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Prevalence and Clinical Characteristics of Patients With Sepsis Discharge Diagnosis Codes and Short Lengths of Stay in U.S. Hospitals

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OBJECTIVES: Some patients diagnosed with sepsis have very brief hospitalizations. Understanding the prevalence and clinical characteristics of these patients may provide insight into how sepsis diagnoses are being applied as well as the breadth of illnesses encompassed by current sepsis definitions.

DESIGN: Retrospective observational study.

SETTING: One-hundred ten U.S. hospitals in the Cerner HealthFacts dataset (primary cohort) and four hospitals in Eastern Massachusetts (secondary cohort used for detailed medical record reviews).

PATIENTS: Adults hospitalized from April 2016 to December 2017.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: We identified hospitalizations with *International Classification of Diseases,* 10th Edition codes for sepsis (including sepsis, septicemia, severe sepsis, and septic shock) and compared "short stay sepsis" patients (defined as discharge alive within 3 d) versus nonshort stay sepsis patients using detailed electronic health record data. In the Cerner cohort, 67,733 patients had sepsis discharge diagnosis codes, including 6,918 (10.2%) with short stays. Compared with nonshort stay sepsis patients, short stay patients were younger (median age 60 vs 67 yr) and had fewer comorbidities (median Elixhauser score 5 vs 13), lower rates of positive blood cultures (8.2% vs 24.1%), lower rates of ICU admission (6.2% vs 31.6%), and less frequently had severe sepsis/septic shock codes (13.5% vs 36.6%). Almost all short stay and nonshort stay sepsis patients met systemic inflammatory response syndrome criteria at admission (84.5% and 87.5%, respectively); 47.2% of those with short stays had Sequential Organ Failure Assessment scores of 2 or greater at admission versus 73.2% of those with longer stays. Findings were similar in the secondary four-hospital cohort. Medical record reviews demonstrated that physicians commonly diagnosed sepsis based on the presence of systemic inflammatory response syndrome criteria, elevated lactates, or positive blood cultures without concurrent organ dysfunction.

CONCLUSIONS: In this large U.S. cohort, one in 10 patients coded for sepsis were discharged alive within 3 days. Although most short stay patients met systemic inflammatory response syndrome criteria, they met Sepsis-3 criteria less than half the time. Our findings underscore the incomplete uptake of Sepsis-3 definitions, the breadth of illness severities encompassed by both traditional and new sepsis definitions, and the

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possibility that some patients with sepsis recover very rapidly.

KEY WORDS: administrative data; sepsis; short hospitalizations

Sepsis hospitalizations are associated with substantial morbidity, mortality, and costs to the healthcare system (1, 2). However, there is substantial variability in how sepsis is diagnosed and coded (3–5). "Sepsis" connotates severe illness and organ failure for many clinicians, yet a significant fraction of patients diagnosed with sepsis never require ICU care, are hospitalized for very short intervals, or are even discharged home directly from the emergency department (6–8). It is unclear whether this reflects variability in what clinicians consider sepsis, differences in which sepsis definitions clinicians use and how they apply them, rapid recovery following appropriate therapy, misdiagnosis of noninfectious conditions as sepsis, and/or financial incentives to code patients for sepsis.

In 2016, the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) defined sepsis as "life-threatening organ dysfunction secondary to a dysregulated immune response to infection," replacing traditional definitions based on systemic inflammatory response syndrome (SIRS) criteria and eliminating the term "severe sepsis" (9). However, it is unclear the degree to which the Sepsis-3 definitions have penetrated clinical practice in the United States, particularly as the Centers for Medicare and Medicaid Services (CMS) continues to use SIRS-based definitions for the Severe Sepsis/Septic Shock Early Management Bundle (SEP-1) and the *International Classification of Diseases,* 10th Edition (ICD-10) lexicon still includes codes for severe sepsis (10).

Understanding the clinical characteristics of patients diagnosed with sepsis and discharged alive after short hospitalizations may provide insight into how sepsis definitions are being applied as well as the breadth of illnesses encompassed by current definitions. We therefore assessed the clinical characteristics of short stay sepsis patients using detailed electronic health record (EHR) data from a large cohort of U.S. hospitals.

