Understanding the association between admission source and in-hospital delirium: a cross-sectional study

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ABSTRACT

Patients admitted via interhospital transfer (IHT) experience increased risk-adjusted mortality, adverse events, length of stay, and discharge to facility; however, the etiology is not well understood. We hypothesize that IHTs are more likely to experience in-hospital delirium as compared with admissions to the hospital via the emergency department (ED) and clinic. This is a cross-sectional study of all adult admissions to medical, surgical, neurological, and obstetrics and gynecology services at an academic medical center who were screened for delirium between August 2018 and January 2020. Unit of analysis was admission source (IHT vs ED vs clinic) as the independent variable and the primary outcome was in-hospital delirium, assessed with initial brief confusion assessment method (bCAM) screening. 30,100 hospitalizations were included in this study with 3925 admissions (13.0%) screening positive for delirium at the initial bCAM assessment. The prevalence of delirium was much higher in IHTs at 22.3% (1334/5971) when compared with clinic at 5.8% (244/4214) and ED at 11.8% (2347/19,915) admissions. Multivariable logistic regression adjusting for demographics and comorbidities showed that IHT admissions had higher odds (OR 1.91, 95% CI 1.74 to 2.10) and clinic admissions had lower odds (OR 0.56, 95% CI 0.48 to 0.64) of in-hospital delirium compared with ED admissions. Increased odds of delirium in IHT admissions may contribute to the observed increased length of stay, discharge to facility, and mortality. These results emphasize the importance of routine screening and possible intervention prior to patient transfer.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Interhospital transfers and delirium are both independently associated with poor hospital outcomes including increased mortality, discharge to a facility and length of stay.

WHAT THIS STUDY ADDS

⇒ Interhospital transfers experienced significantly higher percentages of in-hospital delirium (22.3%) than admissions from the emergency department (11.8%) (p<0.0001).

⇒ Interhospital transfers have 1.91 times the odds of in-hospital delirium when compared with admissions through the emergency department, after adjusting for patient-level characteristics and exposures (OR 1.91, 95% CI 1.74 to 2.10).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The risk associated with the transfer process may alert hospital leadership to establish algorithmic intervention prior to transfer and/or other means for tertiary care, such as telemedicine.

INTRODUCTION

Interhospital transfer (IHT) is defined as the transfer of hospitalized patients between acute care hospitals.[1] Multiple studies have demonstrated worse outcomes for patients admitted to hospitals following an IHT compared with patients admitted directly through the emergency department (ED); specifically, increased risk-adjusted mortality, adverse events, cost, discharge to a facility, and length of stay (LOS).[2–4] The etiology of these poor outcomes is neither well understood nor described in the literature.

Delirium is a state of confusion that can last hours to days and can be costly and fatal.[5] Delirium is common, life threatening and expensive and thus has been used as a patient safety marker for quality improvement.[5] The diagnosis of delirium is made with the combination of an acute change in mental status and inattention. It can be identified by physician examination or by using one of many validated screening tools.[5 6] A large systematic review has shown that delirium occurs anywhere from 11% to 42% in hospitalized patients.[7] Despite non-detection rates as high as 33%–66%, delirium has also been associated with increased risk of mortality, discharge to a facility and LOS.[5 8] Risk factors for delirium include: history of dementia, low

