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ORIGINAL ARTICLE

Urban and Rural Emergency Department Performance on National Quality Metrics for Sepsis Care in the United States

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Abstract

Purpose: The Centers for Medicare and Medicaid Services (CMS) and the American College of Emergency Physicians (ACEP) developed national quality measures for emergency department (ED) sepsis care. Like care for many conditions, meeting sepsis quality metrics can vary between settings. We sought to examine and compare sepsis care quality in rural vs urban hospital-based EDs.
Methods: We analyzed data from EDs participating in the national Emergency Quality Network (E-QUAL). We collected preliminary performance data on both the CMS measure (SEP-1) and the ACEP measures via manual chart review. We analyzed SEP-1 data at the hospital level based on existing CMS definitions and analyzed ACEP measure data at the patient level. We report descriptive statistics of performance variation in rural and urban EDs.
Findings: Rural EDs comprised 58 of the EDs reporting SEP-1 results and 405 rural patient charts in the manual review. Of sites reporting SEP-1 results, 44% were rural and demonstrated better aggregate SEP-1 bundle adherence than urban EDs (79% vs 71%; $P = .049$). Both urban and rural hospitals reported high levels of compliance with the ACEP recommended initial actions of obtaining lactate and blood cultures, with urban EDs outperforming rural EDs on metrics of IV fluid administration and antibiotics (74% urban vs 60% rural; $P \leq .001$; 91% urban vs 84% rural; $P \leq .001$, respectively).
Conclusions: Sepsis care at both rural and urban EDs often achieves success with national metrics. However, performance on individual components of ED sepsis care demonstrates opportunities for improved processes of care at rural EDs.

Key words emergency department, quality measurement, rural health, SEP-1, sepsis.

Sepsis is a leading cause of mortality in the United States and the most common cause of hospital death.[1,2] The emergency department (ED) serves as the primary site of initial treatment for sepsis patients hospitalized, with over 850,000 visits each year.[3] Early sepsis care alters mortality,[4,5] and ED volume is associated with sepsis outcomes, with higher sepsis mortality in low-volume EDs.[6,7] Low-volume EDs are often located in rural communities.[8] Patients who experience rural hospital bypass and interfacility transfer have observed worse outcomes.[9,10] Thus, rural EDs play an important role in sepsis survival.

Variation exists in compliance with well-established sepsis best practices,[11,12] an observation that prompts nationwide efforts to improve sepsis care quality. The Centers for Medicare and Medicaid Services (CMS) introduced the first national quality measure of sepsis care for public reporting and hospital accountability, commonly referred to as SEP-1.[13] Similarly, the American College of Emergency Physicians (ACEP) recently launched a Clinical Emergency Data Registry (CEDR) which includes several sepsis quality metrics. This registry seeks to support and align the clinician measurement of early screening, management, and reassessment of ED sepsis patients with hospital-focused measurement.[14]

In 2016, ACEP's Emergency Quality Network (E-QUAL) was launched with the support of the CMS Transforming Clinical Practice Initiative (TCPI) to help emergency clinicians improve the quality of sepsis care and meet requirements of the new CMS Quality Payment Program. Within the E-QUAL learning collaborative, EDs collect and submit contemporaneous sepsis quality improvement data for benchmarking purposes. Little is known about ED performance on any sepsis quality metrics outside of clinical trials limited to highly restricted patient populations in select academic centers.[15,16] Thus, the E-QUAL offers the first national insight into rural and community hospital emergency sepsis care. Recognizing the key role of early sepsis care and the differences between urban and rural settings that could impact delivery, we sought to describe and compare ED sepsis care quality measure performance between rural and urban EDs.

Methods

Study Design and Participants

We analyzed the E-QUAL Sepsis Initiative quality improvement (QI) data submitted voluntarily by US hospital-based EDs. Participation in E-QUAL is open to any ED in the United States. EDs voluntarily report to the E-QUAL sepsis initiative, and a large portion are sites already engaged in sepsis quality improvement. The dataset had no patient-identifiable information and was not considered human subjects research.

