Discharge Against Medical Advice and Risk of Readmission After Sepsis Hospitalization

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Research

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Abstract

Background: To describe characteristics of sepsis patients who discharged against medical advice (AMA), identify factors associated with AMA discharges in the patients, and evaluate the association of AMA discharge with 30-day unplanned readmission and outcomes of readmission.

Methods: Using the National Readmission Database of the United States, we identified inpatients with sepsis who discharged AMA or discharged home between 2010 and 2017. The baseline characteristics were compared between the two groups. Multivariable models were used to identify factors related to AMA discharge, evaluate the association between AMA discharge and 30-day unplanned readmission, and elucidate the relationship between the AMA discharges and in-hospital outcomes.

Results: AMA discharges accounted for 2.29% of all the hospitalized sepsis patients. The prevalence of AMA discharge in sepsis patients increased from 1.99% in 2010 to 2.55% in 2014 (p for trend < 0.001).The unplanned 30-day readmission rates of sepsis patients who discharged AMA and who discharged home are 25.51% and 12.26%, respectively. AMA discharge is statistically significantly associated with 30-day [odds ratio (OR), 2.24; 95% confidence interval (CI), 2.15–2.33], 60-day (OR, 2.07; 95% CI, 1.99–2.15), and 90-day (OR, 1.97; 95% CI, 1.90–2.05) readmission. AMA discharge is also associated with longer length of stay in 30 days (0.44 day, 95% CI, 0.12 days-0.76 days, p=0.007), whereas there was no statistically significant difference in hospitalization costs and in-hospital mortality for patients discharged AMA versus those discharged home.

Conclusions: Due to the high risk of readmission, vulnerable patients should be early identified. Medical institutions should conduct post-discharge interventions for patients with AMA discharge, such as follow-up visits and psychological counseling, to reduce readmission.

Introduction

More than 970,000 sepsis cases are diagnosed in the United States (U.S.) each year, and the number is increasing.[1] Although the in-hospital mortality rate decreased from 24.1–14.8%,the proportion of hospitalized patients with sepsis increased from 3.9% in 2010 to 9.4% in 2017.[2] Reducing readmissions has been addressed in order to improve patient outcomes and control health care costs. The Centers for Medicare & Medicaid Services (CMS) of the U.S. use the 30-day readmission rate as a measure of hospital care quality. Because heart failure (HF), pneumonia, and acute myocardial infarction (AMI) account for a large proportion of readmissions, CMS reports readmissions for these conditions.[3] In fact, initial hospitalization costs for sepsis only account for 30% of total costs and are related to severity and length of stay (LOS),[4] but the hospitalization costs and LOS of readmission in sepsis patients are higher than patients with AMI, HF, and pneumonia.[5, 6]

Discharge against medical advice (AMA) is a global public health problem. In the U.S., about 1 to 2 percent of discharges are AMA.[7] Compared with patients who discharged routinely, patients who discharged AMA are more likely to discharge with inadequate care, and increased risk of readmission and

death.[8] A study of AMI patients found that those who left AMA were more than twice as likely to be readmitted, and resulted in a mortality 57% higher.[9] In patients who underwent PCI, AMA discharge was a strong predictor for readmission, and associated with greater mortality.[10] However, little has been known about the impact of AMA discharge in sepsis patients. Using the National Readmission Database (NRD) of the U.S., Shruti et al. evaluated the factors associated with 30-day readmission in patients with sepsis, while they classified patients who left AMA into other discharge group.[6]

In this study, we aimed to describe characteristics of patients who left AMA, identify factors associated with AMA discharge in patients with sepsis, and evaluate the association of AMA discharge with 30-day unplanned readmission, and outcomes of readmission.

Methods

Institutional approval and data availability

The NRD is publicly available, therefore this study was exempt from the formal institutional review board approval.

Data source

The NRD is maintained by the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality (AHRQ). It is one of the largest publicly available all-payer inpatient databases in the U.S., representing approximately half of total resident population and hospitalizations in the country.[11] The large database may support various types of analyses related to specific diseases or procedures. The current register-based cohort study used data from the NRD covering the period from 2010 to 2017.

Study population

The study population involved patients 18 years or older with a diagnosis of sepsis who were subsequently discharged home or discharged AMA between 2010 and 2017. The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and ICD-10-CM diagnosis codes, which have been proved effectiveness in identifying sepsis patients, were used to identify sepsis patients in our study.[12, 13] The NRD variable ‘DISPUNIFORM’ was used to identify patients who discharged AMA. We excluded patients who died during the first index admission or discharged in December of each year because of incomplete 30-day follow-up data. We further excluded patients with elective readmissions, and those who were not discharged home or not discharged AMA. The details regarding inclusion and exclusion are showed in Figure 1.

Covariates

Information related to demographic characteristics (age, sex, weekend admission, income by postal code, insurance type), hospital characteristics (bed size and teaching status), the degree of loss of function,

and the risk of mortality were extracted from the NRD database. Elixhauser Comorbidity Index (ECI) was calculated to account for the burden of 29 common comorbidities.[14] The comorbidities related to sepsis, such as acute kidney injury, chronic kidney disease, shock, vasopressor use, acute cardiorespiratory failure, ventilator use, gastrointestinal bleeding, endocarditis, meningitis, and urinary tract infection or pyelonephritis were also identified using ICD-9-CM and ICD-10-CM codes (e-Table 1).

Primary and secondary outcomes

The primary outcome was 30-day unplanned readmission. An unplanned readmission was defined as the first readmission of a sepsis patient within 30 days of discharge that was not elective. The secondary outcomes were (1) the temporal trend of AMA discharge from 2010 to 2014; (2) the temporal trend of 30-day unplanned readmissions; (3) 60-day and 90-day unplanned readmissions; (4) outcomes of readmission.