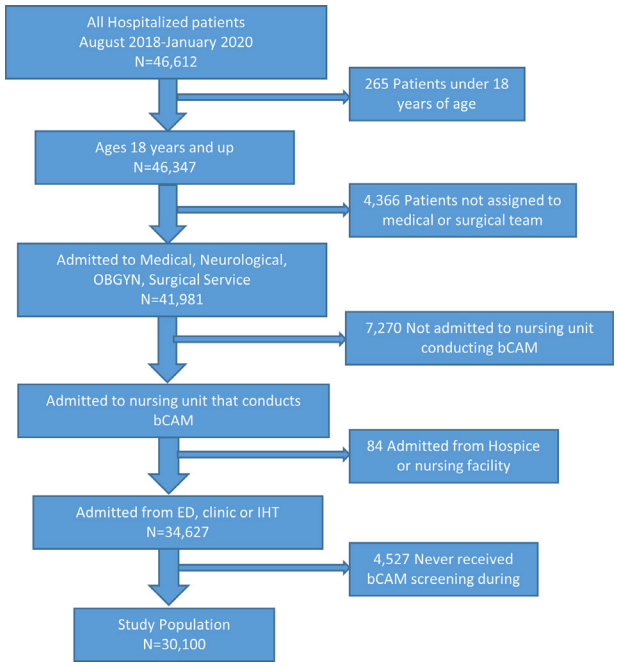

Figure 1 Cohort selection. bCAM, brief confusion assessment method; ED, emergency department; IHT, interhospital transfer; OBGYN, obstetrics and gynecology.

education level, advanced age, high comorbidity burden, visual impairment, depression, alcohol abuse, malnutrition and home use of benzodiazepines or opiates.[9] In addition, many comorbid diagnoses may play a role in delirium risk including infection, electrolyte disturbances, withdrawal, or central nervous system insults.[9]

To our knowledge, the relationship between admission source, specifically admission via IHT, and in-hospital delirium has not been evaluated. We hypothesize that IHTs are more likely to experience in-hospital delirium compared with admissions through the ED or clinic. The objective of our study is to evaluate whether admission source, specifically IHT, is independently associated with in-hospital delirium.

MATERIALS AND METHODS

Study population

This cross-sectional study was conducted at the Medical University of South Carolina (MUSC), an academic, tertiary referral center located in Charleston, South Carolina.

This data set included hospitalizations of adults ≥18 years of age screened for delirium between August 1, 2018 and January 31, 2020. Admissions to the medical (general medicine, cardiology, gastroenterology, hepatology, pulmonary, hematology/oncology), intensive care, surgical, neurological and obstetrics/gynecology services were included (figure 1). All data were obtained from the MUSC Data Warehouse.

Outcome measures

In-hospital delirium was the primary outcome. Delirium was defined using the brief confusion assessment method (bCAM) in the non-intensive care unit (ICU) setting or CAM-ICU in the ICU setting. Both screening tools are assigned twice daily on every admission. Literature has shown that the CAM-ICU screening tool is 93%–100% sensitive and 89%–100% specific with high inter-rater reliability (κ=0.79–0.96).[10 11] The bCAM screening tool is 76% sensitive and 96% specific with high inter-rater reliability (κ=0.87).[12] Both CAM-ICU and bCAM take less than 1 minute to perform and have been validated in the literature.[10–12] The bCAM and CAM-ICU results were documented in the same location in the electronic medical record as either positive or negative. Over the period of analysis, there was high nursing compliance with 87% of patients receiving delirium screen at least once during their hospitalization. Seventy-five percent of screened patients had their initial bCAM screening within 72 hours of admission.

The independent variable was admission source coded as an unordered categorical variable (IHT vs ED vs clinic).

Covariates

Age group, gender, marital status, race, poverty status, distance to MUSC and admitting service were coded as binary or categorical variables. Distance to MUSC greater than 50 miles from home zip code address was coded as a binary variable. Zip code was used as a surrogate for socioeconomic status and poverty. The admitting service was defined as the service in which the attending physician billed for the admission (medicine, surgery, neurology, obstetrics and gynecology (OBGYN), ICU) and medicine service was the reference category. Other covariates known to be risk factors for delirium were included as categorical variables: medications ordered during hospitalization (benzodiazepines, antipsychotics, anticholinergics and opiates), falls, and comorbidities.

Statistical analysis

Univariate analyses were performed to identify variables associated with admission source, the unit of analysis. For categorical variables, Pearson's χ^2 test was performed to determine difference in proportions between ED, clinic and IHT admissions. For continuous variables, analysis of variance was used to analyze difference in means comparing admissions through the ED, clinic and IHT. Four multivariable regression analyses were performed to examine the association between admission source and in-hospital delirium. The aforementioned covariates were strategically added based on clinical judgement to adjust for confounding. Model 1: admission source (IHT vs ED vs clinic). Model 2: admission source, admitting service. Model 3: model 2 plus age group, gender, race, marital status, distance to MUSC, and poverty. Model 4: model 3 plus medications, falls and comorbidities. Receiver operating characteristic curves were created by plotting sensitivity against (1-specificity) to assess the accuracy of the prediction model. The area under the curve (AUC) was used to assess the quality of chosen predictors. SAS V.9.4 (SAS Institute) was used for statistical analysis and significance was determined at $\alpha=0.05$ level.