METHODS

Study Design, Data Source, and Patients

This was a retrospective cohort study using the Cerner HealthFacts dataset, a deidentified database populated with clinical data from geographically diverse U.S. hospitals that use the Cerner EHR system (1). We included patients 18 years or older hospitalized between April 2016 (after publication of Sepsis-3 definitions [9]) and December 2017. The study was approved by Mass General Brigham (MGB) Institutional Review Board (protocol 2016P001291).

We identified patients with discharge diagnoses for any of the ICD-10 codes specified in the denominator for the CMS SEP-1 measure, including septicemia, sepsis, severe sepsis, and septic shock (A021, A227, A267, A327, A400-401, A403, A408-409, A4101-4102, A411-414, A4150-4153, A4159, A4181, A4189, A419, A427, A5486, B377, R6520, R6521) (2). We defined "short stay sepsis" as patients discharge alive within 3 calendar days (excluding discharges to hospice). Three days was chosen as a cut off as this is a common length of stay target for short stay units (11–13). Patients who were transferred to another acute care hospital and those with missing discharge dispositions were excluded.

We compared the clinical characteristics of short stay versus nonshort stay sepsis patients, including Sequential Organ Failure Assessment (SOFA) scores and SIRS criteria (temperature > 100.9°F or < 96.8, heart rate > 90, respiratory rate > 20, and WBC count > 12 or < 4 × 10^9/L) at admission. SOFA scores were implemented as previously described in this dataset (14). For SOFA score and SIRS calculations, we included the worst physiologic values recorded up through 1 calendar day after presenting to the hospital to ensure that at least 24 hours of clinical data were available. We excluded sepsis hospitalizations with no reported temperature, heart rate, respiratory rate, blood pressure, creatinine, platelet, and WBC measurements to enable accurate SIRS and SOFA score calculations. Underlying infections and comorbidity burden (Elixhauser method) were defined using ICD-10, Clinical Modification, codes (15, 16).

Medical Record Reviews in Independent Cohort

We conducted 120 medical record reviews of a random sample of sepsis-coded hospitalizations (stratified evenly by short stay and nonshort stay) in a separate cohort of two academic hospitals (Brigham and Women's Hospital and Massachusetts General Hospital) and two community hospitals (Faulkner Hospital and Newton-Wellesley Hospital) in the MGB healthcare system in order to validate findings from the Cerner dataset. We did this because patients' medical records are not accessible from Cerner, and we felt it was important to correlate our EHR-based findings with insights gleaned from medical record reviews. Specifically, our medical record reviews focused on determining whether Sepsis-3 criteria were met, defined by an increase in patients' baseline SOFA score by greater than or equal to 2 points related to definite, probable, or possible infection, using previously described methodology (17). Medical record reviews were conducted among patients discharged alive in order to clearly delineate differences among those with hospital stays of less than or equal to 3 versus greater than 3 days. For patients who did not meet Sepsis-3 criteria, we assessed the treating physician's notes to determine their basis for diagnosing sepsis. An initial 20 cases were reviewed independently by two physician reviewers (I.K., V.A.) to assess interrater reliability for applying Sepsis-3 criteria. The two reviewers agreed in 16 of 20 cases (Krippendorff's alpha 0.61). The four discrepant cases were reviewed by a third physician (C.R.) and discussed together to make a final adjudication and to encourage standardized abstractions moving forward.

Statistical Analysis

All bivariate group comparisons were conducted using chi-square test and Student *t* test for categorical and continuous variables, respectively. All tests of significance used two-sided *p* values at less than or equal to 0.05. 95% CIs were calculated from binomial distributions. Analyses were conducted using SAS Version 9.4 (SAS Institute, Cary, NC) or Microsoft Excel 365 (Microsoft Corporation, Redmond, WA).