Statistical analysis

The NRD was based on a complex sampling design and we utilized survey estimation commands according to the HCUP guideline to obtain national estimates. Descriptive statistics were presented as means and standard errors for continuous variables, and as frequencies and percentages for categorical variables. Chi-squared test was used to compare differences between categorical variables and t-test was used for the comparison between continuous variables. We calculated weighted annual prevalence of AMA discharge for the overall study population as well as subgroups categorized by age, gender, insurance type and income. The trends of annual AMA discharge prevalence over the study period were evaluated using the Cochran-Armitage trend test.

Multivariable logistic regression analysis was used to identify statistically significant factors associated with AMA discharge, adjusted for demographic characteristics, hospital factors, severity indices, and treatment variables. Both univariate model (model 1) and multivariable-adjusted models (models 2 and 3) were constructed to evaluate the associations between AMA discharge and 30-day, 60-day, or 90-day unplanned readmissions in the sepsis patients. Model 2 was adjusted for age, weekend admission, sex, elective admission status, insurance, income, hospital bed size, and teaching status. Model 3 was additionally adjusted for individual comorbidities based on model 2. We also performed a multivariable regression analysis to elucidate the relationship between AMA discharge and in-hospital outcomes (hospitalization costs, LOS, and in-hospital mortality) in readmission, adjusted for demographic characteristics, hospital factors, severity indices, and treatment variables.

Statistical significance was defined as two-sided p values ≤ 0.05. All statistical analyses were conducted in SAS software version 9.4 (SAS Institute, Cary, NC).

Results

Baseline characteristics

A total of 8,139,849 sepsis patients were identified in the NRD over the study period. Patients who left AMA (n =211,533) accounted for 2.60% of the final population. The baseline characteristics of sepsis patients stratified by whether they discharged AMA are shown in Table 1. The sepsis patients who discharged AMA were younger (47.83 vs. 55.13, $p < 0.001$), less females (41.14% vs. 54.15%, $p < 0.001$), more likely to receive Medicaid (36.72% vs. 18.41%, $p < 0.001$), and more likely to have lower income (0–25th percentile: 41.66% vs. 30.79%, $p < 0.001$). In addition, patients who discharged AMA showed a greater likelihood of drug abuse (28.71% vs. 5.97%, $p < 0.001$), alcohol abuse (13.16% vs. 5.25%, $p < 0.001$), current or past smoker (49.48% vs 27.12, $p < 0.001$), and psychoses (11.17% vs.4.65%, $p < 0.001$). Similar trends were also observed for shock, acute cardiorespiratory failure, ventilator use, and endocarditis. Furthermore, we also noticed that patients who discharged AMA had shorter LOS (2.09 days vs. 3.05 days, $p < 0.001$) during their index admission.

Detailed comparisons of the baseline characteristics of the sepsis patients with further stratification according to readmission and AMA discharge status were summarized in e-Table 2. Among the patients who were not readmitted, patients who discharged AMA tended to be younger (47.89 vs. 54.88, $p < 0.001$), less females (41.20% vs. 54.62%, $p < 0.001$), more likely to be smoker (49.31% vs. 27.11%, $p < 0.001$), drug abuse (27.17% vs. 5.79%, $p < 0.001$), alcohol abuse (12.94% vs. 5.12%, $p < 0.001$), and psychoses (10.60% vs. 4.47%, $p < 0.001$). Similar trends were also observed for the readmitted patients who discharged AMA. Notably, patients who discharged AMA had a greater likelihood of AMA discharge AMA during readmission (33.09% vs. 1.42%, $p < 0.001$).

Time trends of annual AMA discharge

The annual prevalence of AMA discharge in sepsis patients increased from 2.00% in 2010 to 3.89% in 2017 (p for trend < 0.001) (Figure 2). E-Figure 1 shows the temporal trends of annual AMA discharge prevalence in the subgroups categorized by age, sex, types of insurance, and income. The prevalence was highest in patients younger than 50 years of age. The prevalence of AMA discharge was higher in males and increased from 2.72% in 2010 to 4.36% in 2017 (p for trend < 0.001). In addition, higher prevalence of AMA discharge AMA was observed among patients with self-pay and lower income.

Factors associated with AMA discharge

In the multivariable analysis, factors associated with AMA discharge AMA include diabetes (odds ratio [OR], 1.12; 95% confidence interval [CI], 1.10–1.14), smoke (OR, 1.65; 95% CI, 1.61–1.68), drug abuse (OR, 2.58; 95% CI, 2.53–2.65), alcohol abuse (OR,1.19; 95% CI,1.16–1.22), and psychoses (OR,1.46; 95% CI, 1.42–1.50), whereas female sex, elective admission, obesity, acute cardiorespiratory failure, metastatic cancer, solid tumor without metastasis, meningitis, and urinary tract infection or pyelonephritis were associated with reduced odds of AMA discharge (Table 2).

Associations of AMA discharge with readmissions

The unplanned 30-day readmission rates of sepsis patients who discharged AMA and who discharged home are 21.64% and 10.27%, respectively (Table 1). The unplanned 60-day and 90-day readmission rates are also higher in patients who discharged AMA .The 30-day readmission rate increased from 21.28% in 2010 to 27.21% in 2017 (p for trend < 0.001) in patients who discharged against medical advice. And the 30-day readmission rate in patients who discharged home increased from 10.46% in 2010 to 13.08% in 2017 (p for trend < 0.001) (Figure 3). Table 3 shows the associated factors of unplanned 30-day readmission. AMA discharge was statistically significantly associated with unplanned 30-day readmission (OR, 1.96; 95% CI, 1.92–2.00), as well as 60-day (OR, 1.82; 95% CI, 1.79–1.86), and 90-day (OR, 1.76; 95% CI, 1.73–1.79) readmissions (Table 4).

