ORIGINAL ARTICLE

Association Between Physician Caseload and Patient Outcome for Sepsis Treatment

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q1 OBJECTIVE. The purpose of this study was to investigate whether physicians with larger sepsis caseloads provide better outcomes, defined as lower in-hospital mortality rates, for patients with sepsis.

q3 DESIGN. Retrospective cross-sectional study.

METHOD. This study used pooled data from the 2002–2004 Taiwan National Health Insurance Research Database. A total of 48,336 q4 patients hospitalized with a principal diagnosis of septicemia were selected and assigned to 1 of 4 caseload groups on the basis of their treating physician's sepsis caseload during the 3 years reflected in the pooled data (low caseload, less than 39 cases; medium caseload, 39– q5 88 cases; high caseload, 89–176 cases; and very high caseload, more than 176 cases). Generalized estimating equation models were used for analysis.

q6 RESULTS. Receipt of treatment from physicians in the very high, high, and medium caseload groups decreased patients' odds of in- q7 hospital mortality to 49% (95% confidence interval [CI], 41%–67%; $P < .001$), 40% (95% CI, 53%–68%; $P < .001$), and 18% (95% CI, 73%–92%; $P < .001$), respectively, of the odds for patients treated by low-caseload physicians. These findings persisted after partitioning out systematic physician-specific and hospital-specific variation and isolating the effects of most hospital, physician, and patient confounders.

q8 CONCLUSION. Patients treated by physicians who had a larger sepsis caseload had a substantially lower in-hospital mortality rate than did patients treated by physicians in the other caseload groups, and the difference was statistically significant. This result supports the "practice makes perfect" hypothesis.

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Sepsis is a common and devastating syndrome that represents a major cause of morbidity and mortality for hospitalized patients.[1] An 8.7% annual increase in the incidence of sepsis between 1979 and 2000 has been reported.[2] In addition, death rates range from 15% to 20% for sepsis, from 25% to 30% for severe sepsis, and from 40% to 70% for septic shock.[3] q9 Because of the high incidence, high mortality rate, and consequent healthcare burden associated with sepsis, clinicians and healthcare administrators frequently receive information about sepsis that emphasizes early detection and appropriate interventions to prevent deterioration of organ function.

Death that results from sepsis-induced organ failure is considered to be the consequence of an excessive or uncontrolled q10 host response to infection.[4] Because hospitals generally offer the equipment needed to diagnose and treat sepsis, most of the associated in-hospital mortality reflects the skills and clinical experience of the attending physicians and the support team.[5] Sepsis is an inherently complex disease that may be treated by physicians with various levels of clinical experience, and physician experience or caseload may play an important role in treatment outcomes.

Numerous studies have reported an inverse association between caseload and the rate of adverse outcomes, as a result of an increased awareness of accountability and elevated concern for quality of care and patient safety among high-caseload physicians.[6,7] In a review of more than 100 published q11 papers, 78% concerned physician caseload and outcomes for major surgical procedures,[8,9] and similar results were found for nonsurgical conditions requiring hospitalization, such as myocardial infarction and intensive care.[10,11] Despite the substantial body of literature, to our knowledge there have been q12 no studies to date that examined the effects of physician caseload on outcomes for patients with sepsis.

Thus, the purpose of this nationwide, population-based study was to investigate whether physicians with larger caseloads provide better outcomes for patients with sepsis. The in-hospital mortality rate was used to assess treatment outcome.

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TABLE 1. Distribution of In-Hospital Mortality for Patients Hospitalized for Treatment of Septicemia, According to Patient Characteristics and Comorbidities: Taiwan, 2002–2004