RESULTS

Characteristics of Short Stay versus Nonshort Stay Sepsis Hospitalizations in Cerner

The Cerner study cohort included 110 hospitals from across the United States (62 [56.4%] from the South, 20 [18.2%] West, 17 [15.5%] Midwest, 11 [10%] Northeast) of different sizes (73 [66.4%] with < 200 beds, 29 [26.4%] 200–499 beds, 8 [7.3%] ≥ 500 beds) and teaching status (37 [33.6%] teaching, 73 [66.4%] nonteaching). Among these hospitals, there were 67,733 patients with sepsis discharge diagnosis codes that met inclusion criteria, of whom 6,918 (10.2%) were discharged alive within 3 days (short stay sepsis) (study flowchart presented in **Fig. 1**). The proportion of short stay sepsis patients coded for severe sepsis or septic shock (as opposed to sepsis or septicemia alone) was 14.4%, compared with 38.1% in the nonshort stay group. Median length of stay was 3 days (interquartile range [IQR], 2–3 d) in short stay sepsis patients versus 8 days (IQR, 5–13 d) in nonshort stay patients. Of the

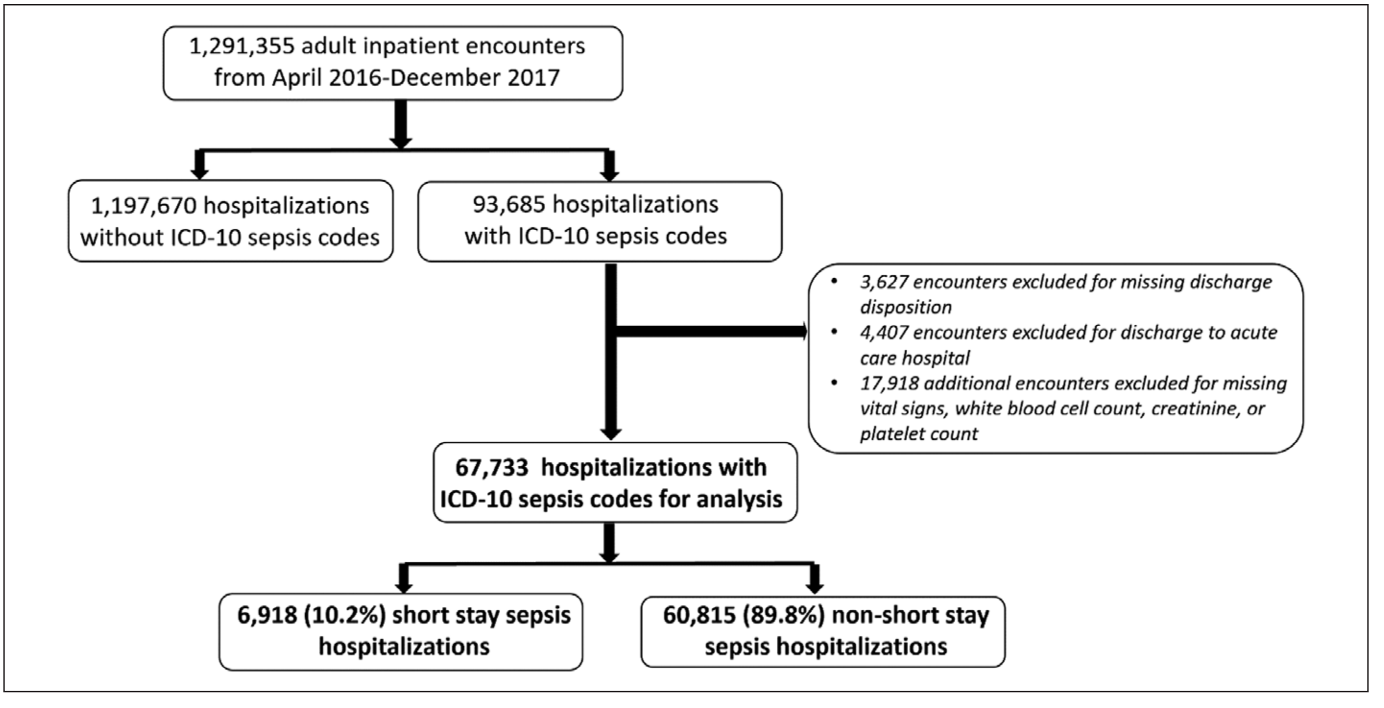

Figure 1. Study flowchart. ICD-10 = *International Classification of Diseases,* 10th Edition.