Impact of AMA discharge on outcomes after readmission

In the multivariable model, AMA discharge AMA was statistically significantly associated with higher in-hospital mortality in 30-day readmission (OR, 1.27; 95% CI, 1.16–1.38, P=0.045), whereas there was no statistically significant difference found in hospitalization costs ($190, 95% CI, $-161-$541, p=0.290) and LOS (0.11 day,95% CI,-0.03 days-0.25days, p=0.135) for patients discharged AMA versus discharged home (Table 5).AMA discharge was also statistically significantly associated with higher in-hospital mortality in 60-day readmission (OR, 1.27; 95% CI, 1.17–1.37, p<0.001), and 90-day readmission (OR, 1.29; 95% CI, 1.19–1.39, p<0.001).

Causes of 30-day unplanned readmissions

Table 6 shows the top 10 causes of 30-day unplanned readmissions. The most common cause for readmission is infections, while the proportion was higher in patients who left AMA (41.51%) than that in patients who discharged home (34.30%). The top 15 causes of readmission accounted for more than 85 percent of all readmissions.

Discussion

Our results reveal that although the proportion of patients with AMA discharge is not high, they were more likely to be readmitted compared to those discharged home. We observed that the unplanned 30-day readmission rate of patients who left AMA was 21.64%, twice as the rate of patients who discharged home, and comparable to that for patients with severe sepsis.[15] In addition, we found that 60-day and 90-day readmission rates for patients who left AMA were also significantly higher than that for patients who discharged home. Our findings support the need for a deeper understanding of AMA discharge in sepsis patients to further develop efficient interventions.

In our study, AMA discharge was associated with younger age, male, Medicaid, lower income, higher risk of mortality, more comorbidities, psychoses, drug abuse, and alcohol abuse. We found that patients with a high risk of mortality were more likely to discharge AMA, which may be related to palliative care.[16] Hospital-level characteristics, such as location and teaching status were also found associated with AMA discharge. The high prevalence of AMA discharge in urban nonteaching hospitals may be related to the

limited attention of service providers. Patients with alcohol and drug abuse were more likely to discharge AMA, consistent with previous findings.[10, 17, 18] Both alcohol and drugs can impair cognition and lead to impulsive or risky behavior, prompting the patient's subsequent decision to leave AMA.[19] In addition, patients who are dependent on drugs and/or alcohol may be more likely to leave the hospital toobtain dependent substances, especially if withdrawal symptoms are not properly treated.[20]

The risk of AMA discharge was lower in patients with obesity, acute cardiorespiratory failure, metastatic cancer, solid tumor without metastasis, meningitis, and urinary tract infection or pyelonephritis. We speculate that the associated more severe comorbidities may place a greater burden on sepsis patients and thus influence their discharge decisions. We also found that the patients admitted electively in the index hospitalization are less likely to discharge AMA, which suggests that there might be selection bias in the included population. The patients who were admitted at an elective hospital were likely to have better compliance than those who were not. In addition, it also may be related to the expectations of the patients and capacity to plan. The LOS is usually controlled and communicated with family members prior to admission, so patients generally do not decide to discharge AMA.

It is essential to increase our understanding of the factors associated with AMA discharge. It helps us identify high-risk groups for AMA discharge and intervene early to reduce subsequent readmission and additional health care costs. Previous studies have shown that although there may be many reasons for patients to leave AMA, communication disorders are often the main reason.[21, 22] Known factors affecting communication quality include patient’s age, gender, race, and income. Insurance status, hospital type, hospital size, and severity of illness were also identified as associated factors of AMA discharge. Although these factors are immutable, they can be used as indicators to identify vulnerable patients who may need to improve communication to prevent AMA charge.[7] Providing a prescription at the time of discharge to patients who are about to leave AMA may reduce readmission and mortality rates in infected patients who need to complete a course of antibiotics. If the patient persists in leaving AMA, appropriate drug intervention and follow-up may play an important role after discharge. Establishing a discharge plan that bring the least harm to patients may increase patients’ adherence to the plan and eliminate disadvantageous factors at discharge.[23]

In this analysis, AMA discharge was a factor associated with 30-day readmission, which is consistent with several previous studies. In a survey of trauma patients by Olufajo et al., the risk of 30-day readmission was three times higher in patients who discharged AMA and two times higher in patients with multiple readmissions compared to those discharged upon medical advice.[24] A retrospective cohort study in California showed that patients with AMI who discharged AMA had a 60% higher risk of hospital readmission with AMI or unstable angina within two years of discharge than those who were discharged routinely.[9] In our study, the effect of AMA discharge on readmission after the first discharge of the sepsis patients lasted for 3 months.

Our analysis showed that patients who left AMA had a higher rate of readmission for infection. A retrospective cohort study showed that half of sepsis patients readmitted for infection were due to

recurrent or unresolved infections.[25] The initial treatment strategy for infection is to eliminate the causative organism, and the duration of treatment is critical. Patients who discharged AMA are likely to be discharged from the hospital before the course of treatment is completed. The patients who leave the hospital before reaching clinical stability will have their conditions continue to deteriorate, leading to an increased risk of readmission.