Variable	In-hospital mortality, no. (%) of patients: Yes (n = 5,628)	No (n = 42,708)	P
Sex			< .001
Male	3,479 (14.0)	21,349 (86.0)	
Female	2,149 (9.1)	21,359 (90.9)	
Age			< .001
<45 years	338 (6.8)	4,637 (93.2)	
45–64 years	1,010 (9.5)	9,589 (90.5)	
65–74 years	1,130 (9.6)	10,671 (90.4)	
>74 years	3,150 (15.0)	17,811 (85.0)	
Cardiac arrhythmia			.888
Yes	142 (11.5)	1,091 (88.5)	
No	5,486 (11.7)	41,617 (88.3)	
Congestive heart failure			< .001
Yes	543 (17.7)	2,523 (82.3)	
No	5,085 (11.2)	40,185 (88.8)	
Valvular disease			.003
Yes	20 (6.4)	295 (93.6)	
No	5,608 (11.7)	42,413 (88.3)	
Pulmonary circulation disorder			.778
Yes	10 (12.7)	69 (87.3)	
No	5,618 (11.6)	42,639 (88.4)	
Peripheral vascular disorder			< .001
Yes	54 (25.1)	161 (74.9)	
No	5,574 (11.6)	42,547 (88.4)	
Hypertension			< .001
Yes	381 (5.8)	6221 (94.2)	
No	5,427 (12.6)	36,487 (87.4)	
Paralysis			< .001
Yes	31 (5.7)	512 (94.3)	
No	5,597 (11.7)	42,196 (88.3)	
Coagulopathy			< .001
Yes	163 (24.9)	491 (75.1)	
No	5,465 (11.5)	42,217 (88.5)	
Neurological disorder			.032
Yes	150 (9.9)	1,364 (90.1)	
No	5,478 (11.7)	41,344 (88.3)	
Chronic pulmonary disease			.279
Yes	558 (12.1)	4,042 (87.9)	
No	5,070 (11.6)	38,666 (88.4)	
Diabetes			
Uncomplicated			<.001
Yes	617 (9.0)	6,250 (91.0)	
No	511 (12.1)	36,458 (87.9)	
Complicated			<.001
Yes	490 (9.6)	4,628 (90.4)	
No	5,138 (11.9)	38,080 (88.1)	
Hypothyroidism			.018
Yes	48 (8.5)	519 (91.5)	
No	5,580 (11.7)	42,189 (88.3)	
Renal failure			<.001
Yes	797 (15.2)	4,460 (84.8)	
No	4,831 (11.2)	38,248 (88.8)	
Liver disease			<.001
Yes	535 (9.8)	4,924 (90.2)	
No	5,093 (11.9)	37,784 (88.1)	
Peptic ulcer disease, excluding bleeding			<.001
Yes	84 (4.5)	1,780 (95.5)	
No	5,544 (11.9)	40,928 (88.1)	
Solid tumor without metastasis			<.001
Yes	688 (15.8)	3,666 (84.2)	
No	4,940 (11.2)	39,042 (88.8)	
Rheumatoid arthritis			.028
Yes	33 (8.2)	372 (91.9)	
No	5,595 (11.7)	42,336 (88.3)	
Fluid and electrolyte disorder			<.001
Yes	350 (9.9)	3,179 (90.1)	
No	5,278 (11.8)	39,529 (88.2)	
Deficiency anemia			<.001
Yes	197 (8.3)	2,177 (91.7)	
No	5,431 (11.8)	40,531 (88.2)	
Alcohol abuse			.004
Yes	5 (3.7)	129 (96.3)	
No	5,623 (11.7)	42,579 (88.3)	
Psychosis			.083
Yes	35 (8.9)	360 (91.1)	
No	5,593 (11.7)	42,348 (88.3)	
Depression			< .001
Yes	1 (0.9)	105 (99.1)	
No	5,627 (11.8)	42,603 (88.3)	
AIDS			.001
Yes	6 (37.5)	10 (62.5)	
No	5,622 (11.6)	42,698 (88.4)	
Lymphoma			.006
Yes	63 (16.1)	328 (83.9)	
No	5,565 (11.6)	42,380 (88.4)	
Metastatic cancer			<.001
Yes	249 (16.8)	1,231 (83.2)	
No	5,379 (11.5)	41,477 (88.5)	
Weight loss			.972
Yes	51 (11.6)	389 (88.4)	
No	5,577 (11.6)	42,319 (88.4)	
Drug abuse			.042
Yes	7 (5.7)	115 (94.3)	
No	5,621 (11.7)	42,593 (88.3)	
Blood loss anemia			.002
Yes	9 (4.5)	192 (95.5)	
No	5,619 (11.7)	42,516 (88.3)	

NOTE. The total number of patients was 48,336, and the overall in-hospital mortality rate was 11.6%.