short stay sepsis patients, 185 (2.7%) were discharged alive within 1 day, 1,661 (24.0%) after 2 days, and 5,072 (73.3%) after 3 days; overall, 6,382 patients (92.3%) were discharged home, whereas only 534 (7.7%) were discharged to a facility.

Compared with nonshort stay sepsis patients, short stay patients were younger (median age 60 vs 67 yr) and had fewer comorbidities (median Elixhauser score 5 vs 13), lower rates of documented bacteremia (8.2% vs 24.1%), and lower rates of ICU admission (6.2% vs 31.6%) ($p < 0.01$ for all) (**Table 1**). Nearly all sepsis-coded patients met two or more SIRS criteria at admission, including 84.5% of short stay sepsis patients and 87.5% of nonshort stay sepsis patients. However, all other severity of illness markers at admission were substantially lower in short stay sepsis patients, and only 47.2% of short stay patients met Sepsis-3 criteria based on SOFA scores of 2 or greater at admission versus 73.2% in nonshort stay sepsis patients (**Fig. 2**). In-hospital mortality was 0% among short stay patients versus 13.1% in nonshort stay sepsis patients (and an additional 7.9% of nonshort stay patients were discharged to hospice).

The proportion of short stay and nonshort stay sepsis patients with SOFA scores of 2 or greater at admission across the different groups of sepsis diagnoses are shown in **Table 2**. Among the short stay patients coded for sepsis or septicemia ($n = 5,924$), 2,623 (44.3%) met Sepsis-3 criteria with SOFA scores greater than or equal to 2 at admission; the corresponding number was 64.8% (24,401/37,659 cases) in the nonshort stay sepsis group. The proportion of patients with SOFA scores of 2 or greater at admission was higher for severe sepsis and septic shock-coded patients in both the short stay and nonshort stay groups.

Presence of Sepsis-3 Criteria by Medical Record Reviews in Separate Hospital Cohort

In the MGB cohort, there were 6,035 sepsis-coded patients, of whom 352 (5.8%) had short stays. We reviewed 120 cases, including 60 short stay and 60 nonshort stay patients discharged alive; these medical record reviews confirmed that short stay sepsis patients less frequently met Sepsis-3 criteria (based on an increase in SOFA score by 2 or greater over baseline related to infection) versus nonshort stay patients (46.7% [28/60 cases] vs 75.0% [45/60]; $p < 0.01$) and had lower median increases in baseline SOFA scores (2 [IQR, 1–4] vs 4 [IQR, 3–6]). Of the 56 short stay sepsis patients coded for sepsis or septicemia without severe sepsis/septic shock codes, 25 (44.6%) met Sepsis-3 criteria; this proportion was 37 of 49 (75.5%) in the nonshort stay sepsis group. Among sepsis-coded patients in both short stay and nonshort stay groups who did not meet Sepsis-3 criteria ($n = 47$), reviewers determined that the diagnosis was likely based on infection with SIRS alone ($n = 25$) or with a lactate greater than 2 mmol/L but without other organ dysfunction ($n = 8$) or the presence of positive blood cultures without organ dysfunction ($n = 5$); reasons for sepsis diagnoses were unclear in nine patients.

DISCUSSION

In this large U.S. cohort, one in 10 patients with sepsis discharge diagnosis codes were discharged alive within 3 days of admission. Compared with other sepsis-coded patients, these short stay sepsis patients were younger and substantially healthier at baseline, had milder illnesses at admission, and were more often coded for sepsis/septicemia as opposed to severe sepsis or septic shock. Although almost all short stay sepsis patients met SIRS criteria, only 47% of them met Sepsis-3 criteria based on SOFA scores of 2 or greater at admission compared with 73% in nonshort stay sepsis patients. These findings were consistent in a separate hospital cohort when using detailed medical record reviews to manually abstract Sepsis-3 criteria. Our findings underscore the variable use of Sepsis-3 criteria to diagnose sepsis and highlight the broad range of illnesses encompassed by current sepsis definitions, including mild events that resolve within 3 days.