We found that AMA discharge was associated with higher in-hospital mortality in 30-day, 60-day, and 90-day readmission, which is consist with previous studies. A retrospective cohort study from a Veterans Administration hospital showed that AMA patients had a higher mortality rate than those who discharged home for all admissions.[8] In another retrospective cohort study involving adults in Manitoba from 1990 to 2009, elevated mortality associated with AMA discharge was manifest within one week and continued to 180 day after discharge.[26] We have the following assumptions. First, behaviors of the patients with AMA discharge after discharge from hospital may lead to higher mortality, such as substance abuse, rather than AMA discharge itself. Secondly, these patients often failed to complete the relevant examinations, which limits clinicians to make accurate diagnosis. Third, the patients with AMA discharge have poor compliance, such as taking prescription drugs on time.

There are several limitations in our study. First, as in other administrative databases, reporting biases, data loss, and coding errors are also existing in the NRD. Second, sociodemographic data, such as race, marriage and other characteristics, are associated with the AMA dischagre[7], however they are not available in the NRD. Third, the yearly datasets contained in the NRD could not be linked across the years, and the patients admitted in December were also excluded, so the prevalence of AMA discharge in this study may be underestimated. Fourth, as a retrospective study, we only evaluated the associations. In order to make causal inference between AMA discharge and the interested outcomes, more refined study design such as propensity score matching, and powerful adjustment such as instrumental variable technique may be considered in the future.

Conclusions

This study identified several characteristics associated with AMA discharge AMA in sepsis patients and revealed the associations between AMA discharge and unplanned readmissions. Due to the high risk of readmission, vulnerable patients should be early identified, and medical institutions should conduct post-discharge interventions for patients with AMA discharge, such as follow-up visits and psychological counseling, to reduce readmission. Our findings are helpful to raise awareness among clinicians and policy makers about the patient population, thereby use the health care resources efficiently. Further studies on the effects of AMA discharge on the outcomes of readmission are needed in the future.

Abbreviation List

AMA, Against medical advice

CMS , Centers for Medicare & Medicaid Services

HF, Heart failure

AMI, Acute myocardial infarction

LOS, Length of stay

ECI Elixhauser Comorbidity Index

LOS, Length of stay

NRD, National Readmission Database

HCUP , Healthcare Cost and Utilization Project

AHRQ , Agency for Healthcare Research and Quality

ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification

ECI, Elixhauser Comorbidity Index

OR Odds ratio

CI Confidence interval

Declarations

Ethics approval and consent to participate The NRD is publicly available, so this study was exempt from formal institutional review board approval.

Consent for publication Not applicable.

Availability of data and materials The datasets generated and/or analysed during the current study are available in the https://www.hcup-us.ahrq.gov/nisoverview.jsp.

Competing interests The authors declare that they have no competing interests.

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Authors' contributions Zhen Lin, Yinghong Zhai, Hedong Han, and Jia He designed the research. Zhen Lin, Yinghong Zhai, Hedong Han and Yang Cao had full access to the data and conducted all analyses. Zhen Lin, Yinghong Zhai, Hedong Han and Yang Cao wrote the article draft. Xin Wei, Cheng Wu, Yang

Cao, and Jia He critically reviewed and revised the article. All authors contributed to the writing of the manuscript and read and approved the final manuscript. He Jia acted as the guarantor.

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Tables

Table 1. Baseline characteristics of sepsis patients according to discharge against medical advice status

	Not Discharge AMA (N=7,928,316)	**Discharge AMA** (N=211,533)	P-value
Age, year, (mean±SE)	55.13±0.05	47.83±0.19	<0.001
Age, year			<0.001
≤49	2936457 (37.04)	114911 (54.32)	
50–64	2247281 (28.35)	62171 (29.39)	
65–79	1921694 (24.24)	25035 (11.83)	
≥80	822883 (10.38)	9417 (4.45)	
Female sex	4293447 (54.15)	87022 (41.14)	<0.001
Weekend admission	1878681 (23.70)	56477 (26.70)	<0.001
Elective admission	984182 (12.43)	7435 (3.52)	<0.001
Insurance			<0.001
Medicare	3353124 (42.38)	68662 (32.52)	
Medicaid	1456931 (18.41)	77521 (36.72)	
Private insurance	2282386 (28.85)	24361 (11.54)	
Self-pay	482196 (6.09)	29176 (13.82)	
Other	337185 (4.26)	11397 (5.40)	
Resident of same state	7545633 (95.17)	202217 (95.60)	0.001
Patient zip code income quartile			<0.001
0–25th percentile	2401328 (30.79)	86352 (41.66)	
26th–50th percentile	2032598 (26.06)	52567 (25.36)	
51st–75th percentile	1865660 (23.92)	41999 (20.26)	
76th–100th percentile	1499745 (19.23)	26364 (12.72)	
APR-DRG severity			<0.001
Minor loss of function	1325401 (16.72)	26973 (12.75)	
Moderate loss of function	2696964 (34.02)	66296 (31.34)	
Major loss of function	2772264 (34.97)	74001 (34.98)	
Extreme loss of function	1130461 (14.26)	44194 (20.89)	
APR-DRG Risk of Mortality			<0.001