METHODS

Database

This study used pooled data from the 2002–2004 *National Health Insurance Research Database* (NHIRD) published by the Taiwan National Health Research Institute. The NHIRD includes monthly claims summaries that consist of inpatient claims, details of inpatient orders, a registry of contracted medical facilities, and a registry of board-certified specialists for every inpatient admission of a National Health Insurance

(NHI) beneficiary. Taiwan's NHI provides universal coverage to all citizens—more than 21 million people (approximately 97% of Taiwan's population). It is a single plan that provides generous benefits, low copayments, and free choice in a widely dispersed network of healthcare providers. The NHIRD provides a unique opportunity to explore the relationship between physician caseload and treatment outcomes for sepsis. Because the NHIRD consists of deidentified secondary data released to the public for research purposes, this study was exempt from full review by the institutional review board.

Study Sample

We selected all records for all patients who were hospitalized with a principal diagnosis of septicemia (*International Classification of Diseases, 9th Revision, Clinical Modification,* code 038) ($n = 63{,}169$). We included only patients with a principal diagnosis of septicemia to assure that all individuals selected were admitted for treatment of septicemia, rather than other disorders. We limited the study sample to the adult population, excluding patients under 18 years of age ($n = 4{,}263$). We also excluded patients who were discharged against medical advice or transferred to another hospital and patients who had been transferred in from another hospital ($n = 2{,}678$). We limited our study sample to first-time admissions, if a patient had been admitted more than once during the period covered by the data. Ultimately, a total of 48,336 patients were included in this study.

Physicians' Septicemia Caseloads

Unique physician identifiers are available in the NHIRD for each medical claim submitted, which enabled us to identify when the same physician admitted 1 or more patients for septicemia treatment during the study period. All physicians identified as treating patients for septicemia were sorted in ascending order of caseload, and caseload cutoff points were determined so as to classify the sampled patients into 4 groups of approximately equal size, in accordance with standard practice.[10,12,13] The sample of 48,336 patients was thus divided into 4 caseload groups on the basis of their treating physician's sepsis caseload during the 3 years reflected in the pooled data. The caseload groups were as follows: fewer than 39 cases, 39–88 cases, 89–176 cases, and more than 176 cases (hereafter referred to as the "low caseload," "medium caseload," "high caseload," and "very high caseload" groups, respectively).

Statistical Analysis

We used SAS, version 9.1 (SAS Institute), for statistical analysis. The key independent variable of interest was physician caseload, and the key dependent variable was in-hospital death, for which "patient" was the unit of analysis. In-hospital death was treated as a dichotomous variable (yes or no) and was defined as the death of a patient at any time after admission if the patient had not left the hospital.

Global χ^2 analyses were conducted to examine the relationship between variables of interest and the unadjusted rate of in-hospital patient deaths. We employed a generalized estimating equation model to account for any clustering of the sampled patients with respect to particular hospitals and/or physicians.[14]

In the modeling, we adjusted for physicians' sex, age (divided into the following 3 categories: younger than 41 years, 41–50 years old, and older than 50 years), and specialty (presented as infection, internal medicine, surgery, or other); the hospital's accreditation level; and patients' age, sex, and comorbidities. The hospital accreditation level variable, which was used as a proxy for both hospital size and clinical service capabilities, classified each hospital as a medical center (with a minimum of 500 beds), a regional hospital (minimum 250 beds), or a district hospital (minimum 20 beds). We adjusted for patients' comorbidities by using the Elixhauser Comorbidity Index.[15] This comorbidity index has been widely used for risk adjustment in administrative data sets,[16,17] and it uses 30 binary comorbidity measures (ie, 1 indicates the comorbidity is present, and 0 indicates that it is absent) to account for inpatient morbidity and mortality rates. On the basis of available data and a literature review, we initially inserted all potential variables in the model. Then, we used the quasi-likelihood under the independence model criterion to select an appropriate model, with the smallest criterion value chosen as the best model.[18]

Finally, to detect a critical caseload level at which the hazardous effects of low caseload vanished, we used model results to ascertain the critical caseload that would divide the cohort into 2 significantly different groups. A 2-sided P value of .05 was employed.

