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The epidemiologic characteristics, temporal trends, predictors of death, and discharge disposition in patients with a diagnosis of sepsis: A cross-sectional retrospective cohort study

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ABSTRACT

Purpose: To assess recent epidemiologic characteristics, temporal trends, and predictors of death and discharge disposition in patients with sepsis.
Material and methods: This is a cross-sectional retrospective cohort study using the US National Inpatient Sample (NIS) data from 2009 to 2012. The study population included adults (18 years and older) with sepsis-related *International Classification of Diseases, Ninth Revision, Clinical Modification* codes at the time of discharge. Factors associated with in-hospital mortality and patient discharge disposition were derived from multivariate analyses using multinomial logistic models by SAS PROC LOGISTIC with GLOGIT link.
Results: Of 1 303 640 patients admitted, 15% died, 30% were discharged to home without home care, 34% were transferred to a skilled outpatient facility, and 4% were transferred to another short-term hospital. In-hospital mortality decreased from 16.5% to 13.8% ($P < .001$) across time. Length of stay also decreased from 6.7 to 5.9 days ($P < .001$). Reductions in mortality and length of stay were seen despite an increase in the number of comorbidities ($P < .001$). Multivariate analysis revealed that the strongest predictors of in-hospital mortality were respiratory, cardiovascular, and hepatic failures, and neurologic events. The predictors of transfer to an outpatient facility were a major operative procedure, neurologic event, respiratory failure, and weight loss. Weight loss was also an independent predictor of in-hospital mortality.
Conclusion: Certain comorbidities and organ failures were associated with death and discharge to a skilled outpatient facility.

1. Introduction

Sepsis is an increasingly important contributor to hospitalizations, in-hospital deaths, and transfer to a short-term acute care hospital or a skilled outpatient health care facility. Although the implementation of specific guidelines to assist with earlier recognition of and treatment for patients with severe sepsis and septic shock has been shown to decrease morbidity and mortality, both still remain high [1-4]. Other factors associated with morbidity and mortality need to be identified so that targeted interventions can be implemented and studied. Hence, this reinforces the need for continuous monitoring of trends as done in this study.

Sepsis, defined as a syndrome of physiologic, pathologic, and biochemical abnormalities induced by infection, accounted for more than $20 billion (5.2%) of total US hospital costs in 2011 [5]. In fact, sepsis consumes almost half of intensive care unit (ICU) resources. Multiple reports have suggested that the incidence of septicemia, sepsis, and severe sepsis has been increasing steadily for the past several decades. The Centers for Disease Control and Prevention's National Center for Health Statistics estimates that the number of hospitalization for sepsis increased from 621 000 in 2000 to 1 141 000 in 2008 [6]. Septicemia was the most expensive condition in 2009 and its costs grew fastest between 1997 and 2009 [7].

Furthermore, there is increasing awareness that patients who survive sepsis often have long-term physical, psychological, and cognitive disabilities with significant health care and social implications [8-11].

The reported incidence of sepsis is rising, likely reflecting an aging population with more comorbidities, better recognition of sepsis, and the advent of reimbursement-favorable coding [12]. Commonly cited explanations for this emerging trend include increasing use of

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immunosuppression, invasive procedures, and the spread of multidrug-resistant pathogens. Most existing studies on temporal trends, however, are based on analyses of administrative data. It is therefore possible that some of the observed increase in incidence is due to changes in diagnosis and coding practices rather than true increases in disease frequency.

The treatment of sepsis involves caring for sicker patients who have longer inpatient stays than those with other diagnoses. Total nationwide inpatient annual costs of treating those hospitalized for septicemia have been rising and were estimated to be $14.6 billion in 2008 [13]. Patients who do survive severe cases are more likely to have negative long-term effects on health and on cognitive and physical functioning [8-11,14].

Only 2% of hospitalizations in 2008 were for septicemia or sepsis, yet accounted for 17% of in-hospital deaths [15]. In-hospital deaths were more than 8 times as likely among patients hospitalized for septicemia or sepsis (17%) compared with other diagnoses (2%). Therefore, understanding the factors that impact disposition of patients with sepsis is important from a societal and economic standpoint.

Many studies suggest that acute infections worsen preexisting chronic diseases or result in new chronic diseases, leading to poor long-term outcomes in acute illness survivors [15]. Almost half of sepsis survivors are discharged to skilled nursing facilities. In addition, those hospitalized for septicemia or sepsis were one-half as likely to be discharged home, twice as likely to be transferred to a short-term acute care hospital, and 3 times as likely to be discharged to a skilled outpatient facility, as those with other diagnoses [16].

