

The Sensitivity of Clinician Diagnosis of Sepsis in Tertiary and Community-Based Emergency Settings

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Objectives To assess whether the risk of missed clinician diagnosis of pediatric sepsis requiring care in the intensive care unit (ICU) was greater in community vs tertiary pediatric emergency care settings with sepsis pathways.

Study design An observational cohort study in a tertiary pediatric emergency department (ED) staffed by pediatric emergency physicians and 4 affiliated community pediatric ED/urgent care sites staffed by general pediatricians. Use of an institutional sepsis order set or pathway was considered clinician diagnosis of sepsis. Risk of missed diagnosis was compared for 2 outcomes: suspected infection plus ICU admission (sepsis-ICU) and suspected infection plus vasoactive agent/positive-pressure ventilation (sepsis-VV).

Results From January 1, 2014 to December 31, 2015, there were 141 552 tertiary and 139 332 community emergency visits. Clinicians diagnosed sepsis in 1136 visits; median age was 5.7 (2.4, 12.0) years. In the tertiary ED, there were 306 sepsis-ICU visits (0.2%) and 112 sepsis-VV visits (0.08%). In community sites, there were 46 sepsis-ICU visits (0.03%) and 20 sepsis-VV visits (0.01%). The risk of missed diagnosis in community vs tertiary sites was significantly greater for sepsis-ICU (relative risk 4.30, CI 2.15-8.60) and sepsis-VV (relative risk 14.0, CI 2.91-67.24). Sensitivity for sepsis-ICU was 94.4% (91.3%-96.5%) at the tertiary site and 76.1% (62.1%-86.1%) at community sites.

Conclusions The risk of missed diagnosis of sepsis-ICU was greater in community vs tertiary emergency care settings despite shared pathways and education, but with differences in resources, providers, and sepsis incidence. More research is needed to optimize diagnostic approaches in all settings. (*J Pediatr* 2017;■■■■■■■■■■).

Missed early diagnosis of sepsis, a leading cause of pediatric death, causes delays in care and preventable mortality.¹⁻³ Quality improvement programs in tertiary academic pediatric emergency departments (EDs), including sepsis education, sepsis pathways, and triage sepsis-screening tools, have improved outcomes.⁴⁻⁷ Based on the success of these comprehensive sepsis quality improvement programs, recent guidelines have recommended that emergency care settings should implement triage screening of all patients for pediatric sepsis.⁸ However, data are conflicting about clinical diagnostic accuracy in emergency settings without triage screening but with sepsis education and clinical pathways. Previous studies in pediatric tertiary EDs have reported the sensitivity of clinician diagnosis of sepsis in the absence of universal triage screening to range from 73% to 100%, and the most sensitive screening systems reported to date rely heavily on the clinical judgment of subspecialty physicians in tertiary centers.^{4,6,9,10}

The majority of children seeking emergency care in the US are treated outside of pediatric tertiary EDs, instead being seen in general community-based EDs or urgent care settings.^{11,12} Little has been published about sepsis diagnosis and care in pediatric emergency care settings outside of tertiary academic EDs, and it is unknown whether the techniques that have been successful in improving pediatric sepsis care in pediatric tertiary EDs will be effective in other settings. The sensitivity of clinical sepsis diagnosis in the context of quality improvement is a particularly important aspect to understand as a background comparator to evaluating the many different triage sepsis tools in use.

Thus, this study sought to compare the sensitivity and specificity of clinician diagnosis of sepsis, in tertiary vs community-based pediatric emergency care settings within a children's hospital health system that had a sepsis quality improvement program that encompassed all sites. We hypothesized that the relative risk of missed diagnosis would be greater in the community-based

ED	Emergency department
EHR	Electronic health record
ICU	Intensive care unit
PEM	Pediatric emergency medicine
sepsis-ICU	Suspected infection plus intensive care unit admission within 24 hours of arrival
sepsis-treated	Suspected infection plus treatment with intravenous antibiotics and fluid bolus
sepsis-VV	Suspected infection plus vasoactive agent/positive-pressure ventilation during hospitalization

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pediatric emergency care setting compared with the tertiary pediatric emergency care setting, because of the relative infrequency of pediatric sepsis in community-based sites, as well as differences in resources and provider training. Gaps in care between settings would be important to identify to focus research and quality improvement efforts in pediatric sepsis into areas in which it is most needed and identify needs that may differ between care settings.