There are few prior data on the prevalence of short hospitalizations in patients diagnosed with sepsis. Using data from a national cohort, Wang et al (7) found that 20% of patients with sepsis were discharged home from the emergency department, which is both a higher proportion and more rapid disposition than seen in our study. The sepsis definition in that analysis, however, was based on clinical criteria or infection and organ dysfunction codes without requiring sepsis diagnoses. Explicit sepsis codes tend to capture more severely ill patients with sepsis, which may explain the lower rate of sepsis patients being discharged home quickly in our study (18).

Although the Sepsis-3 criteria were published in February 2016 and branded as the new international

TABLE 1.
Characteristics of Patients With Sepsis Discharge Diagnosis Codes With Short Versus Nonshort Hospital Stays

Characteristics	Short Stay Sepsis Patients[a] (*n* = 6,918)	Nonshort Stay Sepsis Patients[a] (*n* = 60,815)
Median age (IQR)	60 (44–73)	67 (54–78)
Male sex[b], *n* (%)	3,404 (49.2)	31,288 (51.4)
Race[b], *n* (%)		
White	5,249 (75.9)	44,471 (73.1)
Black	995 (14.4)	10,383 (17.1)
Other	674 (9.7)	4,961 (8.2)
Comorbidities[c], *n* (%)		
Cancer	491 (7.1)	7,530 (12.4)
Congestive heart failure	636 (9.2)	15,862 (26.1)
Chronic lung disease	1,270 (18.4)	16,214 (26.7)
Diabetes mellitus	2,004 (29.0)	22,179 (36.5)
Neurologic disease	859 (12.4)	14,095 (23.2)
Renal disease	786 (11.4)	15,670 (25.8)
Median Elixhauser score (IQR)	5 (0–11)	13 (5–22)
Infectious diagnoses, *n* (%)		
Pulmonary infection	2,587 (37.4)	28,945 (47.6)
Urinary tract infection	2,443 (35.3)	22,669 (37.3)
Intra-abdominal infection	534 (7.7)	9,303 (15.3)
Skin/soft-tissue infection	288 (4.2)	3,762 (6.2)
Severe sepsis/septic shock codes, *n* (%)	994 (14.4)	23,156 (38.1)
Positive blood culture[d], *n* (%)	570 (8.2)	16,052 (24.1)
Median Sequential Organ Failure Assessment score at admission[e], median (IQR)	1 (1–3)	3 (1–5)
IV antibiotics at admission[e], *n* (%)	5,676 (82.1)	45,702 (75.2)
Required vasopressors on admission[e], *n* (%)	150 (2.2)	7,494 (12.3)
Required ICU admission, *n* (%)	430 (6.2)	19,193 (31.6)
Median hospital length of stay, d (IQR)	3 (2–3)	8 (5–13)
Discharge disposition, *n* (%)		
Home	6,382 (92.3)	30,859 (50.7)
Subacute facility	534 (7.7)	17,153 (28.2)
Hospice	0 (0)	4,827 (7.9)
In-hospital death	0 (0)	7,976 (13.1)

IQR = interquartile range.

[a]Sepsis hospitalizations were identified using the *International Classification of Diseases,* 10th Edition codes for septicemia, sepsis, severe sepsis, and septic shock. "Short stay sepsis" was defined as patients discharged alive within 3 d (excluding hospice discharges). "Nonshort stay sepsis" included all other patients with sepsis diagnosis codes.

[b]Sex was missing in three patients. Race was missing in 1,044 patients; missing race was included in the "Other" category.

[c]Comorbidities were imputed using the Elixhauser method. "Cancer" includes lymphoma, solid tumor without metastasis, and metastatic cancer. "Diabetes" includes diabetes with and without complications.