Data and Definitions

We collected data using a standard web-based submission portal. Each ED submitted institutional data including annual ED visit volume, hospital ZIP code, and hospital type (Academic/Emergency Medicine Residency, Academic/No Emergency Medicine Residency, Community). We classified EDs as rural or urban based on ZIP code Rural-Urban Commuting Area Codes.[17] All participating EDs reported sepsis quality data using 1 of 2 quality measurement options at their discretion:

CMS SEP-1 Preliminary Data Submission

EDs selecting this option obtained preliminary SEP-1 data from hospital quality staff or ED quality staff on which local chart review had been completed consistent with existing CMS definitions.[18] The SEP-1 measure is a composite clinical process measure reported as the proportion of eligible severe sepsis or septic shock patients receiving a bundle of care within a designated time period (Table 1). Each ED submitted preliminary SEP-1 data for October 1, 2016, through December 31, 2016, including measure details for each SEP-1 denominator (severe sepsis, septic shock, septic shock with persistent hypotension) and both the overall numerator as well as numerator components. These components included administration of 30 mL/kg IV fluids, blood cultures prior to antibiotics, early administration of antibiotics, lactate measurement, application of vasopressors and a reassessment of lactate, and each measure was evaluated only in qualifying patients. Consistent with the CMS SEP-1 measure specifications, sites collected data elements during the entire hospital stay, whether the bundle element was delivered in the ED or not. Importantly, the process excluded patients received in outside hospital transfer, consistent with the CMS definition.

ED Sepsis Chart Review

EDs selecting this option identified severe sepsis and septic shock cases based on an ICD-10 definition using ED diagnostic codes and consistent with the ACEP CEDR sepsis quality measures.[14] Rather than a composite measure of a bundle of care, each measure is calculated as an individual component indicating the proportion of severe sepsis and septic shock cases receiving each care component (Table 1). Specific process measures assessed include: administration of IV fluids, antibiotics, blood cultures, and

Table 1 Measure Definitions, Details of SEP-1 and ACEP Quality Measures

Measure	Numerator with Key Elements	Denominator
CMS		
SEP-1	Entire bundle completed, including all components specific to denominator	Severe Sepsis Denominator: ICD-10-CM diagnosis code of Sepsis, Severe Sepsis, Septic Shock
Components		
Lactate	Lactate drawn w/in 3 hours of presentation	Severe Sepsis
Blood cultures	Blood cultures drawn w/in 3 hours	Severe Sepsis
Antibiotics	Antibiotics given w/in 3 hours of presentation	Severe Sepsis
IV fluids	Received 30 cc/kg crystalloid fluid w/in 3 hours of presentation	Severe Sepsis
ACEP		Septic Shock and Severe Sepsis Denominator: ED diagnosis or clinical impression consistent w/ septic shock or severe sepsis or infection with hypotension (ICD-10 codes)
Components		
Lactate	Initial lactate resulted	Septic Shock and Severe Sepsis
Blood cultures	Blood culture draw before antibiotics	Septic Shock and Severe Sepsis
Antibiotics	Antibiotics received	Septic Shock and Severe Sepsis
30 cc/kg IV fluids	Received 30 cc/kg crystalloid fluid	Septic Shock and Severe Sepsis

both initial and repeat lactate measurement. Each participating hospital submitted chart review data for at least 20 sepsis cases that were the most recent sepsis cases seen at that hospital between October 1, 2016, and December 31, 2016. If sites had fewer than 20 available cases during the measurement period, all eligible cases were submitted. Data elements were collected at the individual department level. Similar to SEP-1, the process excluded patients received in transfer.

Outcomes

The primary outcome was compliance with SEP-1 or ACEP ED sepsis quality measures (depending on which was reported). We defined compliance for SEP-1 as the proportion of all severe sepsis and septic shock cases receiving all required bundle elements; for the ACEP measure, we defined compliance as the proportion of severe sepsis and septic shock patients, as defined by ACEP in the dataset, receiving each of the separately measured care processes.

