Infection Control & Hospital Epidemiology (2024), **45**, 120–122
doi:10.1017/ice.2023.155

SHEA

Concise Communication

Indication-driven order entry decreases stewardship and pharmacist interventions

Jacey L. Nishiguchi PharmD, BCPPS[1], Laura L. Bio PharmD, BCPS, BCIDP[1], Sean T. Cornell BSBA[2] and Hayden T. Schwenk MD, MPH[3]

[1]Department of Pharmacy, Lucile Packard Children's Hospital Stanford, Palo Alto, California, [2]Center for Pediatric & Maternal Value, Lucile Packard Children's Hospital Stanford, Palo Alto, California and [3]Department of Pediatrics, Stanford School of Medicine, Stanford, California

Abstract

Indication-driven order entry (IDOE) was implemented at our pediatric institution for cefazolin, piperacillin-tazobactam, and meropenem; the 3 most intervened upon antibiotics during prospective audit and feedback (PAF) by the antimicrobial stewardship program (ASP). IDOE was associated with a significant reduction in both ASP PAF recommendations and clinical pharmacist interventions.

(Received 1 April 2023; accepted 9 June 2023; electronically published 2 August 2023)

Prospective audit and feedback (PAF) is a core component of antimicrobial stewardship programs (ASPs); however, it is labor- and resource-intensive relative to many other stewardship strategies.[1] ASP resources, including personnel and time, are limited.[2] Implementing tools that support existing stewardship strategies could alleviate some of the overwork currently experienced by antimicrobial stewards. The selection of a clinical indication at the time of antibiotic ordering suggested by the Centers for Disease Control and Prevention Core Elements of Hospital Antibiotic Stewardship Programs is one way to facilitate the PAF process.[3,4]

At our hospital, cefazolin, piperacillin-tazobactam, and meropenem accounted for nearly a quarter of ASP PAF recommendations. Approximately half of those recommendations were to clarify the indication or optimize the dose. We developed a novel intervention embedded in the electronic health record (EHR) that provides a dose regimen recommendation based on the selected antibiotic indication and evaluated whether this indication-driven order entry (IDOE) reduced the number of PAF recommendations by our ASP. Given that non-ASP clinical pharmacists typically review and intervene on medication orders prior to ASP PAF, the impact of IDOE on the rate of clinical pharmacist interventions was evaluated as a secondary aim.

Methods

Lucile Packard Children's Hospital Stanford is a 397-bed freestanding children's hospital in Palo Alto, California. At our hospital, an ASP pharmacist performs PAF Monday through Friday for all inpatient antimicrobial orders active ≥48 hours and documents all audits and recommendations in a custom smart form (Supplementary Fig. 1 online) in the Epic EHR (Epic Systems, Verona, WI).[5] Our clinical pharmacists review orders upon verification or while performing rounds, and they document interventions using the Epic iVent tool, which tracks and communicates medication-related interventions (Supplementary Fig. 2 online). iVents are not part of the medical record and can only be viewed and created by pharmacists.[6]

IDOE was implemented in our EHR on July 1, 2019, via cefazolin, piperacillin-tazobactam, and meropenem order panels that guide prescribers to the recommended dose regimen based on the selected antibiotic indication (Supplementary Fig. 3 online). Given unique antibiotic indications and dosing, neonates and obstetric patients were excluded from the order panels and, therefore, this study. Freestanding antibiotic orders remained available within the EHR.

In this retrospective cohort study, we compared the percentage of PAF audits with recommendations and types of PAF recommendations in the pre-IDOE period versus the IDOE period. All inpatient orders and PAF for cefazolin, piperacillin-tazobactam, or meropenem between July 1, 2018, and June 30, 2019, were included in the pre-IDOE period and those between May 1, 2020, and April 30, 2021, were included in the IDOE period. The washout period between July 1, 2019, and April 30, 2020, accounted for the time needed to embed the IDOE order panels within the EHR.

We also compared the rates of iVents for inpatient cefazolin, piperacillin-tazobactam, and meropenem orders in the pre-IDOE period versus the IDOE period. Antibiotic orders and iVents were linked through an order identifier. Orders and associated iVents with dose frequencies of "once" or "as needed" were excluded. iVents created ≥48 hours after the order date were excluded to focus on iVents created prior to ASP PAF. Only iVent types predicted to be affected by IDOE were included (Supplementary Table 1 online). When there was >1 iVent for an order, only the first iVent was counted. The denominator was calculated as the number of unique patients with an antibiotic order for cefazolin, meropenem, or

Corresponding author: Jacey L. Nishiguchi; Email janishiguchi@stanfordchildrens.org
Cite this article: Nishiguchi JL, Bio LL, Cornell ST, Schwenk HT. Indication-driven order entry decreases stewardship and pharmacist interventions. *Infect Control Hosp Epidemiol* 2024. 45: 120–122, doi: 10.1017/ice.2023.155

