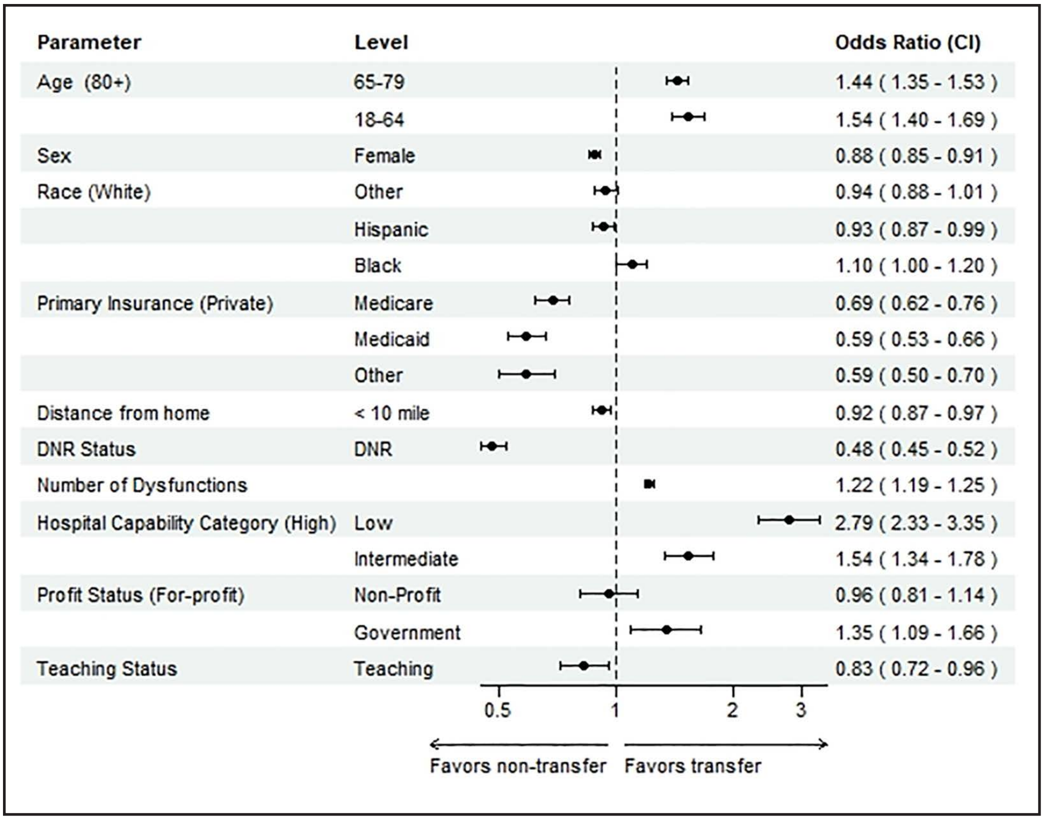

Figure 4. Adjusted odds ratios of predictors of sepsis interhospital transfer. The reference group for categorical variables is indicated in parentheses. DNR = do-not-resuscitate.

need of unique specialty services and hospital capabilities that are not locally available (34, 35). Likewise, transfers out of intermediate and high-capability hospitals may represent patients being moved to hospitals closer to home. It is also possible the hospital capability designation may not completely differentiate all hospital capabilities. For example, a patient may have been transferred to a high-capability hospital to avail of extracorporeal membrane oxygenation, from a high-capability hospital without such capability.

There is little knowledge of the selection process for transferring critically ill patients in general and patients with sepsis in particular. Qualitative studies of patient and provider perspectives have demonstrated poor consensus between patients, transferring physicians, and receiving physicians (14, 35, 36). Our study demonstrated that the typical transferred patient with sepsis is younger, male, resides farther away from the admitting hospital, has private medical insurance, has more organ dysfunctions, and has no care limitation orders. Some of these findings are consistent with prior literature.

Patients who live closer to the admitting hospitals are often faced with the dilemma of whether gains in outcome warrant interhospital transfer given losses in convenience and family separation and may therefore decline IHT in preference for local care (37, 38). We found that patients with sepsis who were older or who had limits on life-sustaining treatments were less likely to be transferred. A prior study demonstrated reduced odds of transfer among older mechanically ventilated critically ill patients (26). This suggests that older, critically ill patients generally receive less aggressive care than their younger counterparts (39) and that limitations on life-sustaining treatments may considerably and perhaps appropriately weigh on the transfer decision-making process (40).

Our finding that early renal dysfunction and early respiratory dysfunction were associated with increased odds of sepsis IHT has not been described before. This suggests that the need for organ replacement or organ support therapy, capabilities that are less available or lacking at low-capability hospitals may underlie sepsis IHT (41, 42). These low-capability hospitals, inclusive of all critical access hospitals are mostly rural and nonteaching hospitals (12). Indeed, we also observed in this study that admission into a nonteaching or low-capability hospital was associated with higher odds of transfer.

The pattern of reduced odds of IHT for female patients with sepsis has also been observed in prior work on IHT for patients with stroke and other common medical diagnoses (43, 44). The etiology of this disparity is unclear, although it could relate to implicit bias. Women are also less likely to receive intervention for ST-elevation myocardial infarction than men (45), which may suggest that clinicians are less aggressive in general when treating women with critical illness. Whether this is due to a lack of recognition of the severity of disease or a lack of belief in the benefit of treatment or transfer is unknown. Lower rates of transfer could also relate to patient preference, although we have no a priori reason to believe that preferences would differ by sex or gender.

Lastly, we observed that patients with sepsis who had public insurance (Medicare or Medicaid) were less likely to be transferred in comparison to patients with private insurance. However, we found no difference in the odds of transfer out of nonprofit hospitals in relation to for-profit hospitals. Other studies have shown that the likelihood of IHT is increased by private commercial insurance, and nonprofit status of the sending hospital (26, 46). These findings suggest that financial reimbursement considerations may influence the transfer decision-making process.

Our study has several strengths and limitations. We provide novel insights into the patterns and predictors of IHT using a large sample size of patients with sepsis and hospitals. The study's limitations include the potential inaccuracies of billing codes used in identifying diagnoses, residual confounding from the use of administrative claims data, and limited generalizability to other U.S. states.

CONCLUSIONS

Sicker patients with sepsis with more organ dysfunctions are admitted more to high-capability hospitals. Sepsis IHT rates were low among our study population. Low-capability hospitals accounted for the greatest proportion of transferred patients relative to the proportion of admitted patients. Patient age, gender, need for organ support therapies, presence of care limitation orders, and patient's insurance status appear to factor into the transfer decision-making process. Further studies are required to evaluate the mechanisms of concentration of sicker patients at high-capability hospitals and the comparative benefits of IHT from low-capability hospitals.

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