RESULTS

A total of 30,100 hospitalizations were included in this study (figure 1). Of these, 5971 (19.8%) were admissions via IHT, 19,915 (66.2%) were admissions via the ED, and 4214

Table 1 Demographics

	ED n=19,915	Clinic n=4214	IHT n=5971	P value
Age (mean±SD)	58.1±17.4	57.5±16.1	58.6±17.2	0.0008
Age group (%)				<0.0001
<50	29.3	28.3	28.7	
50 to <65	29.8	33.4	29.2	
65 to <80	31.9	32.5	32.6	
80+	9.0	5.8	9.4	
Gender (%)				<0.0001
Male	48.0	49.2	54.0	
Female	52.0	50.9	46.0	
Race (%)				<0.0001
Black	37.0	29.7	33.6	
Other	3.2	3.2	4.7	
White	59.9	67.1	61.7	
Marital status (%)				<0.0001
Married	46.6	55.1	47.9	
Single	19.7	17.0	20.6	
Other	33.7	27.9	31.5	
Distance to MUSC (>50 miles) (%)	34.6	58.2	76.0	<0.0001
Poverty (%)	30.3	27.1	30.2	0.0002
CCI score (mean±SD)	4.1±3.2	4.1±3.1	4.3±3.1	<0.0001
CCI score (%)				<0.0001
0	12.8	10.1	10.0	
1–2	25.0	25.6	22.4	
3–4	24.4	27.7	26.0	
5+	37.8	36.6	41.7	
Medication exposure (%)				
Antipsychotic	30.4	33.6	29.1	<0.0001
Anticholinergic	63.3	68.9	59.6	<0.0001
Opioid	81.9	86.1	82.3	<0.0001
Benzodiazepine (anytime)	38.3	43.2	49.5	<0.0001
ICU during hospitalization (%)	18.1	11.9	40.2	<0.0001
Group of specialty (%)				<0.0001
ICU	0.3	0.4	0.5	
General Internal Medicine	50.5	40.4	45.1	
Neurology	13.8	11.5	24.6	
OBGYN	1.9	3.3	2.1	
Surgery	33.5	44.4	27.7	
Alcohol abuse	7.8	3.0	7.9	<0.0001
Dementia	4.9	2.4	5.0	<0.0001
Myocardial infarction	12.4	8.6	16.6	<0.0001
Congestive heart failure	19.4	16.2	23.1	<0.0001
Cerebrovascular disease	9.0	7.7	19.9	<0.0001
Chronic pulmonary disease	21.1	19.4	20.0	0.0185
Peptic ulcer disease	1.7	1.0	2.5	<0.0001
Uncomplicated diabetes	10.9	9.7	11.2	0.0347
Complicated diabetes	19.1	17.6	19.6	0.0341
Hemiplegia	3.3	1.5	9.0	<0.0001
Renal disease	20.3	20.2	19.8	0.6385
Cancer	19.5	29.3	19.1	<0.0001
AIDS/HIV	1.4	1.4	1.1	0.2560
Liver disease	7.9	7.1	9.9	<0.0001

CCI, Charlson Comorbidity Index; ED, emergency department; ICU, intensive care unit; IHT, interhospital transfer; MUSC, Medical University of South Carolina; OBGYN, obstetrics and gynecology.

(14.0%) were admissions via clinic. A total of 3925 (13.0%) of hospital admissions screened positive for delirium during the initial delirium screening. Demographic information comparing the groups based on admission source is shown in table 1.

