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Concise Communication

Improved rates of antimicrobial stewardship interventions following implementation of the Epic antimicrobial stewardship module

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Abstract

We evaluated the impact of the Epic antimicrobial stewardship module (EAM) on the number of interventions, antimicrobial usage, and clinical outcomes. Use of the EAM allowed us to significantly increase the number of ASP antimicrobial reviews and interventions while maintaining a sustained impact on antimicrobial utilization.

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Antimicrobial stewardship programs (ASPs) optimize antimicrobial usage by facilitating safe, efficacious, and judicious use.[1,2] As of January 2017, the Joint Commission requires all hospitals to have an ASP. The required standards are based on CDC core elements, including monitoring antimicrobial usage and interventions (eg, prospective review/feedback, automatic alerts to streamline therapy).[3,4] The ability to meet requirements is contingent upon the ability to identify patients requiring intervention and having an optimal strategy for documenting recommendations. Clinical decision support systems, such as the Epic Antimicrobial Stewardship Module (EAM, Epic Systems, Verona, WI), provide a mechanism for ASPs to quickly identify patients based on current therapy and laboratory results, while also allowing for efficient documentation of activities. We sought to determine the impact of implementing the EAM on the number of interventions made by ASP. Additionally, we evaluated overall utilization of target antimicrobials, antimicrobial expenditures, mortality, and length of stay (LOS) among patients receiving antimicrobials.

Methods

This study was a single-center, retrospective cohort study performed at the University of Chicago Medicine, an 811-bed tertiary-care center. The institutional review board approved this study. Our medical center has had an established ASP since 2010, which consists of 2 infectious diseases (ID) physicians and 3 ID pharmacists performing daily antimicrobial stewardship activities. Clinical microbiologists and infection control providers are also active members. A daily review of a list of patients meeting criteria for review (based on active orders for antimicrobials, culture data) is performed Monday through Friday. Prior to EAM implementation, an average of 0.5–1 hours per day was needed to identify patients for review by filtering a pharmacy report generated based on antimicrobial orders and manually adding patients to a separate database (ie, an Excel spreadsheet) for documentation. We also utilized an 'in-basket' feature in the electronic medical record (EMR) that provided messages to the ASP pharmacist whenever a patient had a blood culture with *Staphylococcus aureus* or yeast, or if they were growing an organism in culture with incongruent susceptibilities with active antimicrobials (ie, pathogen–drug mismatch).

The EAM was implemented July 7, 2015, utilizing specific criteria to generate a list of alerts for review. The alerts include (1) new start restricted antimicrobial, (2) intravenous to oral administration, (3) azole therapeutic drug monitoring, (4) antiretrovirals, (5) pathogen–drug mismatch, and (6) *Staphylococcus aureus* or yeast in blood culture. In addition, the EAM provides a list of patients with specific pathogens, such as multidrug-resistant organisms (MDRO) or organisms with elevated minimum inhibitory concentrations (MIC) to certain antibiotics (eg, *Pseudomonas* MIC 8 ≥ μg/mL to cefepime).

Interventions are documented by placing specific 'i-vents' in the EMR associated with each antimicrobial order. These notes can be pulled into a report to enable the assessment of the specific number and types of interventions made during any period.

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The primary outcome was to assess the impact of the EAM on ASP interventions. We compared total number of interventions during the preimplementation period (February 1, 2014, through January 31, 2015) versus the postimplementation period (May 1, 2016, through April 30, 2017). The secondary outcomes included assessing: impact on target antimicrobial utilization (days of therapy [DOT] per 1,000 patient days), percentage of patients that received any antibiotic during admission, all-cause inpatient mortality among patients that received antimicrobials, LOS among patients that received antimicrobials, and percentage of total drug expenditures spent on antimicrobials (based on wholesale acquisition cost per patient day). Target antimicrobials were selected based on breadth of spectrum, propensity for toxicities and drug–drug interactions, need for therapeutic drug monitoring to ensure efficacious use, and/or high cost.

Statistical analyses

Data were analyzed using descriptive statistics for total number of interventions, utilization, and cost. The χ^2 analysis was used to assess differences in types of interventions relative to total interventions, mortality rates, and discharged patients that received antimicrobials during admission. Average LOS and antimicrobial expenditures were compared using the Mann-Whitney *U* test. Antibiotic utilization was assessed using the *t* test. All statistical analyses performed using Stata version 15 software (StataCorp, College Station, TX).

Results

Prior to EAM implementation (pre-EAM), the ASP team documented 5,433 antimicrobial reviews and made 1,436 interventions (119.7 interventions/month) (Table 1). After EAM implementation (post-EAM), the ASP team documented 8,288 reviews with 7,444 interventions made (ie, 620.3 interventions per month). Optimization and monitoring of antimicrobial therapy constituted most interventions pre-EAM and post-EAM (46.8% and 54.3%), followed by safety/monitoring (37.2% and 28.2%). We observed a marked increase in the rate of all types of interventions. Interventions were accepted >96% of the time.

Utilization of target antimicrobial agents decreased in the post-EAM period compared to the pre-EAM period (Figure 1). Overall, combining all target antimicrobials, the DOTs per 1,000 patient days per group was 5,338.5 (pre-EAM) and 4,753.2 (post-EAM) ($P = .04$). Relative to overall drug expenditures at our medical center pre-EAM and post-EAM, antimicrobial expenditures represented 7.14% and 8.32%, respectively ($P > .05$). The average LOS was similar between groups (9.2 days vs 9.0 days; $P > .05$), but the overall inpatient all-cause mortality rate was higher in the pre-EAM group (0.39 vs 0.20; $P < .01$).