RESULTS

Table 1 shows the distribution of in-hospital mortality after treatment of septicemia, according to patient sex, age, and comorbidities. Of 48,336 patients admitted during the 3 years for which data were studied, 5,628 (11.6%) were discharged at death. Global χ^2 analyses showed that there were statistically significant differences in the in-hospital mortality rate with respect to sex ($P < .001$), age ($P < .001$), and comorbidity (congestive heart failure [$P < .001$], valvular disease [$P = .003$], peripheral vascular disorders [$P < .001$], hypertension [$P < .001$], paralysis [$P < .001$], coagulopathy [$P < .001$], neurological disorders [$P = .032$], uncomplicated diabetes [$P < .001$], complicated diabetes [$P < .001$], hypothyroidism [$P = .018$], renal failure [$P < .001$], liver disease [$P < .001$], peptic ulcer [$P < .001$], solid tumors without metastasis [$P < .001$], rheumatoid arthritis [$P = .028$], fluid and electrolyte disorders [$P < .001$], deficiency anemia [$P < .001$], alcohol abuse [$P = .004$], depression [$P < .001$], AIDS [$P = .001$], lymphoma [$P = .006$], metastatic cancer [$P < .001$], drug abuse [$P = .042$], and blood loss anemia [$P = .002$]).

Table 2 shows the distribution of in-hospital mortality rates, patient characteristics, and physician characteristics

TABLE 2. Physician and Patient Data, According to Physicians' Septicemia Caseload Group: Taiwan, 2002–2004

Variable	Caseload group			
	Low, <39 cases	Medium, 39–88 cases	High, 89–176 cases	Very high, >176 cases
In-hospital mortality rate, %	16.0	12.9	9.7	7.9
Physician data				
Total no.	3,556	818	37	136
Sepsis caseload, mean ± SD	13.7 ± 10.0	58.0 ± 14.0	120 ± 24.4	276 ± 99.7
Age				
⩽40 years	1,807 (50.8)	445 (54.4)	183 (48.4)	57 (41.9)
41–50 years	1,239 (34.8)	276 (33.7)	148 (39.2)	58 (42.7)
>50 years	510 (17.3)	97 (11.9)	47 (12.4)	21 (15.4)
Mean ± SD	43.2 ± 7.9	42.1 ± 7.0	42.2 ± 6.9	43.1 ± 7.1
Sex				
Male	3,162 (88.9)	750 (91.7)	338 (89.4)	125 (91.9)
Female	394 (11.1)	68 (8.3)	40 (10.6)	11 (8.1)
Specialty				
Infection	44 (1.2)	36 (4.4)	34 (9.0)	27 (19.9)
Internal medicine	1,977 (55.6)	689 (84.2)	325 (86.0)	105 (77.2)
Surgery	401 (11.3)	40 (4.9)	8 (2.1)	1 (0.7)
Other	1,134 (31.9)	53 (6.5)	11 (2.9)	3 (2.2)
Patient data				
Total no.	12,323	12,144	12,161	11,708
Age				
<45 years	1,130 (9.2)	1,082 (8.9)	1,154 (9.5)	1,609 (13.7)
45–64 years	2,759 (22.4)	2,701 (22.2)	2,684 (22.1)	2,455 (21.0)
65–74 years	3,109 (25.2)	3,067 (25.3)	2,965 (24.4)	2,660 (22.7)
>74 years	5,325 (43.2)	5,294 (43.69)	5,358 (44.1)	4,984 (42.6)
Mean ± SD	68.8 ± 15.7	69.0 ± 15.7	68.8 ± 16.0	66.8 ± 18.4
Sex				
Male	6,227 (50.5)	6,272 (51.7)	6,132 (50.4)	6,197 (52.9)
Female	6,096 (49.5)	5,872 (48.4)	6,029 (49.6)	5,511 (47.1)