[d]Positive blood cultures exclude common skin contaminants (e.g., coagulase-negative *Staphylococci*).

[e]Sequential Organ Failure Assessment scores were calculated using the worst values up through 1 calendar day after presenting to the hospital. IV antibiotics and vasopressors include any of these medications given during this timeframe.

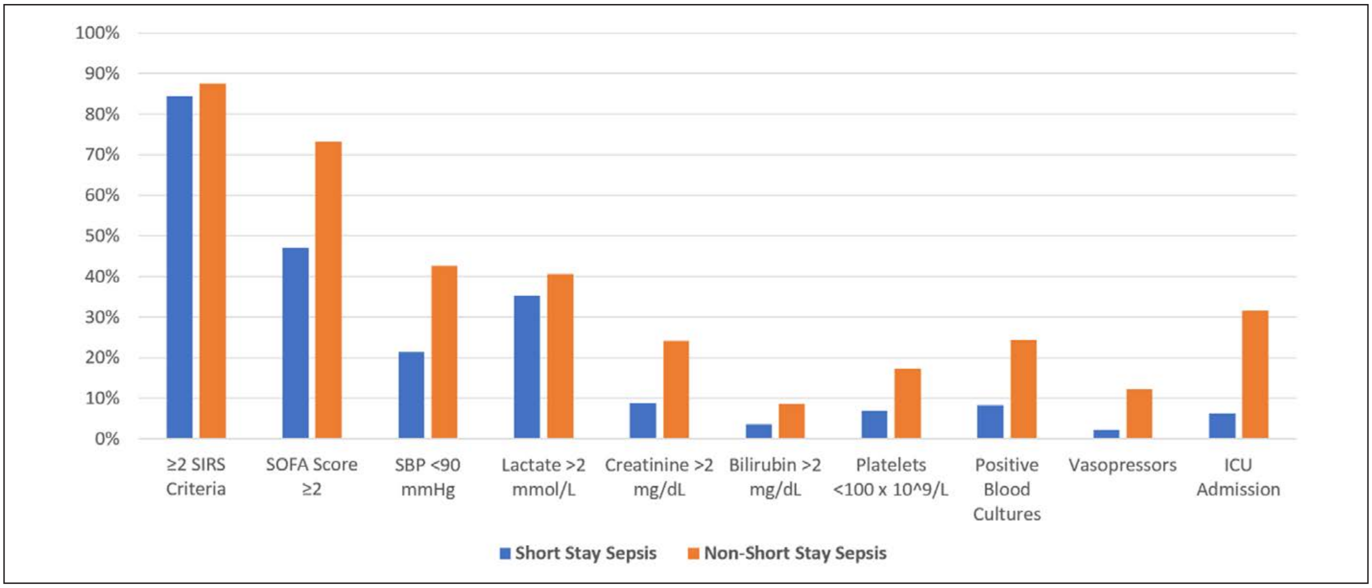

Figure 2. Comparison of severity of illness at admission between short stay and nonshort stay sepsis-coded hospitalizations. Systemic inflammatory response syndrome (SIRS) criteria, Sequential Organ Failure Assessment (SOFA) scores, systolic blood pressure (SBP), lactate, creatinine, bilirubin, platelets, and need for vasopressors were derived from the worst values up through 1 calendar day following the day of admission. Positive blood cultures (excluding common skin contaminants) and ICU admission reflect data throughout patients' entire hospitalization.

consensus definitions (9), they have been met with controversy; in particular, many experts have defended the traditional definitions based on decades of experience anchoring quality-improvement initiatives (19–21). CMS also announced their intention to continue using the traditional severe sepsis definition for SEP-1 pending further evaluation of Sepsis-3 (10). Even among nonshort stay sepsis patients in our analysis, more than a quarter did not meet Sepsis-3 criteria at admission, whereas most met SIRS criteria. The ongoing common use of SIRS to

TABLE 2.
Proportion of Sepsis-Coded Patients With Sequential Organ Failure Assessment Scores Greater Than or Equal to 2 at Admission Across Different Sepsis Diagnoses