Check for updates

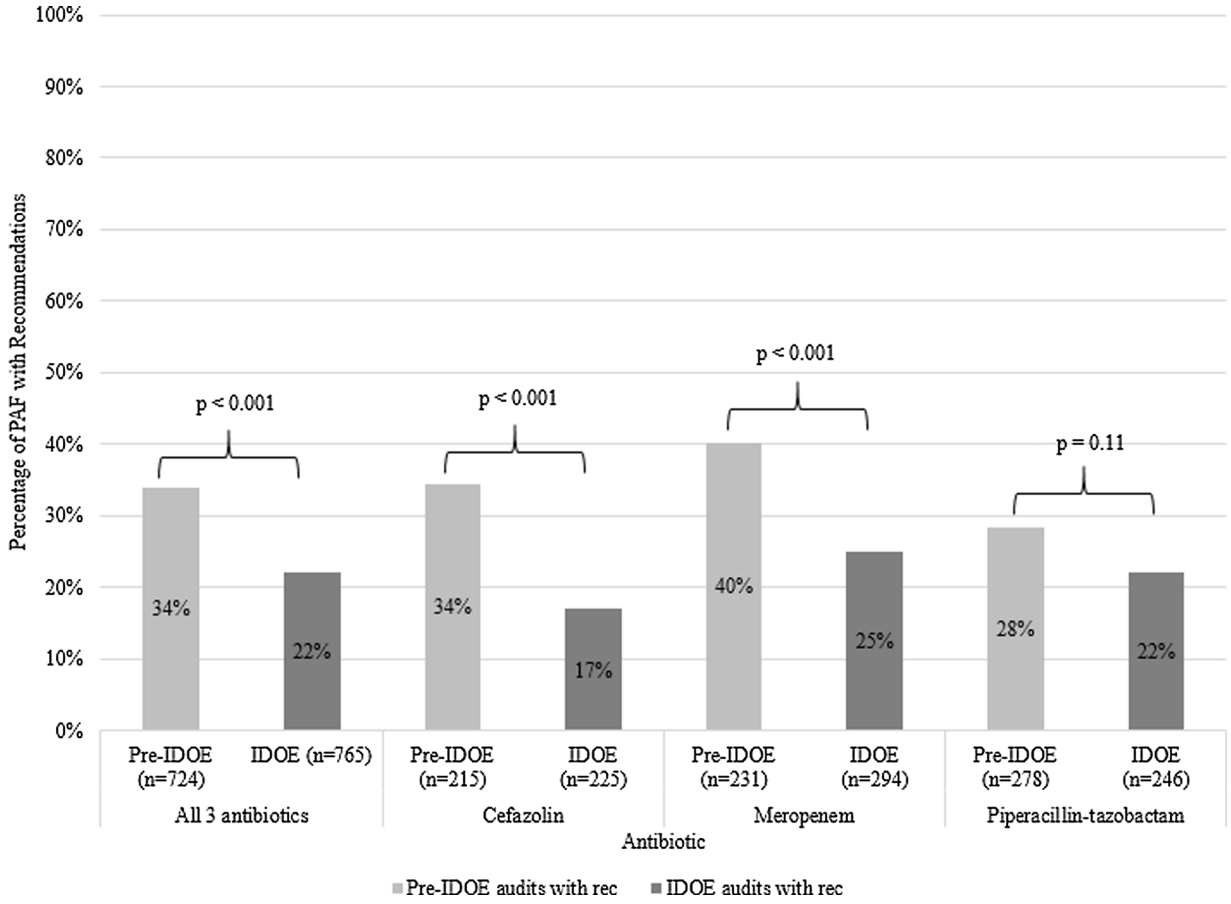

Figure 1. Comparison of ASP audits with recommendations before IDOE compared to IDOE.
Note. PAF, prospective audit with feedback; IDOE, indication-driven order entry; rec, recommendation.

piperacillin-tazobactam per day to account for duplicate orders resulting from order modification. This metric was subsequently normalized to 1,000 patient order days for ease of interpretation.

Comparisons were performed using the χ^2 test. Prism 9 software (GraphPad Software, San Diego, CA) was used for statistical analyses. We also constructed a statistical process control chart to visually display the change in percentage of PAF recommendations during the pre-IDOE and IDOE periods.

Results

In the pre-IDOE and IDOE periods, 724 audits and 765 audits were included, respectively. In the IDOE period, 621 (81%) of 765 audited orders were placed using an IDOE order panel. Indication selection within the order panel matched the indication identified during PAF in 604 (97%) of 621 audits.

The overall percentage of PAFs with a recommendation was significantly reduced after implementation of IDOE (34% vs 22%; $P < .001$) (Fig. 1 and Supplementary Fig. 4 online). At the individual antibiotic level, there were significant reductions in PAF recommendations for cefazolin and meropenem but not for piperacillin-tazobactam. We did not detect a statistically significant difference in the types of infectious problems or types of PAF recommendations communicated between periods (Supplementary Tables 2 and 3 online).

The overall iVent rate was significantly reduced during the IDOE period (Table 1). The iVent rates decreased for each antibiotic individually following IDOE implementation, but the differences were only statistically significant for cefazolin and piperacillin-tazobactam.