Discussion

Following the implementation of the EAM, all intervention types performed by our ASP team increased markedly, including an increase in the number of safety-related interventions and those related to optimization of therapy. Notably, during the pre-EAM period, the percentage of ASP reviews that resulted in an intervention was only 26.5%, and this increased to 89.8% during the post-EAM period. We did not observe a change in the percentage of antimicrobial drug expenditures relative to overall drug expenditures; however, the lack of observed impact on this outcome is likely related to changing drug prices, availability of certain products, changes in utilization of nonantibiotic medications, and changes in patient census.

Table 1. Overall Number and Type of Interventions Before and After the Epic Antimicrobial Stewardship Module (EAM) Implementation Periods

Interventions	Pre-EAM (2/1/2014–1/31/2015)	Post-EAM (5/1/2016–4/30/2017)	*P* Value
Total (all interventions)	1,436	7,444	< .01
Intervention types, no.			
Optimization of therapy[a]	673	4,040	< .01
Safety/monitoring[b]	534	2,100	< .01
De-escalation[c]	120	758	.032
Cost savings[d]	79	310	.227
ID consult recommended[e]	30	236	.027

NOTE. ID, infectious diseases.
[a]Dosage adjustment, alternative therapy, additional therapy.
[b]Review of *Staphylococcus aureus* and yeast in blood culture alerts, review of anti-retroviral therapy, pathogen–drug mismatch, susceptibility-based reports, monitoring for antibiotic related toxicities, azole therapeutic drug monitoring, monitoring for drug–drug interactions.
[c]Change in antibiotic to more narrow-spectrum therapy.
[d]Modification in therapy to more cost-effective therapy, conversion from intravenous to oral administration.
[e]Recommendation to primary service to consult ID physician.

The increased number of antimicrobial orders reviewed and interventions are likely attributable to 2 primary factors. First, the EAM allowed for real-time notification for patients meeting criteria for ASP review. Real-time alerts allowed ASP pharmacists to assess appropriateness of antimicrobial agents immediately and provided additional opportunities to identify interventions and implement recommendations. Due to improved efficiency and expanded reporting capabilities, we were able to review additional reports and alerts during the post-EAM period. Second, the EAM allowed for documentation of interventions within the EMR. This represents a more efficient, streamlined, and consistent process for documentation, tracking, and reporting compared to the previous manual method.

The average LOS was similar between groups. We observed a reduction in mortality rate for all patients that received an antimicrobial during their admission. Although reduced mortality could be explained by many factors, including targeted quality improvement initiatives for specific infections or differences in acuity of illness of patients, it is possible that this change may also correlate with significantly more ASP interventions, especially those relating to optimization of therapy, safety and monitoring, and recommending ID consultation for patients with severe or complicated infections. Previous studies have found a correlation between real-time alerting with ASP follow-up and reduced mortality.[5–7] Although these studies focus on specific culture-related alerts, it is evident that real-time notification and intervention by the ASP team may contribute to reduced mortality in addition to improvements in other clinical outcomes.

The improved process for identification of patients requiring ASP review and/or intervention as well as streamlined documentation resulting from the EAM have broadened our ability to ensure optimal, safe, and judicious use of antimicrobials. Based on our experience, hospitals looking to establish or improve upon

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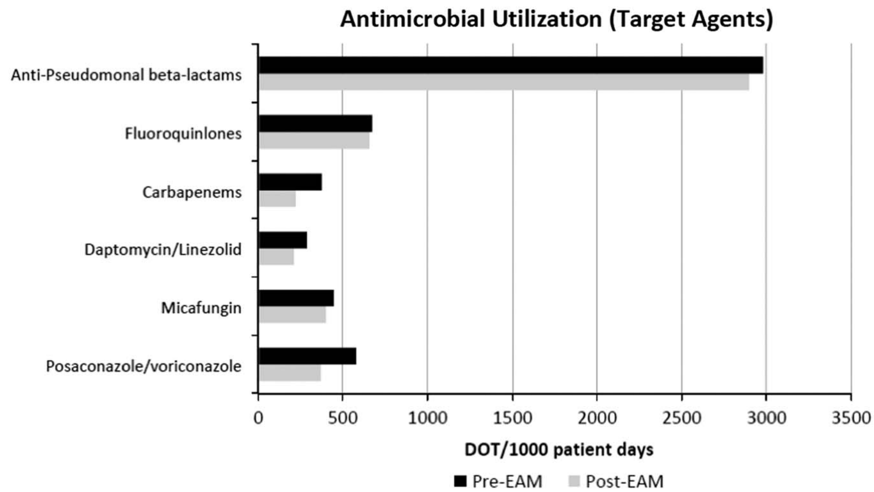

Fig. 1. Overall utilization of select, high-impact, restricted antimicrobials. Overall, combining all target antibiotics, the days of therapy (DOT) per 1,000 patient days per group was 5,338·5 (in the pre-Epic antimicrobial stewardship module [EAM] implementation period) and 4,753·2 (in the post-EAM period) ($P = \cdot 04$). The DOT per 1,000 patient days was calculated on a per month basis, and the sum of 12 months (pre-EAM and post-EAM) is represented here.

existing ASP practices should consider investing in a comprehensive clinical decision support system to improve efficiency and document value.

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