Diagnosis Category	Short Stay Sepsis (n = 6,918), n (%)	Nonshort Stay Sepsis (n = 60,815), n (%)
Sepsis/septicemia	5,924 (85.6)	37,659 (61.9)
SOFA score ≥ 2	2,623/5,924 (44.3)	24,401/37,659 (64.8)
SOFA score < 2	3,301/5,924 (55.7)	13,258/37,659 (35.2)
Severe sepsis	733 (10.6)	8,784 (14.4)
SOFA score ≥ 2	433/733 (59.1)	7,010/8,784 (79.8)
SOFA score < 2	300/733 (40.9)	1,774/8,784 (20.2)
Septic shock	261 (3.8)	14,372 (23.6)
SOFA score ≥ 2	206/261 (78.9)	13,090/14,372 (91.1)
SOFA score < 2	55/261 (21.1)	1,282/14,372 (8.9)

SOFA = Sequential Organ Failure Assessment.

This table shows the number of patients in the short stay and nonshort stay sepsis groups who have codes for sepsis or septicemia (without severe sepsis/septic shock codes), severe sepsis (without septic shock), or septic shock. Within each diagnosis category, the number of patients who had SOFA scores of ≥ 2 vs < 2 at admission is reported.

diagnose sepsis was corroborated by our medical record reviews; in addition, we found that sepsis was commonly diagnosed based on elevated lactate levels or bacteremia without organ dysfunction. This underscores the inconsistent uptake of Sepsis-3 definitions as well as variability in how physicians apply sepsis diagnoses (3–5). Both of these factors could contribute to variability in comparing sepsis rates and outcomes across hospitals as well as potential bias in assessing sepsis trends over time using administrative data (22–24).

Our findings also have implications for surveillance, as there has been a recent movement to use electronic health record clinical data rather than administrative data to track sepsis prevalence and outcomes. CDC's Adult Sepsis Event definition requires 4 days of antibiotics (along with blood culture orders and concurrent organ dysfunction) so long as patients do not expire (or transition to hospice) before 4 days (1, 25). Thus, CDC's definition assumes patients with sepsis—as defined by Sepsis-3 criteria—are rarely discharged alive earlier than 4 days. Our study suggests, however, that this assumption will trade specificity at the cost of some sensitivity, as there are indeed some septic patients with SOFA scores of 2 or greater who respond quickly to treatment and can be discharged within 3 days. Future revisions of the Adult Sepsis Event definition, such as including discharge antibiotics, may need to be undertaken to acknowledge the full breadth of sepsis.

Our study has several limitations. First, it was retrospective and conducted within a convenience sample of hospitals, potentially limiting generalizability. However, the cohort was large, and the primary findings were consistent across two independent datasets. Second, ascertaining Sepsis-3 criteria by medical record reviews can be subjective, but we attempted to mitigate this by using a shared training set and leveraging consensus discussions. Third, our study was not designed to evaluate the quality of care provided for sepsis patient in our cohort, including timeliness of recognition and treatment, source control, and bundle compliance. We therefore cannot quantify the degree to which early and aggressive sepsis treatment was able to avert progression of organ dysfunction and adverse outcomes in some or many of the patients who ended up having short hospitalizations (26, 27). Fourth, it is likely that some of the nonshort stay sepsis patients did not develop sepsis until after admission, as prior studies suggest that 10–20% of sepsis cases develop in the hospital (28–30). This may have caused us to underestimate the proportion of these cases that met SIRS and Sepsis-3 criteria as well as underestimate the proportion of sepsis patients with relatively brief illnesses.

In conclusion, our analysis suggests that even after publication of the Sepsis-3 definitions, sepsis is still being diagnosed and coded based on traditional SIRS-based definitions in many patients; furthermore, both SIRS-based and Sepsis-3 definitions encompass a broad range of illnesses including mild events that can quickly resolve. These findings have important implications for sepsis epidemiology, surveillance, hospital benchmarking, and clinical care.

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