The goal of this study was to assess epidemiologic characteristics, factors associated with disposition and trends in patients with sepsis who died or were discharged to a short-term acute care hospitals or a skilled outpatient health care facility vs routine discharge to home without home care services. Understanding risk factors associated with mortality, poor functional outcomes, and increased post-discharge care is important for providers to know. This knowledge can improve patients' outcomes and minimize odds of morbidity or mortality if extrapolated conclusions from this data are implemented. Please refer to the discussion section for further elaboration. Also, disclosure of this information to the patient or family can help with post-discharge planning and with decision making during goals of care meetings.

In addition, this is important information in regard to health care planning and allocation of governmental, social, and hospital resources. In a time where we are seeking health care reform and where post sepsis syndrome is increasingly recognized, it is imperative to continuously assess such trends to see if there are changes with respect to cost, morbidity, and mortality (eg, insured and noninsured patients)

2. Methods

2.1. Study design and population

A series cross-sectional study, the National Inpatient Sample (NIS) contains data on community "non-Federal short-stay" hospitalizations, not patient-level records from states, participating approximately 40 states in the Healthcare Cost and Utilization Project. The NIS is a stratified probability sampling frame of 20% of discharges from community hospitals that represent approximately 95% of the US population (see full information on study design, procedures, and quality control on reference) [17,18]. Patients with sepsis were identified by presence of any listed (up to 25 diagnosis codes per episode) the *International Classification of Diseases, Ninth Revision* (*ICD-9*) diagnosis codes as 038 (septicemia), 020.0 (septicemic), 790.7 (bacteremia), 117.9 (disseminated fungal infection), 112.5 (disseminated candida infection), and 112.81 (disseminated fungal endocarditis) in 2009 and 2012. We excluded patients 17 years or younger as well patients with missing information on key variables (discharge status, the total charge, age, sex, length of stay [LOS], demographic variables, approximately 3% of the sepsis cohort).

2.2. Outcomes

Patients' dispositions were categorized into the following: (1) routine discharge to home without home health services, (2) transfer out to another short-term acute care hospital, (3) transfer to a skilled outpatient health care facility (eg, skilled nursing facility, intermediate care facility, long-term care rehabilitation facility, (4) home health care (includes patients discharged home with intravenous antibiotics and those discharged home with hospice services), (5) against medical advice and (6) died in-hospital. Invalid and unknown destinations were excluded from the analytical cohort.

2.3. Characteristics of study

Available variables included patients' demographic information: age; sex; race was recoded as white, black, other (included Hispanic, Asian, and other race), and "not available" for accounting missing (15% in 2009, 11% in 2010, 10% in 2011 and 5% in 2012); elective admission or not; primary payer (Medicare, Medicaid, private including health maintenance organization, uninsured, no charge, other); median income in patient"'s zip code (categorized into quartiles relative to the nationwide distribution for each year); hospital size (estimated using the number of beds, categorized by size as small, medium, large); location/teaching (rural, urban nonteaching, urban teaching); and region (Northeast, Midwest, South, or West). The total number of hospital charges, procedures, diagnoses, and LOS (days) were also included with each discharge. Charges were adjusted for 2012 US dollars by Consumer Price Index [19].

The comorbidities were derived from the coexisting medical conditions that are not related to the principal diagnosis in NIS and were defined by the Agency for Healthcare Research and Quality comorbidity measures [20]. These coexisting medical conditions were based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes and include those diagnoses that preceded the hospitalization. Potential comorbidities were grouped as the following: (1)acquired immune deficiency; (2) substance abuse (alcohol abuse, drug abuse); (3)rheumatoid arthritis/collagen vascular diseases; (4)congestive heart failure; (5)hypertension, uncomplicated and complicated; (6)peripheral vascular disorders, disease; (7)pulmonary diseases (chronic pulmonary disease, pulmonary circulation disorders); (8)depression/psychoses; (9)diabetes uncomplicated/with chronic complications; (10)liver disease; (11)renal disorders (fluid and electrolyte disorders, renal failure); (12)cancer (metastatic cancer, lymphoma, solid tumor without metastasis); (13)paralysis/other neurologic disorders were also evaluated; (14)obesity; and (15)weight loss and reported for each discharge together with the severity of illness for the patient measured according to the All Patient Refined Diagnosis Related Groups (classified into minor loss of function, including cases with no comorbidity or complications; moderate loss of function; major loss of function; extreme loss of function).

For the purpose of the study, the 7 following organ failures were identified by the *ICD-9-CM* codes (Table 1) An indication of any organ failure was created in the presence of at least 1 of the 7 organ failures.

2.4. Data analysis

Simple descriptive statistics were examined by calendar year and by disposition status. To analyze patient disposition, we used a multivariate multinomial logistic model with routine discharge to home (without home health services) as the reference, and demographic, socioeconomic, hospital, and clinical characteristics as the independent variables. We used backward model selection ($P = .10$) to select a robust set of independent variables for the final model (Table 5). The natural logarithm transformed the following variables: the total charge, LOS, and number of procedures in the models to highly right skewed variation. A 2-sided P value less than .05 was considered statistically