Table 2 Outcomes

	ED n=19,915	Clinic n=4214	IHT n=5971	P value
Primary outcome				
bCAM positive (%)	11.8	5.8	22.3	<0.0001
Secondary outcome				
Discharge to a facility (%)	13.0	5.8	22.8	<0.0001
LOS (mean±SD)	5.7±6.3	5.6±7.2	8.9±9.3	<0.0001
Mortality (%)	0.8	0.6	1.9	<0.0001

bCAM, brief confusion assessment method; ED, emergency department; IHT, interhospital transfer; LOS, length of stay.

IHT admissions were more likely to be male, live greater than 50 miles from MUSC, have a higher Charlson Comorbidity Index score, have a benzodiazepine ordered and be admitted to neurology services when compared with admissions through the ED. In contrast, admissions from clinics were more likely to be under the age of 80, White, have both anticholinergic and opiate medications ordered and be admitted to the surgical services when compared with the admissions through the ED.

Admissions screening positive for delirium, compared with those without delirium, were more likely to be older in age (>65), male, Black, have low socioeconomic status, comorbidities, medication orders (benzodiazepines, antipsychotics, anticholinergics and opiates) and admitted to the ICU during the hospitalization (online supplemental table). Furthermore, admissions to the medicine service had higher odds of delirium when compared with neurology, OBGYN and surgical teams. However, the ICU posed the highest odds of delirium over any other admission service.

Admissions via IHT experienced significantly higher percentages of in-hospital delirium (22.3%) than admissions from the ED (11.8%) or clinic (5.8%) (p<0.0001) (table 2). Regarding secondary outcomes of discharge to a facility, LOS, and mortality, there were statistically significant differences based on admission source. As many as 22.8% of admissions through IHT were discharged to a facility versus 5.8% from clinic and 13.0% from the ED (p<0.0001). LOS for IHT was 8.9±9.3 days compared with 5.6±7.2 for clinic and 5.7±6.3 for ED admissions (p<0.0001). Finally, 1.9% of admissions through IHT experienced in-hospital mortality compared with 0.6% for clinic and 0.8% for ED admissions (p<0.0001) (table 2).

Based on logistic regression analysis, compared with ED admissions, admissions via IHT had 2.15 times the odds of in-hospital delirium (model 1: OR 2.15, 95% CI 2.00 to 2.32, p<0.0001). After adjusting for admitting service in model 2, admissions through IHT had 2.04 times the odds of in-hospital delirium compared with admissions through the ED (model 2: OR 2.04, 95% CI 1.89 to 2.20, p<0.0001). The estimated odds of in-hospital delirium for IHT admissions in model 3, which additionally adjusted for age group, gender, race, marital status, distance to MUSC and poverty, was 2.24 times the odds compared with ED admissions (model 3: OR 2.24, 95% CI 2.06 to 2.44, p<0.0001). The final model, which additionally adjusted for medications, falls and comorbidities, found that IHT

Table 3 Clinical variables associated with delirium used in the multivariable logistic regression model

	OR	95% CI	P value
Admission source (ref: ED)			
Clinic	0.557	0.481 to 0.644	<0.0001
IHT	1.912	1.741 to 2.099	<0.0001
Group of specialty (ref: General Internal Medicine)			
ICU	3.164	1.900 to 5.267	<0.0001
Neurology	0.992	0.881 to 1.116	0.8903
OBGYN	0.422	0.286 to 0.624	<0.0001
Surgery	0.754	0.682 to 0.834	<0.0001
Age group (ref: 18–49)			
50–64	1.438	1.287 to 1.607	<0.0001
65–79	2.018	1.799 to 2.264	<0.0001
80+	2.8	2.405 to 3.259	<0.0001
Female	0.996	0.921 to 1.077	0.9153
Race (ref: White)			
Black	1.182	1.083 to 1.291	0.0002
Other	1.155	0.939 to 1.423	0.1733
Marital status (ref: Married)			
Other	1.151	1.042 to 1.272	0.0056
Single	1.236	1.122 to 1.362	<0.0001
Distance_MUSC≥50	0.882	0.809 to 0.962	0.0045
Poverty	1.009	0.928 to 1.096	0.8362
Antipsychotic	3.220	2.977 to 3.483	<0.0001
Anticholinergics	0.826	0.761 to 0.897	<0.0001
Opioid	1.032	0.931 to 1.145	0.5481
Benzodiazepine	2.422	2.235 to 2.625	<0.0001
Falls	2.773	2.107 to 3.648	<0.0001
Alcohol abuse	1.728	1.516 to 1.971	<0.0001
Dementia	3.922	3.431 to 4.484	<0.0001
Myocardial infarction	1.284	1.157 to 1.425	<0.0001
Congestive heart failure	1.146	1.039 to 1.265	0.0067
Cerebrovascular disease	2.377	2.132 to 2.650	<0.0001
Chronic pulmonary disease	1.020	0.930 to 1.119	0.6776
Peptic ulcer disease	1.392	1.084 to 1.789	0.0096
Uncomplicated diabetes	0.936	0.826 to 1.061	0.2998
Complicated diabetes	1.206	1.091 to 1.333	0.0002
Hemiplegia	2.494	2.144 to 2.901	<0.0001
Renal disease	1.042	0.939 to 1.155	0.4409
Cancer	0.896	0.811 to 0.989	0.0302
AIDS/HIV	1.308	0.960 to 1.783	0.089
Liver disease	1.589	1.398 to 1.807	<0.0001