Minor likelihood of dying	2909605 (36.70)	70714 (33.43)	
Moderate likelihood of dying	1915925 (24.17)	47849 (22.62)	
Major likelihood of dying	2044473 (25.79)	54086 (25.57)	
Extreme likelihood of dying	1055087 (13.31)	38815 (18.35)	
Hospital Characteristics			
Hospital bed size			<0.001
Small	1147207 (14.47)	29510 (13.95)	
Medium	2049651 (25.85)	61111 (28.89)	
Large	4731458 (59.68)	120912 (57.16)	
Location/teaching status of hospital			<0.001
Urban nonteaching	2624804 (33.11)	75566 (35.72)	
Urban teaching	4404156 (55.55)	118099 (55.83)	
Rural	899356 (11.34)	17868 (8.45)	
Comorbidities			
Elixhauser comorbidity index			<0.001
0	1041716 (13.14)	15226 (7.20)	
1	1215271 (15.33)	30144 (14.25)	
2	1466419 (18.50)	38275 (18.09)	
≥3	4204909 (53.04)	127888 (60.46)	
Hypertension	3948120 (49.80)	88528 (41.85)	<0.001
Diabetes	2115518 (26.68)	52587 (24.86)	<0.001
Drug abuse	473028 (5.97)	60736 (28.71)	<0.001
Alcohol abuse	416482 (5.25)	27846 (13.16)	<0.001
Current or past smoker	2150019 (27.12)	104666 (49.48)	<0.001
Obesity	1178861 (14.87)	22049 (10.42)	<0.001
Depression	880068 (11.10)	25893 (12.24)	<0.001
Psychoses	368585 (4.65)	23629 (11.17)	<0.001
Shock	548783 (6.92)	19459 (9.20)	<0.001
Vasopressor use	38179 (0.48)	1192 (0.56)	0.018

Acute cardiorespiratory failure	954002 (12.03)	29066 (13.74)	<0.001
Ventilator use	233788 (2.95)	10142 (4.79)	<0.001
Metastatic cancer	205250 (2.59)	3006 (1.42)	<0.001
Solid tumor without metastasis	221431 (2.79)	3610 (1.71)	<0.001
Endocarditis	46206 (0.58)	8757 (4.14)	<0.001
Viral or bacterial pneumonia	7864845 (99.20)	209142 (98.87)	<0.001
Meningitis	16969 (0.21)	520 (0.25)	0.052
Urinary tract infection or pyelonephritis	272271 (3.43)	4898 (2.32)	<0.001
In-hospital outcomes			
Length of stay, day	3.05(1.73-5.52)	2.09(0.71-5.21)	<0.001
Cost, $	8033((4820-14430)	6803(3748-14018)	0.764
Readmission in 30-day	814615(10.27)	45769(21.64)	<0.001
Readmission in 60-day	1133133(14.40)	57074(27.07)	<0.001
Readmission in 90-day	1317449(16.83)	33677(30.10)	<0.001

Abbreviation: SE, standard error; AMA, against medical advice; APR-DRG, All Patient Refined Diagnosis Related Groups.

Table 2. Factors associated with AMA discharge in sepsis

`	OR (95 % CI)	P-value
Age		
49	Reference	
50–64	0.74 (0.73,0.76)	<0.001
65–79	0.36 (0.35,0.38)	<0.001
≥80	0.32 (0.29,0.37)	<0.001
Female	0.66 (0.65,0.68)	<0.001
Weekend admission	1.06 (1.04,1.08)	<0.001
Elective admission	0.39 (0.36,0.43)	<0.001
Insurance		
Medicare	Reference	
Medicaid	1.22 (1.19,1.25)	<0.001
Private	0.40 (0.39,0.41)	<0.001
Self-pay	1.15 (1.11,1.19)	<0.001
Others	0.83 (0.79,0.87)	<0.001
Resident of same state	0.95 (0.91,1.00)	0.058
Income quartile		
1st–25th	Reference	
26st–50th	0.83 (0.81,0.85)	<0.001
51st–75th	0.78 (0.75,0.81)	<0.001
76st–100th	0.72 (0.69,0.75)	<0.001
APR-DRG severity		
Minor loss of function	Reference	
Moderate loss of function	0.99 (0.96,1.02)	0.568
Major loss of function	0.95 (0.92,0.99)	0.007
Extreme loss of function	0.97 (0.92,1.02)	0.236
APR-DRG Risk of Mortality		
Minor likelihood of dying	Reference	
Moderate likelihood of dying	1.08 (1.05,1.11)	<0.001

Major likelihood of dying	1.21 (1.17,1.25)	<0.001
Extreme likelihood of dying	1.43 (1.37,1.49)	<0.001
Hospital Characteristics		
Hospital bed size		
Small	Reference	
Medium	1.07 (1.00,1.14)	0.0562
Large	0.87 (0.82,0.92)	<0.001
Location/teaching status of hospital		
Urban nonteaching	Reference	
Urban teaching	0.84 (0.81,0.88)	<0.001
Rural	0.72 (0.68,0.76)	<0.001
Comorbidities		
Elixhauser comorbidity index		
0	Reference	
1	1.32 (1.28,1.37)	<0.001
2	1.31 (1.26,1.36)	<0.001
3	1.38 (1.33,1.44)	<0.001
Hypertension	0.88 (0.86,0.90)	<0.001
Diabetes	1.12 (1.10,1.14)	<0.001
Drug abuse	2.58 (2.53,2.65)	<0.001
Alcohol abuse	1.19 (1.16,1.22)	<0.001
Current or past smoker	1.65 (1.61,1.68)	<0.001
Obesity	0.67 (0.65,0.68)	<0.001
Depression	0.97 (0.95,1.00)	0.012
Psychoses	1.46 (1.42,1.50)	<0.001
Shock	1.00 (0.96,1.03)	0.854
Vasopressor use	0.87 (0.75,1.00)	0.056
Acute cardiorespiratory failure	0.88 (0.86,0.91)	<0.001
Ventilator use	0.99 (0.94,1.04)	0.707

Metastatic cancer	0.71 (0.67,0.75)	<0.001
Solid tumor without metastasis`	0.78 (0.74,0.82)	<0.001
Endocarditis	2.75 (2.62,2.89)	<0.001
Viral or bacterial pneumonia	1.01 (0.93,1.10)	0.765
Meningitis`	0.77 (0.67,0.90)	0.001
Urinary tract infection or pyelonephritis	0.71 (0.67,0.74)	<0.001

Abbreviation: APR-DRG, All Patient Refined Diagnosis Related Groups.