NOTE. Data are no. (%) of subjects, unless otherwise indicated; percentages for all categories other than sex are the percentage of the relevant group, not the percentage of the total *n* value. Caseload groups indicate the physician's sepsis caseload during the 3 years reflected in the pooled data. The total number of patients was 48,336, and the total number of physicians was 4,888. SD, standard deviation.

across septicemia caseload groups. Patients who were treated by low-caseload physicians had statistically significantly higher in-hospital mortality rates than did patients treated by medium-caseload physicians (16.0% vs 12.9%; $P < .001$), high-caseload physicians (16.0% vs 9.7%; $P < .001$), or very high–caseload physicians (16.0% vs 7.9%; $P < .001$). During the 3 years for which data were studied, 4,888 physicians admitted and treated patients with septicemia; the mean (±SD) number of admissions was 36.6 ± 54.9. The mean age of patients was 68.4 years, and that the mean age of attending physicians was 42.9 years. The mean patient age was similar across all groups.

q21 Table 3 presents the crude and adjusted odds ratios for in-hospital mortality, according to the physicians' septicemia caseload. The results of the generalized estimating equations q22 model showed that the adjusted odds of in-hospital mortality for the patients of low-caseload physicians were approximately twice the odds of patients treated by very high–caseload physicians (OR, 1.91 [reciprocal of 0.51]; $P < .001$), 1.67 times the odds of patients treated by high-caseload physicians ($P < .001$), and 1.22 times the odds of patients treated by medium-caseload physicians ($P < .001$). We also found that the critical caseload per physician beyond which the outcome could not be improved further was 190 cases.

DISCUSSION

We found an inverse relationship between the in-hospital mortality rate and the sepsis caseload of attending physicians in the present study, which used nationwide, population-based data for 48,336 patients treated by 4,888 physicians. We provide compelling evidence that physicians with very high, high, and medium septicemia caseloads decreased patients' odds of in-hospital mortality to 49% (95% confidence interval [CI], 41%–67%), 40% (95% CI, 53%–68%), and 18% (95% CI, 73%–92%), respectively, of the odds for patients of low-caseload physicians. These findings held up after partitioning out systematic physician-specific and hospital-specific variation and isolating the effects of most hospital, physician, and patient confounders.

This study was one of the first studies of the caseload- q23 outcome relationship for sepsis treatment, and our results are

TABLE 3. Crude and Adjusted Odds Ratios for In-Hospital Mortality, According to Septicemia Caseload Group

Physician's caseload	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Low, <39 cases (reference group)	1.00	1.00
Medium, 39–88 cases	0.77 (0.72–0.83)	0.82 (0.73–0.92)
High, 89–176 cases	0.56 (0.52–0.61)	0.60 (0.53–0.68)
Very high, >176 cases	0.45 (0.41–0.49)	0.51 (0.41–0.67)

NOTE. Caseload groups indicate the physician's sepsis caseload during the 3 years reflected in the pooled data. For all comparisons with the reference group, $P < .001$. CI, confidence interval; OR, odds ratio.

[a] Adjusted for attending physician's age, sex, and specialty; the hospital's accreditation level; the patient's sex, age, and comorbidities (ie, congestive heart failure, valvular disease, peripheral vascular disorders, hypertension, paralysis, coagulopathy, neurological disorders, chronic pulmonary disease, uncomplicated diabetes, complicated diabetes, hypothyroidism, renal failure, liver disease, peptic ulcer, solid tumors without metastasis, fluid and electrolyte disorders, deficiency anemias, AIDS, lymphoma, metastatic cancer, and blood loss anemia); and physician random effect and hospital random effect (by use of a generalized estimating equations model).