Analysis

In our primary analysis, we report descriptive statistics of SEP-1 performance and ACEP ED sepsis quality performance, as well as a comparison between rural and urban EDs. As a sensitivity analysis, we also assessed sepsis quality performance on ACEP sepsis quality performance data restricted to hospitals who submitted 20 or more charts for review to avoid bias introduced by very low volume rural EDs or potential submission of "high performing" charts. Manuscript preparation followed SQUIRE 2.0 guidelines.[19] R version 3.3.3 (The R Foundation for Statistical Computing) was used for all analyses.

Table 2 Institutional Characteristics

	Overall	Urban	Rural
Number of sites	205 (100%)	127 (62%)	78 (38%)
Mean annual ED visit volume	32,516	42,997	20,494

Results

Of the 205 EDs participating in the ACEP E-QUAL Sepsis Initiative, the mean recent annual visit volume was 32,516 (Table 2). Each ED reported either SEP-1 or ACEP sepsis quality measures, with 2 sites reporting both. Of all SEP-1 reporting sites (n = 133), 75 urban and 58 rural EDs participated. Of the 74 sites reporting on the ACEP sepsis quality measure, a total of 1,457 patient records existed, with 1,052 (72.2%) urban and 405 (27.8%) rural locations.

For SEP-1 compliance, the mean hospital SEP-1 compliance proportion was higher for rural hospitals than urban hospitals (79% vs 71%; $P = .049$). With respect to performance variation, the median hospital SEP-1 compliance proportion was 80% overall (IQR: 62%–95%) as well as for rural (IQR: 67%–100%) and urban (IQR: 51%–90%) hospitals (Figure 1).

Figure 1 SEP-1 Performance, All EDs by Urban and Rural Status.

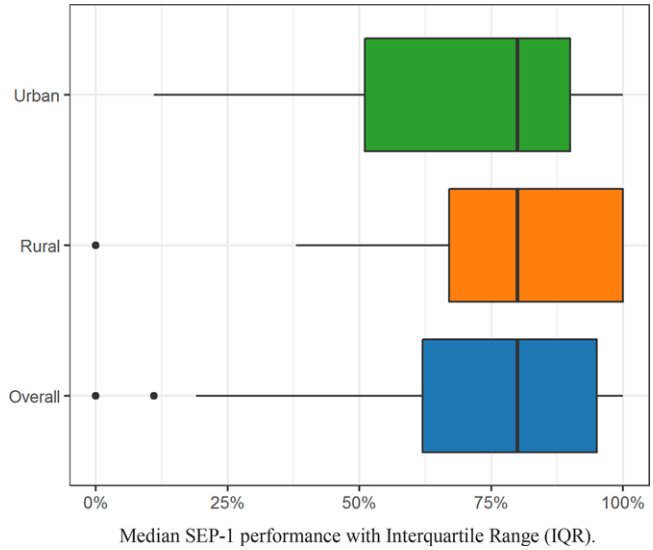
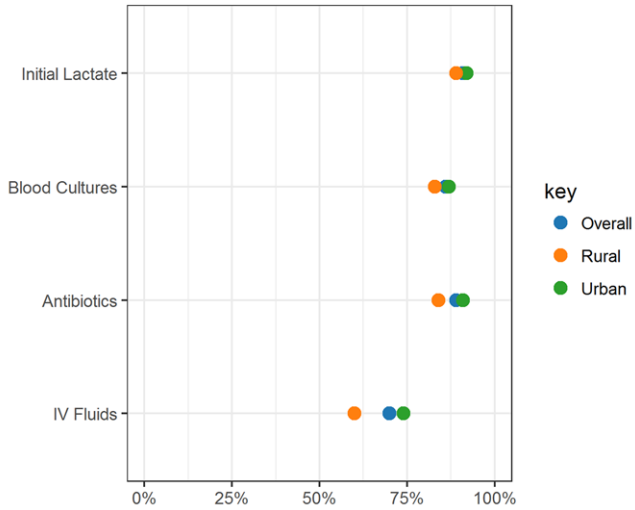


Figure 2 ACEP ED Sepsis Component Compliance, All EDs by Urban and Rural Status.