Methods

This was a retrospective, observational cohort study, conducted using secondary analysis of a sepsis registry at 5 pediatric ED/urgent care sites within a single university-affiliated children's hospital regional care system. Sites shared the same protocols, electronic health record (EHR), pathways, and formulary. All sites only treated pediatric patients. The providers, nurses, and staff at all sites shared the same employers and continuing education requirements. The target patient-to-nurse ratio was 4:1 at all sites. At all sites, a pharmacist within the pediatric health system reviewed and approved orders around the clock remotely through the EHR, with in-person pharmacist presence in each ED/urgent care ranging from 0 to 12 hours daily during the study period.

However, the provider type and training, case mix, and resources available differed between the tertiary ED and four community emergency care sites, as follows: There were 4 community sites in the study, consisting of 2 pediatric ED and 2 pediatric urgent care sites with approximately 70 000 yearly visits across all 4 sites. During the study time period, community sites were staffed by pediatricians and pediatric advanced practice providers (nurse practitioners and physician assistants), as well as pediatric nurses and respiratory technicians. The community sites included were not staffed with pediatric emergency physicians or emergency physicians. There were approximately 100 providers who worked among the 4 community sites. No community site had a pediatric intensive care unit (ICU). Unstable or potentially unstable patients required transfer to the tertiary pediatric site, 15-60 minutes away by ground transportation. All community sites had the ability to perform a limited set of laboratory tests and plain radiography.

The tertiary site was an academic ED in a free-standing children's hospital, a level 1 pediatric trauma center, with subspecialists, operating rooms, and ICUs within the hospital. The ED had pediatric emergency medicine (PEM) physician staffing 24 hours daily, as well as residents, fellows, and advanced practice providers and pediatricians. PEM physicians preferentially cared for the most acutely ill patients, including all critically ill patients. The ED had approximately 75 000 visits yearly. There were approximately 30 PEM physicians practicing at this site during the study time period.

Sepsis Protocol

A multidisciplinary sepsis quality improvement program had begun more than 2 years before the study period and was

ongoing at all sites included in this study. This included standardized pathways for sepsis evaluation and treatment, paging and support of institutional resources, and order sets integrated into the EHR. Providers received monthly feedback letters about their care of patients with severe sepsis (whether they had correctly diagnosed it or not), informing the providers of their performance on diagnosis and treatment care quality metrics. Because of resource constraints, providers did not receive feedback letters on all patients in whom they initiated sepsis care, only those who had suspected infection plus intensive care unit admission within 24 hours of arrival (sepsis-ICU).

The pathways were 2-tiered. The higher tier, indicated for critically ill patients, was resource-intensive and used standardized resuscitation protocols, including mobilization of additional personnel, hand-delivery of antibiotics, and automated notification of need for an ICU bed. The lower tier for noncritically ill patients facilitated expedited intravenous access, laboratories, antibiotics, and enhanced monitoring for a potential sepsis patient with more flexibility in laboratory and treatment decisions. The lower tier response allowed for early diagnosis and communication of a potential sepsis patient without tying clinicians to a specific expansive resuscitation approach and facilitated formalizing a diagnosis of clinically suspected sepsis even in cases in which the clinician did not choose to enact a full resuscitation protocol. In this study, use of either tier of the sepsis pathway was considered clinician diagnosis of sepsis.

Participant Selection

To evaluate the test characteristics of clinician diagnosis, all patients were included who presented for care to any study emergency care site between January 2014 and December 2015. In addition, a subgroup was described in detail, patients from the institutional clinical sepsis registry. This registry included patients who had clinically suspected infection and signs of decreased mental status and perfusion as recommended by the American College of Critical Care Medicine pediatric sepsis guidelines as the criteria to use to identify patients requiring sepsis treatment.⁸ Identified and missed patients were identified and included in the registry in 2 ways. Patients identified by clinicians through use of the sepsis pathways had a time stamp in the medical record, representing the decision of any clinician to initiate sepsis evaluation and treatment. Missed patients with sepsis in whom the sepsis pathway was not initiated clinically were identified through standardized chart review conducted by 5 clinicians monthly (2 physicians and 3 nurses). The reviews were conducted for institutional quality improvement purposes and were performed before the design of this study; reviewers were blind to the study hypothesis. All patients admitted to the ICU up to 24 hours after presentation to one of the included emergency care sites, and receiving antibiotics or having hypotension, were reviewed. Of these, patients who had clinically suspected infection and signs of decreased mental status and perfusion in the ED/urgent care were included in the registry as missed sepsis cases. Interrater reliability for classifying missed sepsis from these

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