[Original Research]

CHEST

Three-Hour Bundle Compliance and Outcomes in Patients With Undiagnosed Severe Sepsis

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BACKGROUND: The aim of this study was to compare completion of the Surviving Sepsis Campaign 3-hour treatment recommendations and patient-centered outcomes between patients who received a sepsis-specific diagnosis with those who did not.

METHODS: This was a retrospective cohort analysis of adult patients admitted through an academic medical center ED who received an antibiotic and met criteria for severe sepsis. We measured and compared the Surviving Sepsis Campaign 3-hour treatment recommendations along with patient-centered outcomes in patients who were diagnosed with severe sepsis and those who were not.

RESULTS: A total of 5,631 patients were identified (60.6 $\pm$ 17.2 years of age; 48.9% women). Less than half (32.8%) received an International Classification of Diseases, ninth revision, diagnosis code of 995.92. Completion of all four bundle components in $<$ 3 hours was low for all patients (8.72%). Therapeutic components (a broad-spectrum antibiotic and IV fluids) were completed more often (31.3%). Those with a diagnosis code received all four bundle components (10.2% vs 7.9%; $P < .005$), as well as therapeutic components at a higher frequency (36.0% vs 29.0%; $P < .001$). Patients with a diagnosis code had higher mortality (6.3% vs 2.3%), more frequent ICU admissions (44.7% vs 22.5%), and longer hospitalizations (9.2 $\pm$ 6.9 days vs 6.9 $\pm$ 6.7 days) than did patients with severe sepsis with no diagnosis code (all $P < .001$).

CONCLUSIONS: Severe sepsis continues to be an underdiagnosed and undertreated condition. Patients who were diagnosed had higher treatment rates yet experienced worse outcomes. Continued investigation is needed to identify factors contributing to diagnosis, treatment, and outcomes in patients with severe sepsis. CHEST 2017; ■(■):■-■

KEY WORDS: clinical coding; ICD-9; outcomes; severe sepsis; treatment bundles

ABBREVIATIONS: CHEST/SCCM = American College of Chest Physicians/Society of Critical Care Medicine; HERON = Healthcare Enterprise Repository for Ontological Narration; ICD-9 = International Classification of Diseases, ninth revision; SOFA = Sequential Organ Failure Assessment

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Severe sepsis is a syndrome of life-threatening organ dysfunction due to a dysregulated host response to infection. It is the leading cause of death among hospitalized patients with infection.[1,2] Despite evidence that early recognition and interventions decrease severe sepsis mortality and morbidity, patients meeting severe sepsis criteria are underdiagnosed. It is estimated that only one in five patients with severe sepsis received an International Classification of Diseases, ninth revision (ICD-9) code of 995.92.[3-5] We hypothesized that uncoded cases represent an underdiagnosed and undertreated group of patients with severe sepsis.

There are limited data regarding treatment rates and outcomes of patients with severe sepsis who are not specifically diagnosed as having sepsis. Only one study to date has compared outcomes between patients with severe sepsis who received codes for sepsis and those who did not. Whittaker et al[5] found that patients with a code of 995.92 had higher mortality rates, longer hospitalizations, and higher measures of organ dysfunction when compared with patients with severe sepsis who received a code. To our knowledge, these findings have not been replicated, and treatment differences between patients who were or were not diagnosed and given a code to indicate they had the condition have not been compared. The primary objective of this study was to compare both treatments and patient-centered outcomes among patients who were diagnosed with severe sepsis and patients who met clinical criteria for severe sepsis but who were not specifically diagnosed with severe sepsis.

Methods

All patients admitted through the University of Kansas Hospital ED from November 1, 2007 (inception of the institution's electronic medical record) through September 30, 2015 (last date before conversion to the ICD-10 diagnosis codes) were eligible for study inclusion. Study inclusion required that patients were ≥ 18 years of age, received an ICD-9 diagnosis code for acute infection, were given an antibiotic within 8 hours of ED triage defined as an initial nursing evaluation, and had discharge disposition codes available for the encounter. We required an antibiotic to be given within 8 hours of triage to better identify those presenting with the condition rather than acquiring sepsis during the hospitalization. After meeting these inclusion criteria, patients were retained for analysis if they met case definitions for severe sepsis: (1) a 995.92 ICD-9 diagnosis code for severe sepsis or (2) documented presence of an infection plus two or more sites of organ dysfunction. Acute organ dysfunction was defined either by using specific ICD-9 diagnosis codes or by the presence of an abnormal first laboratory or physiological marker of acute organ dysfunction (e-Tables 1, 2). Laboratory threshold values followed those proposed by the American College of Chest Physicians/Society of Critical Care Medicine (CHEST/SCCM) definitions.[6,7] Any patient who had criteria for shock who did not meet criteria for severe sepsis or who was not given an antibiotic within 8 hours of triage was excluded from subsequent analysis. We required that patients have organ dysfunction at two or more sites to increase the likelihood that patients had severe sepsis and not isolated organ dysfunction associated with the same site of infection.

The primary outcome measure was completion of the Surviving Sepsis Campaign 3-hour treatment bundle.[8] Each component of the protocol (blood culture ordered, serum lactate levels ordered, broad spectrum-antibiotics administered, and appropriate IV fluids administered) was analyzed independently for frequency of completion within 3 hours. If all four components were completed within 3 hours, the patient was considered to have had successful bundle completion. Appropriate fluid was defined as either IV fluids given at 30 mL/kg if the patient was hypotensive or had a lactate level > 4 mmol/L or no IV fluids if the patient was normotensive and lactate levels were < 4 mmol/L.[8] Additionally, completion of the therapeutic components (defined as both a broad-spectrum antibiotic and appropriate fluids given within 3 hours of triage) was analyzed separately, as these two components have been shown to individually improve mortality. Fluid times were limited to those initiated within $2^1/_2$ hours of triage time to prevent overestimating the actual fluid received by a patient, as fluids could have been initiated, but not completed, by the 3-hour mark.

The second study goal was to compare patient-centered outcomes, including hospital mortality, 30-day readmission, and length of stay, between patients with and those without an ICD-9 code specific to severe sepsis (code 995.92). To evaluate for differences in illness at presentation and baseline medical status, Sequential Organ Failure Assessment (SOFA) scores and Charlson Comorbidity Index scores were calculated and compared. SOFA scores were calculated using the first laboratory and physiological values recorded to capture illness status at ED triage.

Data cleaning and sensitivity analysis were performed using SAS software, version 9.4 (SAS Institute Inc.). All binary outcomes were analyzed using the χ^2 test, and continuous data were evaluated using the Student *t* test. Multivariable logistic regression analysis was performed to identify independent predictors of patients receiving complete treatment within the first 3 hours of admission and factors associated with receiving an ICD-9 diagnosis code of 995.92. Overall model fit was assessed using the Hosmer and Lemeshow goodness of fit test, in which a higher *P* value signifies a better overall fit.

The university's institutional review board approved this study with a waiver of informed consent (study No. 00001753). Data were collected from the electronic medical record using the i2b2-based interface query tool HERON.[9] Flowsheet data not captured by the HERON interface were electronically obtained from the hospital's SQL database by matching medical record numbers and triage dates with the query software Crystal Reports (SAP Software Solutions).