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Improved empiric antibiotic prescribing for common infectious disease diagnoses using order sets with built-in clinical decision support in the emergency department

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To the Editor—The Centers for Disease Control and Prevention estimated that in 2018, emergency departments (EDs) generated 12.7 million antibiotic prescriptions.¹ Up to 50% of these prescriptions may have been inappropriate with respect to antibiotic use or selection, dosing, and duration, based on outpatient prescribing estimates.² Improving prescribing is imperative, but historically, EDs are underrepresented in antibiotic stewardship studies.⁴ EDs may benefit from implementation of the recommended components of an antimicrobial stewardship program, including decision-making tools based on facility-specific practice guidelines.³ For example, antibiotic order sets within an electronic medical record (EMR) have been shown to improve adherence to evidence-based prescribing for single diagnoses,^{5,6} although the use of multiple order sets for a variety of diagnoses has not been well studied. We implemented EMR order sets for common infectious diagnoses in the ED, compared the prescribing practices of providers who utilized them to those who did not, and surveyed providers for barriers to use.

Methods

This study was part of a larger intervention to improve antibiotic prescribing and reduce *Clostridioides difficile* infection (CDI) at a 500-bed quaternary-care academic medical center with ~50,500

yearly ED visits. Order sets were created for cystitis, pyelonephritis, pneumonia, chronic obstructive pulmonary disease (COPD), and cellulitis that included recommended antibiotics and first dose in the ED, followed by a prepopulated prescription for an appropriate duration. Antibiotic choices were prioritized based on clinical practice guidelines,^{7–9} the hospital antibiogram, and a desire to avoid antibiotics associated with higher CDI risk (eg, fluoroquinolones), with guidance included for dosing in patients with renal impairment.

The order sets were deployed in March 2019, with clinician education via a presentation (40% attendance), 1-on-1 sessions (60% of clinicians), and 3 informational e-mails. A survey adapted from Vandenberg *et al*¹⁰ was sent to all ED clinicians in November 2019 to assess whether the order sets were being used and whether they were beneficial to their practice.

Additionally, a retrospective chart review was conducted from October 1, 2019, to November 1, 2019, to assess the impact on prescribing practices for patients presenting with 1 of the 5 diagnoses with a corresponding order set, identified using *International Classification of Disease, Tenth Revision* (ICD-10) codes. Charts were manually reviewed for whether an order set was used, antibiotic doses given in the ED, antibiotic prescribed, creatinine clearance, special population status (eg, pregnancy or organ transplant), prior culture data, and whether a subspecialty consultation was obtained. Patients were excluded from the analysis if antibiotics were not prescribed, if they belonged to a special population, or if they received subspecialty consultation. In total, 213 charts were reviewed and 104 met inclusion criteria. Encounters with order-set use were compared to those without order-set use for appropriate

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Table 1. Appropriate Antibiotic Prescribing With and Without Order Set Use

Variable	With Order Set Use	Without Order Set Use	P Value
First dose of antibiotic given in the ED (n=104)	90.9% (20/22)	71.2% (54/82)	.02
Appropriate empiric agent selected without prior culture data or allergy considerations (n = 99)	86.4% (19/22)	33.8% (26/77)	<.001
Optimal duration of therapy prescribed	68.2% (15/22)	24.5% (13/53)	.0004
Antibiotic prescription with inappropriate renal dosing	10% (2/20)	3% (2/72)	.43

Note. ED, emergency department.

antibiotic selection, duration, and renal dosing. We used the χ^2 test with a $P < .05$ significance level and OpenEpi Open Source Epidemiologic Statistics for Public Health version 3.01 software (www.openepi.com). Patients who received an inappropriate antibiotic were excluded when comparing durations of therapy, and those without a measured creatinine level were excluded when comparing appropriate renal dosing. The study was approved by the Emory Institutional Review Board.

Results

Provider survey

The overall response rate was 59%. Just more than half (51.6%) of clinicians were physicians and 48.4% were APPs. Most respondents were aware of the order sets (75.0%) and 59.4% reported using them. Of the clinicians who used the order sets, 78.9% reported that they saved time, 84.2% reported ease of use, and 94.7% reported successful use.

Chart review

Order sets were used in 22 (21%) of 104 qualifying patient encounters. Use varied by diagnosis. An order set was used in 12 (43.8%) of 32 patients with uncomplicated cystitis, 2 (22.2%) of 9 patients with pyelonephritis, 2 (20%) of 10 patients with cellulitis, 3 (6.7%) of 45 patients with complicated cystitis, and none of 8 patients with pneumonia or COPD. Patients were more likely to receive the first antibiotic dose in the ED when order sets were used ($P = .02$) (Table 1). Patients were also more likely to receive an appropriate antibiotic ($P < .001$) and to have an appropriate duration prescribed ($P = .0004$) when order sets were used. We did not detect a statistically significant difference in appropriate renal dosing between the 2 groups.

Discussion

In this study, EMR antibiotic order sets for treatment of common infectious syndromes were implemented in the ED. They were only used in 21% of qualifying patients, but in these cases they were associated with improved antibiotic selection, first-dose timing, and prescription duration. Almost all providers who reported utilizing the order sets noted that they were easy to use and saved time.