Adjusted for: age, weekend admission, female, elective, insurance, income, APR-DRG severity, APR-DRG Risk of Mortality, hospital bed size and teaching status, and individual comorbidities.

Table 3. The factors of 30-day unplanned readmission in sepsis

	OR (95 % CI)	*P-value*
Discharge against medical advice	1.96 (1.92,2.00)	<0.001
Age		
49	Reference	
50–64	0.96 (0.95,0.98)	<0.001
65–79	0.75 (0.74,0.76)	<0.001
≥80	0.71 (0.69,0.72)	<0.001
Female	0.97 (0.97,0.98)	<0.001
Weekend admission	0.99 (0.98,1.00)	0.121
Elective admission	0.33 (0.32,0.34)	<0.001
Insurance		
Medicare	Reference	
Medicaid	0.99 (0.98,1.01)	0.310
Private	0.74 (0.73,0.75)	<0.001
Self-pay	0.69 (0.68,0.70)	<0.001
Others	0.77 (0.75,0.79)	<0.001
Resident of same state	1.46 (1.41,1.51)	<0.001
Income quartile		
1st–25th	Reference	
26st–50th	0.96 (0.95,0.98)	<0.001
51st–75th	0.93 (0.92,0.95)	<0.001
76st–100th	0.93 (0.91,0.95)	<0.001
APR-DRG severity		
Minor loss of function	Reference	
Moderate loss of function	1.26 (1.24,1.29)	<0.001
Major loss of function	1.80 (1.76,1.85)	<0.001
Extreme loss of function	2.56 (2.49,2.63)	<0.001
APR-DRG Risk of Mortality		
Minor likelihood of dying	Reference	

Moderate likelihood of dying	1.29 (1.27,1.31)	<0.001
Major likelihood of dying	1.57 (1.54,1.60)	<0.001
Extreme likelihood of dying	1.48 (1.44,1.51)	<0.001
Hospital Characteristics		
Hospital bed size		
Small	Reference	
Medium	1.04 (1.02,1.06)	0.0003
Large	1.06 (1.05,1.08)	<0.001
Location/teaching status of hospital		
Urban nonteaching	Reference	
Urban teaching	1.04 (1.03,1.06)	<0.001
Rural	0.91 (0.89,0.93)	<0.001
Comorbidities		
Elixhauser comorbidity index		
0	Reference	
1	1.11 (1.08,1.13)	<0.001
2	1.22 (1.20,1.25)	<0.001
3	1.54 (1.50,1.58)	<0.001
Hypertension	0.97 (0.96,0.98)	<0.001
Diabetes	1.08 (1.07,1.09)	<0.001
Drug abuse	1.08 (1.07,1.10)	<0.001
Alcohol abuse	0.96 (0.94,0.97)	<0.001
Current or past smoker	0.92 (0.91,0.93)	<0.001
Obesity	0.86 (0.85,0.87)	<0.001
Depression	1.09 (1.07,1.10)	<0.001
Psychoses	1.12 (1.10,1.14)	<0.001
Shock	0.99 (0.97,1.00)	0.164
Vasopressor use	1.03 (0.98,1.08)	0.287
Acute cardiorespiratory failure	0.92 (0.91,0.94)	<0.001

Ventilator use	0.86 (0.84,0.88)	<0.001
Metastatic cancer`	1.71 (1.68,1.74)	<0.001
Solid tumor without metastasis`	1.38 (1.35,1.41)	<0.001
Endocarditis	1.39 (1.34,1.43)	<0.001
Viral or bacterial pneumonia	0.69 (0.66,0.71)	<0.001
Meningitis`	0.81 (0.75,0.88)	<0.001
Urinary tract infection or pyelonephritis	0.77 (0.75,0.79)	<0.001

Abbreviation: APR-DRG, All Patient Refined Diagnosis Related Groups.

Adjusted for: Discharge against medical advice, age, weekend admission, female, elective, insurance, income, APR-DRG severity, APR-DRG Risk of Mortality, hospital bed size and teaching status, and individual comorbidities.

Table 4. Associations of AMA discharge with readmissions

	Model 1		Model 2		Model 3	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Readmitted in 30 days	2.41(2.37,2.46)	<0.001	2.03(2.00,2.07)	<0.001	1.96(1.92,2.00)	<0.001
Readmitted in 60 days	2.51(2.17,2.25)	<0.001	1.88(1.84,1.91)	<0.001	1.82(1.79,1.86)	<0.001
Readmitted in 90 days	2.13(2.09,2.17)	<0.001	1.81(1.78,1.85)	<0.001	1.76(1.73,1.79)	<0.001

Abbreviation: OR, odds ratio; CI, confidence interval.

Model 1: Discharge Against Medical Advice as the single predictor.

Multivariable model 2: adjusted for age, weekend admission, female, elective, insurance, income, hospital bed size and teaching status.

Multivariate model 3: model 2 + individual comorbidities.