Mean ACEP ED sepsis component performance, individual components. Urban v. rural differences are statistically significant for IV fluid (74% vs. 60%, *P* value = < .001) and antibiotic (91% vs. 84%, *P* value = < .001) administration.

Chart review analysis of the ACEP sepsis quality measures demonstrated high levels of compliance for all patient encounters, with rural and urban EDs performing well in initial lactate collection (89% vs 92%, $P = .276$) and blood cultures (83% vs 87%, $P = .208$). However, compliance was lower for IV fluid (84% vs 91%; $P \leq .0001$) and antibiotic administration (60% vs 74%; $P \leq .0001$) for rural EDs when compared to urban EDs (Figure 2).

To explore the differences in urban/rural performance on SEP-1 and ACEP ED sepsis quality measures, we performed a sensitivity analysis by limiting our population to hospitals with 20 cases or greater to avoid bias introduced by very low volume rural EDs or potential submission of "high performing" charts. This analysis again demonstrated improved urban ED performance for IV fluid administration and antibiotic administration (Table 3).

Table 3 Sensitivity Analysis. ACEP ED Sepsis Component Measure Performance, Limited to EDs Reporting >20 Cases

	Overall	Urban	Rural	*P* value (χ^2)
Total charts (n)	1309	967	342	
Initial lactate	91%	92%	88%	.027
Blood cultures	85%	86%	82%	.240
Antibiotics	88%	91%	82%	<.001
IV fluid	71%	75%	59%	<.001

Limitations

This study sample included self-selected EDs actively involved in quality improvement efforts. It is likely their performance as "early adopters" of the E-QUAL Sepsis Initiative is not reflective of the average urban or rural ED. Further, observed performance may come from improvement in documentation as opposed to changes in care performance. For SEP-1 reporting, cases were identified based on actual billing practices, which is standard for quality improvement data collection and in use for national quality reporting, but it may be prone to some coding bias.

Discussion

The quality of early sepsis management in rural EDs is critical, as over 40% of all US EDs are in rural counties[8] and delays in early care are associated with worse outcomes.[20,21] Rural hospital bypass and interfacility transfer both are associated with increased sepsis mortality,[22] and transfer is associated with low adherence with national sepsis resuscitation guidelines.[10,22] This study expands the field of rural sepsis care research by being the first to examine compliance with national sepsis guidelines between rural and urban EDs/hospitals.

Literature on rural health care quality is scarce as rural hospitals are traditionally exempted or excluded from quality reporting. Studies examining rural Critical Access Hospital (CAH) quality show mixed results, with worse outcomes for acute illness such as pneumonia, heart failure, and acute myocardial infarction (AMI)[23,24] and equivalent outcomes for semielective surgery.[25] Structural barriers in rural health care delivery related to regionalization networks, limitations in resource availability, and variation in emergency practitioners' training[26] all make adherence with sepsis resuscitation guidelines challenging in the rural setting. Variation in ED sepsis care processes has been shown,[12] yet little is known about modern sepsis care delivery following various statewide and national efforts—particularly in the community and rural setting.

Improving sepsis care in rural settings is a worthy and achievable target for quality improvement. Reporting of quality measures by hospitals has grown exponentially in the past decade as federal, state, and private payer programs transition toward quality-based or quality-tiered hospital payment programs.[27] Quality reporting is a valuable tool in sepsis care, as mortality from sepsis is lower at hospitals with higher levels of guideline compliance[28-30] and reporting is linked to a reduction in sepsis mortality.[21] Our findings demonstrate that rural EDs can perform well on quality metrics for sepsis care. National efforts to establish AMI quality metrics, along with regionalization, have been successful in improving rural hospitals' quality metric performance[31,32] and reducing mortality in states with large rural populations.[33] Similarly, the development of national sepsis metrics may improve adherence to sepsis quality measures and reduce mortality—and our findings indicate that such metrics would not disproportionately penalize rural hospitals. Interestingly, the distribution of SEP-1 median performance indicates the presence of several higher-performing rural hospitals, highlighting an opportunity for these rural sites to engage in knowledge sharing networks to disseminate best practices with rural-specific guidance. Programs like E-QUAL, which has a rural-specific webinar series featuring rural-specific toolkits, may be useful in this way. In comparison, urban hospital median compliance is depressed due to several lower-performing urban hospitals. Thus, regardless of geography, establishing national metrics allows hospitals to benchmark their performance and adjust care delivery and quality accordingly.