ED, emergency department; ICU, intensive care unit; IHT, interhospital transfer; MUSC, Medical University of South Carolina; OBGYN, obstetrics and gynecology.

admissions had 1.91 times the odds of in-hospital delirium than ED admissions (model 4: OR 1.91, 95% CI 1.74 to 2.10, p<0.0001) (table 3). The AUCs of the 4 regression models to evaluate the prediction capability were as follows: model 1: 0.606; model 2: 0.648; model 3: 0.689; model 4: 0.799 (figure 2), consistent with a good prediction model (online supplemental file 1).

Compared with admission to the medicine service, admission to the ICU was associated with increased in-hospital delirium (OR 3.16, 95% CI 1.90 to 5.27, p=0.0278).

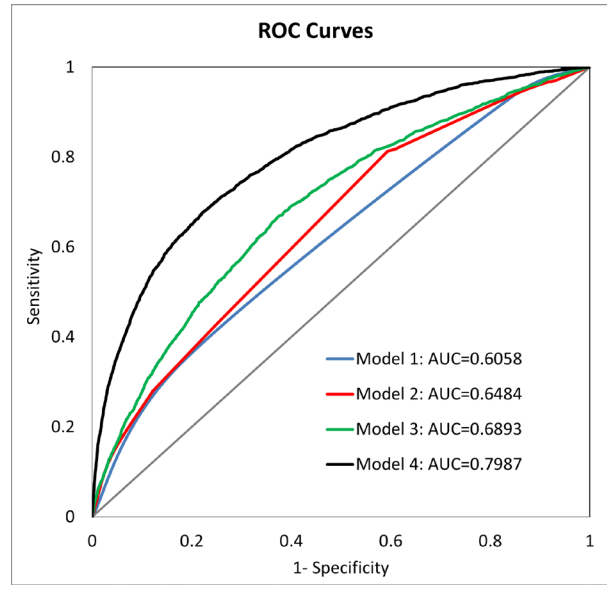

Figure 2 Sequential model receiver operating characteristic (ROC) curves. AUC, area under the curve.

Admissions with an age of 80 years and older (OR 2.80, 95% CI 2.41 to 3.26, p<0.0001), alcohol abuse (OR 1.73, 95% CI 1.52 to 1.97, p<0.0001), exposure to antipsychotics (OR 3.22, 95% CI 2.98 to 3.48, p<0.0001) and benzodiazepines (OR 2.42, 95% CI 2.24 to 2.63, p<0.0001), and falls (OR 2.77, 95% CI 2.11 to 3.65, p<0.0001) were also more likely to have in-hospital delirium. Measures of association for all covariates included in the final model are reported in table 3.