Table 5. Impact of AMA discharge on outcomes after readmission

	Hospitalization costs, $		Length of stay, d		In-hospital mortality	
	Difference (95 % CI)	P-value	Difference (95 % CI)	P-value	OR (95 % CI)	P-value
Readmitted in 30 days	190(-161,541)	0.290	0.11(-0.03,0.25)	0.135	1.27(1.16,1.38)	0.045
Readmitted in 60 days	143(-165,451)	0.362	0.06(-0.07,0.18)	0.368	1.27(1.17,1.37)	<0.001
Readmitted in 90 days	230(-66,527)	0.128	0.06(-0.05,0.18)	0.301	1.29(1.19,1.39)	<0.001

Table 6 reasons for 30-day readmissions

Cause of readmission	Not Discharge AMA (%)	Discharge AMA (%)
Infections	34.3	41.51
Neuropsychiatric	4.95	7.01
Gastrointestinal	9.06	5.94
Respiratory	5.92	5.01
Endocrine/metabolic	3.00	4.64
Complication of device; implant or graft	4.88	4.27
Pericarditis	0.49	3.45
Hematological	4.94	2.68
Complications of surgical procedure or medical care	3.15	2.51
Heart failure	2.77	2.38
Genitourinary	3.56	2.23
Renal disease	2.66	2.04
Hyper/hypotension	1.69	2
Fluid and electrolyte disorders	1.65	1.31
Trauma	1.63	1.23

Figures

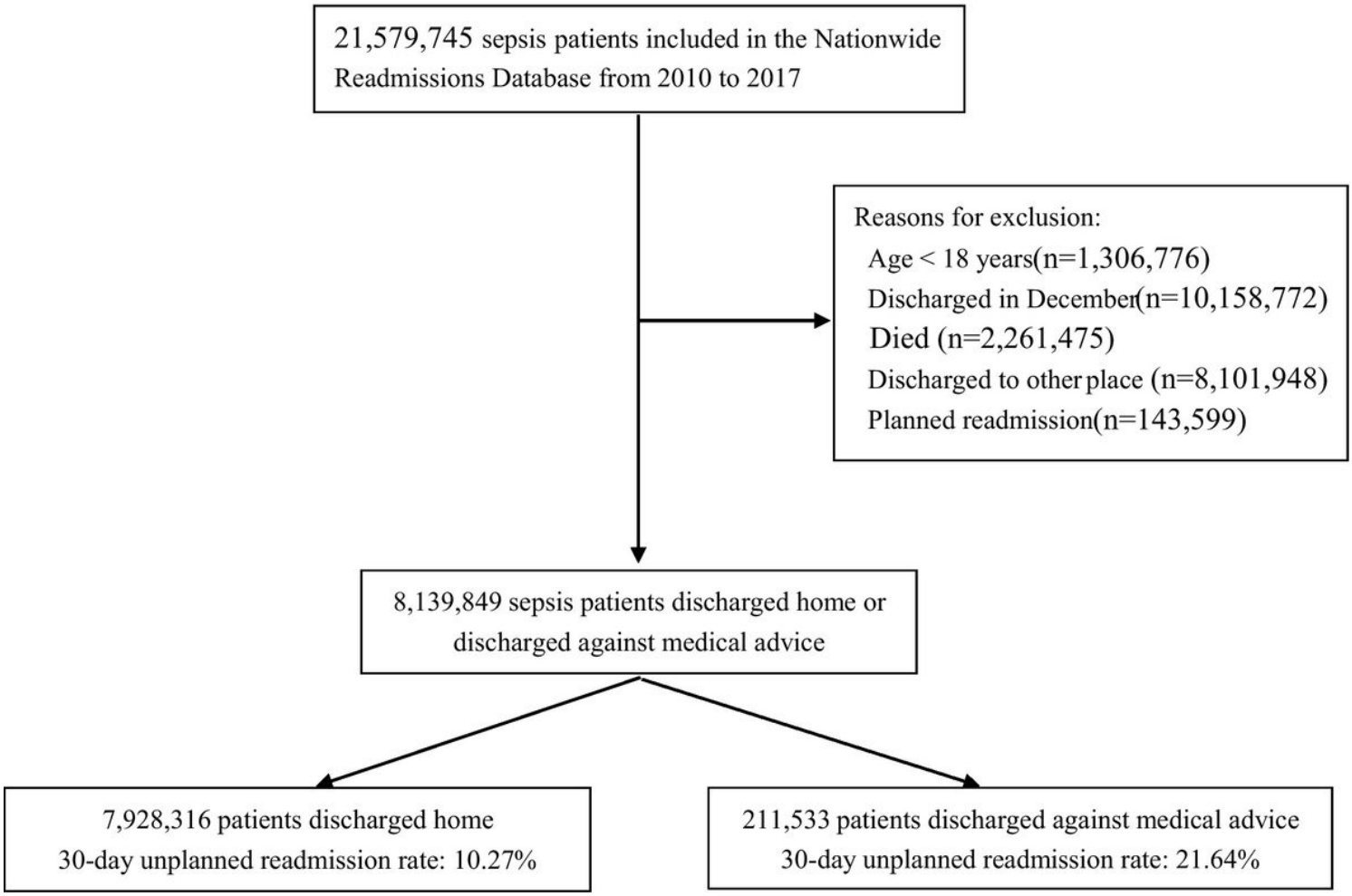

Figure 1

Selection flow diagram of target population.