Discussion

Although it has been suggested that indication selection at the time of antibiotic prescribing may facilitate PAF, the impact of this intervention on antibiotic steward and clinical pharmacist interventions has not been systematically evaluated.[4] Given the competing priorities of individuals tasked with ensuring optimal antibiotic prescribing, understanding whether mandatory indication selection actually facilitates the stewardship process is critically important. In this study, IDOE significantly reduced the percentage of antibiotic orders that required either ASP or clinical pharmacist intervention.

The reduction in ASP PAF recommendations and clinical pharmacist iVents in our study aligns with previous research demonstrating improved antibiotic prescribing as a result of indication selection at the time of antibiotic order entry.[3,7] As in prior studies, the majority of selected indications aligned with the antibiotic steward's assessment during PAF.[3] The dosing guidance provided in the IDOE panels likely enhanced prescription quality and contributed to the observed reduction in subsequent antibiotic steward and pharmacist intervention. IDOE allows antibiotic stewards and clinical pharmacists to focus efforts on antibiotic choice and appropriateness, rather than spending time and resources on correcting doses. Expansion of the current IDOE order panels to include indication-specific therapy durations with

https://doi.org/10.1017/ice.2023.155 Published online by Cambridge University Press

Table 1. Comparison of iVent Rate Before and After IDOE Implementation

	Pre-IDOE			IDOE			
Antibiotic	No. of iVents	Patient Order Days	iVents per 1,000 Patient Order Days	No. of iVents	Patient Order Days	iVents per 1,000 Patient Order Days	*P* Value[a]
Overall	498	2,694	180	349	2,912	120	<.001
Cefazolin	168	1,593	110	124	1,814	70	<.001
Meropenem	131	415	320	132	494	270	.11
Piperacillin-tazobactam	199	686	290	93	604	150	<.001

Note. IDOE, indication-driven order entry.
[a]*P* is for a comparison of iVents per patient order days pre-IDOE to IDOE.

stop dates may further improve antibiotic prescribing. Although the time spent performing PAF was not measured, the reduction in PAF recommendations likely improved ASP efficiency by reducing time spent identifying, communicating, and tracking recommendations. In turn, this time savings may allow ASPs to focus less on corrective mechanisms and instead on other stewardship initiatives.

Although it is understudied, clinical pharmacists are well positioned to improve the quality of antibiotic prescribing, particularly during order review and verification. Although we were unable to capture the full scope of their work in correcting suboptimal antibiotic prescribing, we demonstrated that the rate of pharmacist intervention was significantly lower following the roll-out of IDOE. Similar to antibiotic stewards, clinical pharmacists have multiple competing priorities, and time not spent intervening on antibiotic orders may allow them to focus on other tasks. Additional studies investigating the role of clinical pharmacists in optimizing antibiotic prescriptions are warranted.

Our study had several limitations. There is currently no standard for iVent rate calculation, and the exclusion of multiple iVents for the same order limited our ability to evaluate the types of interventions being made by clinical pharmacists. Additionally, we excluded neonatal patients based on patient unit, which may have resulted in the inclusion for neonates in whom use of the IDOE order panel was not recommended. Inclusion of orders not placed via IDOE likely underestimated, rather than overestimated, the effect of this intervention.

Overall, IDOE decreases interventions by both ASP and clinical pharmacists, which may optimize the quality of antibiotic prescribing while improving the utilization of stewardship and pharmacy resources.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ice.2023.155

Acknowledgments.

Financial support. None reported.

Competing interests. All authors report no conflicts of interest relevant to this article.

References

1. Barlam TF, Cosgrove SE, Abbo LM, *et al.* Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clin Infect Dis* 2016;62:e51–e77.
2. Vaughn VM, Dunn GE, Horowitz JK, McLaughlin ES, Ghandi TN. Duties, resources, and burnout of antibiotic stewards during the coronavirus disease 2019 (COVID-19) pandemic. *Antimicro Steward Healthc Epidemiol* 2021;1:1–3.
3. Timmons V, Townsend J, McKenzie R, Burdalski C, Adams-Sommer V. An evaluation of provider-chosen antibiotic indications as a targeted antimicrobial stewardship intervention. *Am J Infect Control* 2018;46:1174–1179.
4. The core elements of hospital antibiotic stewardship programs, 2019. Centers for Disease Control and Prevention website. https://www.cdc.gov/antibiotic-use/core-elements/hospital.html. Published 2019. Accessed January 27, 2023.
5. Bio LL, Kruger JF, Lee BP, Wood MS, Schwenk HT. Predictors of antimicrobial stewardship program recommendation disagreement. *Infect Control Hosp Epidemiol* 2018;39:806–813.
6. Kullar R, Goff DA, Schulz LT, Fox BC, Rose WE. The "Epic" challenge of optimizing antimicrobial stewardship: the role of electronic medical records and technology. *Clin Infect Dis* 2013;57:1005–1013.
7. Nomura Y, Garcia M, Child J, *et al.* Effect of provider-selected order indications on appropriateness of antimicrobial orders in a pediatric hospital. *Am J Health-Syst Pharm* 2018;75:213–221.