DISCUSSION

Our study demonstrates an association between IHT and development of in-hospital delirium within the first 72 hours of admission before and after adjusting for patient-level characteristics. This association is an important step in understanding the poor outcomes associated with IHT including increased LOS, likelihood of discharge to a facility and mortality.[2–5 8]

Our study was unique in that we were able to demonstrate that certain characteristics play a role in the relationship between IHT status and in-hospital delirium. Model 4, which additionally adjusted for medications, falls and comorbidities, depicts a reduced OR of in-hospital delirium for IHT admissions compared with admissions from the ED from 2.24 (model 3) to 1.91 (model 4). This illustrates that medications, falls, and comorbidities have relatively little influence on the relationship between IHT status and in-hospital delirium. However, even after adjusting for these variables, the stability of the OR of 1.91 in our final model indicates that IHT is associated with in-hospital delirium.

Many factors could contribute to IHT admissions having an increased risk for delirium. The complex illness(es) that resulted in the transfer to a tertiary care hospital, the need for higher level of care in severely ill patients and possibly the transfer process itself could all be explanations for increased risk of developing delirium. The complexity of illness may be due

to many factors including multiple comorbidities and other patient-level risk factors for delirium. Similarly, surgical and procedural interventions are another reason for transport, which may increase the risk of delirium related to the medications associated with the procedures and events themselves. Finally, as mentioned above, disorienting nature of the transfer process may also contribute and may further separate individuals from family and other familiar support. Admissions transferred from other hospitals are likely further along in their presenting illness compared with ED or clinic admissions. However, this could also be protective against delirium as many of the contributing factors for delirium, such as dehydration, metabolic disturbance, and home medication exposure, would be resolved. In addition, there may be overlapping risk factors between delirium and IHT such as advanced age, primary diagnosis or severity of illness. Subacute illness or chronic illness can increase the risk for delirium, but often require an acute process to create the clinical syndrome of acute brain dysfunction.[5] Alternatively, if the reason for transfer is inability to treat the underlying problem, then delirium may also persist.

Strengths of the study include its size: a cohort of greater than 30,000 hospitalizations allowed us to control for multiple covariates and provide generalizability given multiple service types. The comprehensive nature of the screening protocol provides broad applicability, in contrast to many other studies that focus on specific, higher risk groups.

There were several limitations to our study. First, we chose to leave out the small number (n=84) of nursing home and hospice facility transfers as IHTs since it likely would bias our result away from the null hypothesis (figure 1). Similarly, if they were coded as ED admissions, they would inappropriately bias towards the null. Second, the bCAM scores are obtained after admission and thus our comparison focuses on patients who have been exposed to IHT, clinic and the ED but does not demonstrate a temporal relationship of delirium through the transfer process itself. Third, due to this study design, we cannot make any assumptions regarding causality but can only assess the association between admission source and delirium. Lastly, this is a single-site study, and all hospitals have different referral patterns which may limit generalizability.

In conclusion, our large cross-sectional study of all adult hospitalizations suggests higher odds of in-hospital delirium in admissions through IHT when compared with those admissions through the ED. Further analysis to better understand the temporal relationship and additional risk factors will be important in better understanding this relationship. Opportunities for change in practice include the utilization of delirium screening before transfer and immediately on arrival and more attention reducing or ameliorating the impact of delirium on LOS and facility placement. Understanding the timing of delirium allows for the utilization of care bundles or other disease-modifying interventions.[13]

Contributors MKT: study concept and design; acquisition, analysis and interpretation of data; drafting and revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity; guarantor and accepts full responsibility for the completed work and the conduct of the study, had access to the data, and controlled the decision to publish. MEH, WPM: study concept and design; interpretation of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. JZ: study design; acquisition, analysis and interpretation of data; drafting and revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. JM: study design; acquisition and analysis of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. JD: study concept; acquisition and interpretation of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. PR: study concept; interpretation of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. KH, PM: study concept and design; acquisition, analysis and interpretation of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity. BK: study concept and design; acquisition and interpretation of data; revising the manuscript for important intellectual content; final approval of the published version; agreement to be accountable for the work related to accuracy and integrity.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Medical University of South Carolina Institutional Review Board (Pro00062234) and informed consent was waived. This is an observational cross-sectional study. Data were obtained through the hospital database retrospectively and no identifiable information was used in the study.

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