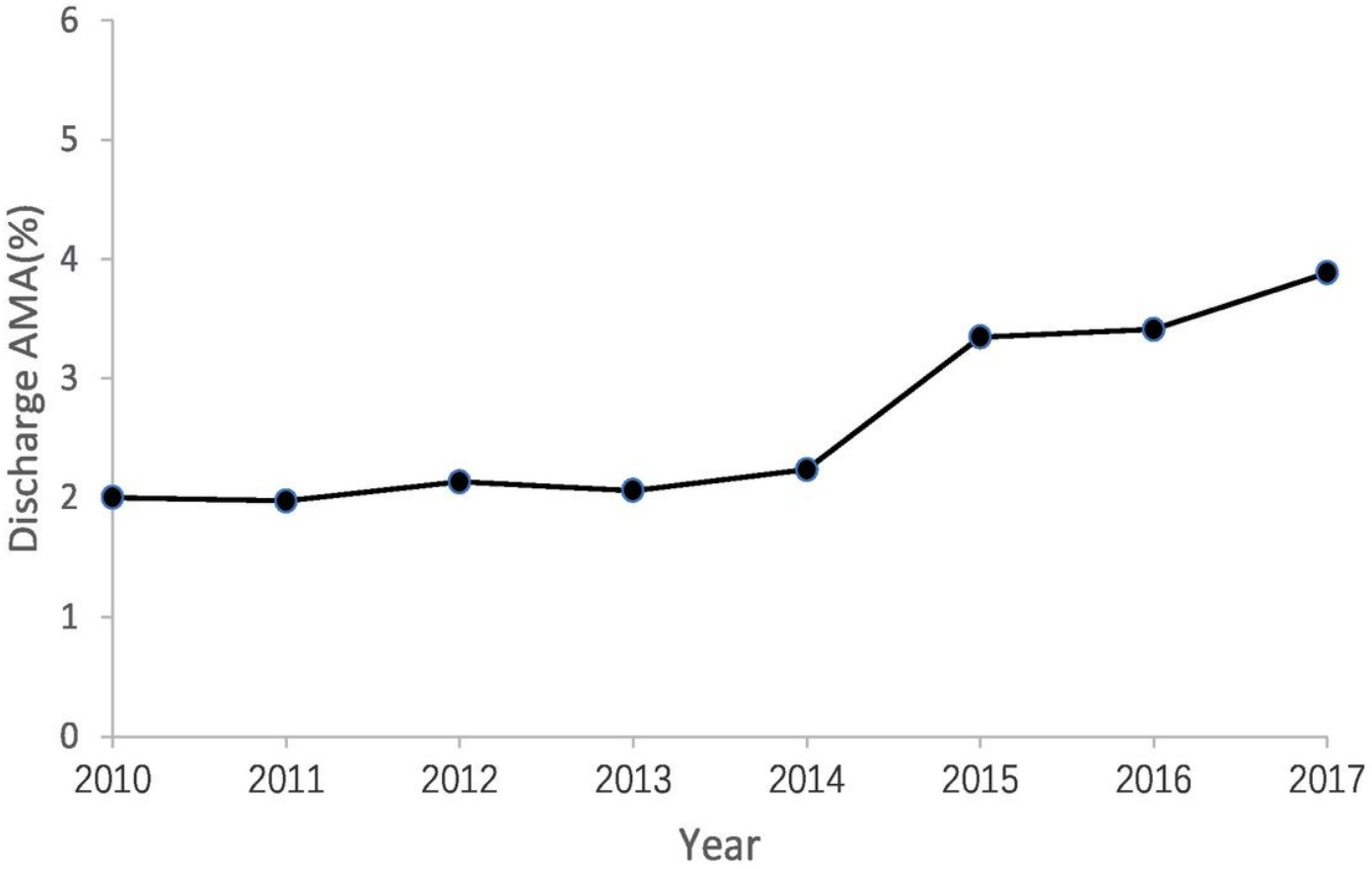

Figure 2

The prevalence of Discharging against Medical Advice in sepsis.

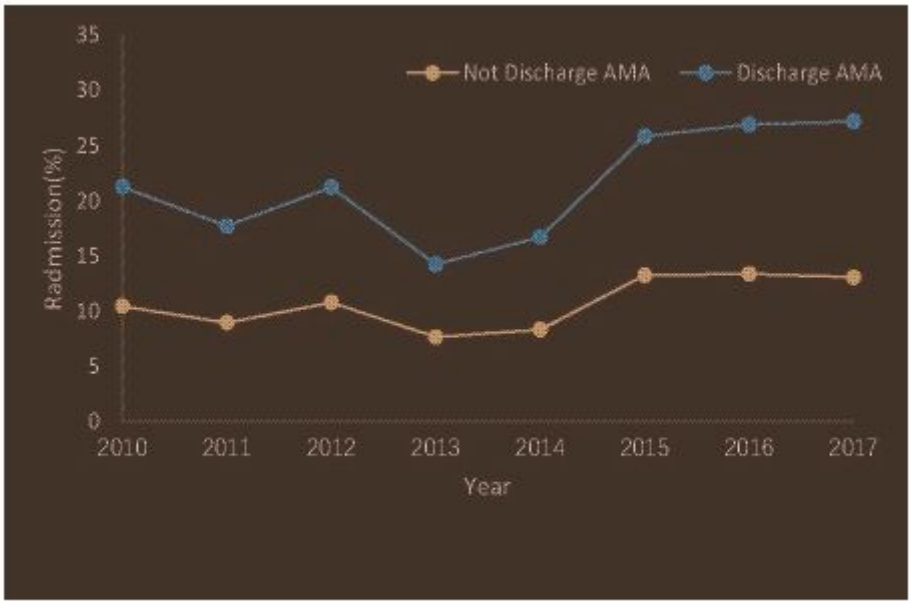

Figure 3

The 30-day readmission rate in sepsis.

Supplementary Files

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