broadly consistent with previous findings regarding the association between larger caseloads and better outcomes in a variety of clinical domains, including surgery (eg, vascular,[19] general,[20] and orthopedic surgery[21]) and treatment of nonsurgical conditions (e.g., pneumonia[10] and myocardial infarction[11]). With respect to treatment of sepsis in intensive care units (ICUs), Peelen et al.[22] found that receipt of treatment in an ICU that had a higher number of patients admitted with severe sepsis was associated with lower in-hospital mortality for these patients, compared with those admitted to an ICU with a lower sepsis case volume. Other studies have also demonstrated that seriously ill patients admitted to ICUs that treat a large number of patients have a lower mortality rate than patients admitted to ICUs that treat fewer patients.[23] Because patients with sepsis who are in critical condition are mostly cared for in the ICU, physician practices and the practices of multidisciplinary ICU teams should be highlighted to improve sepsis treatment outcomes. Furthermore, we identified a very high caseload (190 cases) beyond which the outcome could not be further improved, which indicates that the association between physician caseloads and patient outcomes was fairly constant as caseloads increased up to a very high level.

Several possible explanations have been proposed for the association between high physician caseloads and improved treatment outcomes, including the "practice makes perfect" hypothesis, which suggests that high-caseload physicians may control unexpected medical conditions and problems better,[6] consequently reducing the mortality rate among their patients. The heterogeneity of the patients with sepsis in our study (e.g., the causes of their disease, their comorbidities and complications, and their disease severity at initial presentation) is reflected in the striking variation in mortality risk.[24] Caseload, as a surrogate for experience and quality of care provided by physicians,[5] counts considerably toward effective management of a complex and dynamic disease like sepsis. Furthermore, caseload-outcome relationships for other diagnoses and procedures consistently show that patient outcomes in Taiwan are affected more by physician caseload than by hospital case volume.[25,26] The results of our study, in combination with those of other reports, thus support the "practice makes perfect" hypothesis. An alternative explanation for these results might be the potential effects of patients' selective self-referral to physicians with good reputations. However, patients with serious septicemia are admitted to an ICU or the nearest hospital without much time for self-referral. Patients' septicemia severity levels should, therefore, be fairly evenly distributed across physician caseload groups, and thus self-referral is less likely to affect our findings.

The caseload-outcome relationship we identified has several implications. Although previous reports have recommended selective referrals from low- to high-caseload providers,[9,27] additional problems may result from this practice, such as treatment delays that compromise patient safety and increased medical costs resulting from referrals; in addition, there is a lack of precise criteria for categorizing caseload in each locality. Thus, in addition to the regionalization q24
of care for severe sepsis cases, we propose that it is imperative to reduce the variation in the quality of medical care between low- and high-caseload physicians. As indicated by Sheikh's study,[28] the treatment procedures adopted by high-caseload physicians should be examined closely and used to develop more comprehensive clinical guidelines and protocols for sepsis care, such as competent early recognition of inflammation signs, precise intervention for comorbidities and complications, and appropriate use of empiric antibiotic treatment,[29] efficient fluid resuscitation,[30] and vasoactive drugs.[31] These q25
guidelines and protocols could then be used to modify the clinical practices of low-caseload physicians, thus improving the quality of care and reducing the risk of adverse outcomes. Furthermore, facilitating low-caseload physicians' cooperation with high-caseload physicians or introducing telemedicine (ie, remote-access consulting and transfer of information q26
by telephone or the Internet) to remote areas where physi-

cians have low caseloads could increase experience and the overall quality of care for sepsis treatment.[32]

This study has several unique strengths, including the use of a nationwide, population-based data set. The number of cases provided sufficient statistical power to detect differences between groups after adjusting for confounders. Further, it is generally believed that high-caseload physicians perform better simply because they practice in better-equipped hospitals. In addition, patients with particular characteristics might choose and remain with physicians who have specific characteristics, and thus patients in a physician's practice might "cluster." Our study used a generalized estimating equations model to allow examination of caseload-outcome relationships, taking clustering by physician and clustering by hospital into consideration.[14]

Two limitations of this study merit attention, however. First, because we used a claims database, it is possible to question whether the diagnoses in the database are accurate. However, the NHI implements routine sampling of patient records to cross-check each hospital's claims, and there are q27 punitive measures in place for fraudulent coding. Illegitimate increases in the severity of patient diagnoses should therefore be adequately restrained. This deterrent is further reinforced by the NHI's reimbursement system, which ties a hospital's q28 reimbursement rate to its patient severity profile. No documented systematic sensitivity analyses make diagnostic accuracy a potential limitation, and it is generally believed that the NHI's checks and balances promote accurate coding.