Despite strong SEP-1 performance, there is opportunity to improve sepsis care in rural EDs, given our finding in ACEP quality measures of lower rates of IV fluid and antibiotic administration in rural EDs. IV fluid administration performance was particularly low when compared to overall and urban EDs. As seen in our SEP-1 data, motivated rural hospitals can perform well on national quality metrics with similar processes of care to urban hospitals, but delays to IV fluids and antibiotics likely impact mortality, which may be reflected in higher rates of mortality for sepsis patients in lower-volume EDs.[6] There may be other factors that explain this mortality difference, such as the attribution of mortality to initial rural hospitals even though the majority of care is delivered at a subsequent tertiary hospital, and the limited relationship between what is captured in the existing process measures and outcomes.

Measurement methods may also explain the discrepancy in performance for rural EDs between SEP-1 and ACEP ED measures. SEP-1 is measured at the hospital

level (regardless of whether sepsis care was initiated in the ED or hospital ward) and within a 3-hour timeframe, while ACEP sepsis quality measures are limited to ED care and do not restrict measures to a time window. As a result, delays in care processes such as mixing antibiotics or hanging fluids that occurred in the ED may not be captured in SEP-1 measures, as these were subsequently performed in the hospital in the early hours of care. Further, the SEP-1 and ACEP ED quality metrics capture somewhat different denominator populations: SEP-1 data is limited to patients admitted as inpatients to the same hospital (excluding those transferred in) and is designed to capture the more severe presentations of sepsis. Therefore, the volume of cases at a single hospital may be limited and could result in exclusion of some rural hospitals from quality reporting, if their rates of severe sepsis inpatient hospitalization are low. In comparison, the ACEP measures capture all cases treated in the ED, regardless of severity and even if they were later transferred out. Thus, ACEP measures include a broader and more expansive denominator population, which would likely capture more cases at rural EDs. In this way, the ACEP measures may reflect rural ED practice patterns, which has important implications for rural quality measurement. Interestingly, preliminary observed mortality among CMS SEP-1 patients—reported to be 14.6%[34]—is 3-fold that of the 4.9% mortality rate preliminarily calculated in the ACEP ED sepsis measures. While future work will examine and compare mortality data, these preliminary findings may suggest that rural EDs perform well when caring for the sickest sepsis patients but may miss more subtle or occult sepsis presentations.

While our findings are limited to this motivated sample of EDs, they raise important questions that can be addressed in a larger study and indicate that opportunities remain to improve both component-level and bundle-level compliance for urban and rural EDs. Further research should investigate why rural EDs are less likely to administer IV fluids and IV antibiotics in the early management of sepsis. Rural-specific treatment patterns may be reflected in IV fluid and antibiotic administration delays. While mandated IV fluid resuscitation at 30mL/kg has faced clinician skepticism, it may be more pronounced at rural EDs, reflecting rural clinicians' focus on avoiding complications of fluid-overload for patients they may plan to transfer. Delays to antibiotics may reflect the delays inherent in requiring antibiotics to be mixed and brought from pharmacy. Additionally, important variation may exist between types of rural hospitals with respect to designation (eg, Critical Access Hospitals, Rural Referral Hospitals) and volume. Resource availability and structures of care delivery likely differ between types of rural hospitals, impacting the ability of some rural EDs to meet certain quality metrics.

Conclusion

In this motivated sample of urban and rural hospital-based EDs, performance on sepsis quality measures is strong, but rural EDs have focused opportunities for improvement.

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