Given the advantages of order-set use, improving uptake will be a focus of future interventions. Historically, order sets have been evaluated for single conditions,⁵ but availability of multiple order sets may improve provider acceptance. We observed that clinicians used order sets for uncomplicated cystitis more frequently than for

other conditions, which may be related to the frequency of diagnosis and a large number of antibiotic choices. Ensuring that providers who used the cystitis order set are aware of the other options and can educate other clinicians may help to increase acceptance.

Larger studies are needed to further evaluate the impact of order sets on prescribing and patient care outcomes because early data indicate that they may improve antimicrobial stewardship. In the future, we plan (1) to expand order-set offerings within the ED and in outpatient settings; (2) to increase use via additional didactics, peer-to-peer education, audit and feedback; and (3) to evaluate trends in antibiotic prescribing over a longer time period.

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Conflicts of interest. All authors report no conflicts of interest relevant to this study.

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Can intravenous antimicrobial start data reported to the National Healthcare Safety Network determine appropriateness of antibiotic use in hemodialysis patients?

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To the Editor—In their article, “Inappropriate intravenous antimicrobial starts: An antimicrobial stewardship metric for hemodialysis facilities,” Hahn *et al*¹ describe their application of data reported to CDC’s National Healthcare Safety Network (NHSN) to determine appropriateness of IV antibiotic use in outpatient hemodialysis centers. NHSN’s Dialysis Event (DE) surveillance system was designed to track bloodstream infections (BSIs) and other vascular access infections in hemodialysis outpatients through monitoring of events such as positive blood cultures. The authors examined outpatient IV antimicrobial start (IVAS) events reported to NHSN and considered any IVAS without documentation of coreported positive blood culture, collection of blood sample for culture, or local access site infection to be inappropriate, even when symptoms such as fever, chills, rigors, or drop in blood pressure were present. We applaud these investigators for drawing necessary attention to the issue of antibiotic use in dialysis patients, which is an important area of study with limited data, and for exploring the use of data to inform improvement in practice. However, we have concerns about their approach to the categorization of antibiotic use without incorporation of relevant clinical information or validation of NHSN data for this purpose, and the potential for unintended consequences among patients at high risk for infections and sepsis.

Intravenous antimicrobial starts largely represent empiric antibiotic doses for suspected infection. Initiating empiric antibiotics in the presence of signs and symptoms of serious infection, while awaiting culture information, should be considered appropriate use.² However, Hahn *et al*. excluded symptom data from their assessment of appropriateness, even for the 260 IVAS events (27%) for which these data were available in NHSN. They explained that the data were not consistently reported. We agree that gaps exist in the completeness of the symptom information, which is one of several inherent limitations with the use of NHSN data in this manner. The IVAS events that occurred in the context of symptoms but without preceding blood culture collection may represent gaps in documentation (of blood cultures) or adherence to blood culture collection protocols, rather than actual inappropriate antibiotic use. A more robust appropriateness

determination should incorporate medical record review to identify symptoms that might have been unreported to NHSN, and other relevant information.

Hahn *et al* acknowledge that they did not attempt to identify related events in the same patient (that might justify the IVAS) if they were not coreported on the same form. The NHSN does not require that events such as positive blood cultures and IVAS be coreported as long as each event is reported. Unique identifiers exist within NHSN to facilitate linkage of events that occurred in the same patient, even when events are not submitted together.³ Other potential justifications for antibiotic administration, such as surgical prophylaxis (for which blood culture collection is not typically warranted prior to antibiotic administration), are not captured within the dialysis event surveillance; thus, they were not factored into the appropriateness determination.

Previous studies have identified de-escalation of antibiotic therapy as the most common missed opportunity for improved antibiotic use among patients on hemodialysis,^{4,5} suggesting that continued antibiotic doses, as opposed to the initial dose, should be the priority for antibiotic use measurement efforts in this setting. However, the NHSN does not capture all IV antibiotic doses administered to dialysis patients, nor the specific antibiotic administered (other than vancomycin starts). In our opinion, expanded efforts are needed to identify stewardship interventions that could result in meaningful improvements in outcomes in this population, to help guide the development of useful metrics.

Hahn *et al* conclude that 57.5% of all IVAS in the facilities examined were inappropriate. Given the aforementioned challenges, we believe that they may have overestimated true inappropriate prescribing of IV antibiotics in dialysis facilities. Prior studies have demonstrated that initial doses of antibiotic treatment are a small proportion of all antibiotic doses received by hemodialysis outpatients (eg, 7.6% in one study).^{4,5} In previous studies of maintenance hemodialysis patients, 10%–43% of initial IV antibiotic treatment doses were classified as inappropriate,^{4,5} and 20%–30% of all vancomycin or IV antibiotic doses prescribed (including continued doses) were classified as inappropriate.^{5,6} Few studies have evaluated antibiotic use in outpatient hemodialysis centers, and the resultant estimates of inappropriate use are often challenged by limited medical record documentation.^{4,5,7} Hahn *et al* also draw parallels between outpatient hemodialysis care and outpatient primary care settings. However, hemodialysis clinics and patients are unlike most general outpatient

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