Second, systematic or unmeasured differences in clinical severity might exist across caseload groups. Nevertheless, patients' comorbidities (eg, diabetes mellitus, cardiovascular disease, or renal disease) should be adequately accounted for by the use of the Elixhauser Comorbidity Index, which provides a comprehensive approach to ascertaining a wide set of comorbidities in administrative data sets without additional refinement and applies to a broad range of diseases.[15] As discussed above, there is little time for patients with sepsis to self-refer to highly ranked physicians. Selection bias in terms of disproportionate distributions of patient severity profiles across caseload groups is thus less likely to have occurred and less likely to have confounded our results.

In summary, our study contributes to the literature by demonstrating that both more experience in treating sepsis and a greater sepsis caseload result in substantially lower in-hospital mortality rates, regardless of the institution. The "practice makes perfect" hypothesis is thus supported. Replication of our findings in other countries and settings is needed to further evaluate the caseload-outcome relationship for sepsis treatment. Future studies should be performed to identify modifiable factors (eg, exact clinical processes, physician practices, and degree of compliance with the guidelines, such as the Surviving Sepsis Campaign[33]) that might account for variation in quality across physician caseload groups. Effective strategies for improving treatment should be implemented to increase overall competence in sepsis care.

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QUERIES TO THE AUTHOR

1 Au: Your article has been edited for grammar, clarity, consistency, and adherence to journal style. To expedite publication, we no longer ask authors for approval of routine grammatical and style changes. Please read the article to make sure your meaning has been retained; any layout problems (including table and figure placement) will be addressed after we have incorporated corrections. Note that we may be unable to make changes that conflict with journal style, obscure meaning, or create grammatical or other problems. If you are writing corrections by hand, please print clearly, and be aware that corrections written too close to the edges of the paper may not transmit by fax. Finally, please note that a delayed, incomplete, or illegible response may delay publication of your article. Thank you!

2 Au: (**A**) Journal style does not allow the title to be a complete sentence, so I revised the title accordingly. Please indicate whether this change retains your intended meaning. (**B**) In the title and throughout, I have changed the phrase "caseload volume" to "caseload" (to clarify that this means "a volume or number of cases" not "a volume of caseloads," ie, because "caseload" is itself a measure of volume). Please check these changes and indicate whether they retain your intended meaning. If you would prefer to use the phrase "case volume" instead, please note that and I will revise the text accordingly.

3 Au: Affiliations have been edited according to journal style, please confirm that they are accurate and complete as shown.

4 Au: With respect to the sentence beginning "A total of. . . ," (**A**) I added the phrase "their treating physician's" to clarify how patients were sorted. Please indicate whether this addition retains your intended meaning. (**B**) I revised the sentence to indicate that the measure was caseload during the 3 years represented in the pooled data. I also made this change in the Methods section and in several of the tables. Please indicate whether the change is accurate. If not, please indicate the correct time period for the cases (e.g., cases per month or cases per year).

5 Au: Please indicate whether "were used for analysis" is an accurate interpretation of "were performed for analysis."

6 Au: Please indicate whether "decreased patients' odds of in-hospital mortality" is an accurate interpretation of "decreased patients mortality odds."

7 Au: With respect to the CIs that appear in this paragraph, (**A**) Originally, these numbers appeared only in the Abstract. I added them to the Discussion section where the percentage reductions were mentioned, but they should appear in Results as well (or perhaps instead). Please indicate where you would like to add them and I will revise the text accordingly. (**B**) The CIs were originally presented as decimal values. I changed them to percentages so that they matched the presentation of the main datum. Please indicate whether this change is accurate. If these should be presented as ORs (decimal values) with decimal-value CIs, please note that and I will revise the text. (**C**) The CI given for 18% is 73%–92%, which does not include 18%, and there is a similar problem with the CI for 40%. Please indicate what changes should be made here (I will make the same change to the values I added to the Discussion section). (**D**) I also added *P* values for this data. Please indicate whether these additions are accurate.

8 Au: Table 3 and the Results section of the article suggest that the difference in the mortality rate was statistically significant, so I revised the first sentence of the conclusion paragraph to include that information. Please indicate whether the revised sentence retains your intended meaning.

9 Au: I have edited the sentence beginning "Because of the . . ." for clarity. Please indicate whether it retains your intended meaning.

10 Au: I have edited the sentence beginning "Because hospitals generally . . ." for clarity. Please indicate whether it retains your intended meaning.

11 Au: Please clarify the sentence beginning "In a review . . . ." Specifically, (**A**) Which reference provides this review, 8 or 9? Or was the review conducted by the authors of the present study? (**B**) Should this sentence read "more than 100 published papers on sepsis" or something similar? Please indicate what criteria were used to select the 100 papers reviewed. (**C**) Please clarify how "intensive care" is meant to be a nonsurgical condition. Should this perhaps be something like "nonsurgical conditions requiring hospitalization, such as myocardial infarction, and receipt of intensive care"?

12 Au: I have added the phrase "to our knowledge" to the lase sentence in this paragraph. Please indicate whether this change is acceptable.

13 Au: Please clarify the meaning of "contracted medical facilities." Does this perhaps mean "medical facilities that have contracted to treat the patients" or something similar?

14 Au: To avoid single-sentence paragraphs, the last sentence of this paragraph has been combined with the material preceding it. Please indicate whether this change is acceptable.

15 Au: Please indicate whether "ICD-9-CM" is spelled out correctly.

16 Au: The *n* values given here for the excluded patients account for 6,941 of the 14,833 subjects who were excluded. Please indicate the reason(s) the other 7,892 subjects were

excluded, and the *n* value for each reason, and I will add that information to the text.

17 Au: Please indicate whether "physicians identified as treating patients for septicemia" is an accurate interpretation of "identified physicians."

18 Au: Please indicate whether "In-hospital death was treated as a dichotomous variable (yes or no)" is an accurate interpretation of "In-hospital death was dichotomous."

19 Au: The Results section does not seem to report this "critical caseload level" (although it does report a maximum caseload beyond which no further benefit was obtained). Please indicate where this information should appear and I will add it.

20 Au: **(A)** Table 1 originally included "other neurological disorder" as a row heading. Because the row immediately before it was not a neurological disorder ("coagulopathy"), I changed the row heading to "neurological disorder." I made a similar change to the list of comorbidities in this paragraph. "Neurological disorders" was also missing from the list of comorbidities in table 3, footnote a, so I added it. Please indicate whether these changes retain your intended meaning. **(B)** More generally, your tables have been edited in accordance with journal style. Please check carefully to ensure that all edits are acceptable and that the integrity of the data has been maintained. Please also confirm, where applicable, that units of measure are correct, that table column heads accurately reflect the information in the columns below, and that all material contained in table footnotes (including definitions of symbols and abbreviations) is correct.

21 Au: Because the original footnote b in table 3 applied to all numbers other than the reference group, I moved this information into the table note. Please indicate whether this change retains your intended meaning.

22 Au: I have edited the sentence beginning "The results of . . ." for clarity. Please indicate whether it retains your intended meaning.

23 Au: I have edited this paragraph for clarity. Please indicate whether it retains your intended meaning.

24 Au: Please clarify the meaning of the phrase "regionalization of care." Does this perhaps mean "provision of severe sepsis treatment in multiple regions" or something similar?

25 Au: I have edited the sentence beginning "These guidelines and . . ." for clarity. Please indicate whether it retains your intended meaning.

26 Au: I added the a brief definition of "telemedicine" to the sentence beginning "Furthermore, facilitating. . . ." Please indicate whether this addition retains your intended meaning.

27 Au: Please indicate whether "Illegitimate increases in the severity of patient diagnoses" is an accurate interpretation of "Diagnosis upcoding."

28 Au: Please clarify the phrase "patient severity profile." Does this mean that the hospital reimbursement system requires hospitals to treat patients from all levels of severity, or that the system pays a hospital more if it treats more patients who are severely ill? If the latter, please clarify how this practice would discourage hospitals from increasing the severity of diagnoses, as it seems to give them a reason to do just that.