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Concise Communication

Understanding changes in the standardized antimicrobial administration ratio for total antimicrobial use after implementation of prospective audit and feedback

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Abstract

In this single-center study, the standardized antimicrobial administration ratio (SAAR) for total antimicrobial use decreased in response to a stewardship intervention. Antimicrobial prescribing and clinical outcomes were stable or improved during the period of lower SAARs. Our findings suggest that SAAR values of ~0.8 can be safely achieved.

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Measuring and evaluating antimicrobial use at the facility level is an important component of antimicrobial stewardship.[1] In 2014, the Centers for Disease Control and Prevention introduced a novel metric, the standardized antimicrobial administration ratio (SAAR), which has since been endorsed by the National Quality Forum. The SAAR compares observed antimicrobial use at a given hospital to predicted use, while adjusting for hospital size, unit type, and academic affiliation.[2] A study of 75 hospitals found that 41% had a SAAR for total antimicrobial use that was statistically >1.[3]

While the purpose of the SAAR is to facilitate benchmarking across hospitals, it is unclear whether changes in the SAAR correspond to changes in antimicrobial appropriateness or in clinical outcomes.[4,5] The goal SAAR also remains undefined.

Our objective was to evaluate whether declines in the SAAR at our facility were associated with changes in antimicrobial prescribing and associated outcomes.

Methods

Study design

This retrospective cohort study was conducted at the Iowa City Veterans Affairs (VA) Medical Center, which includes a 58-bed medical-surgical unit and a 10-bed intensive care unit.

In October 2015, the hospital's antimicrobial stewardship program (ASP) began performing prospective audit and feedback (PAF) during weekdays on all inpatients receiving antimicrobials. For this report, we describe a pre-PAF period (January 1, 2013, through June 30, 2015), a washout period (July 1, 2015, through September 30, 2015), and a PAF period (October 1, 2015, through December 31, 2017). During the pre-PAF period, an infectious disease–trained pharmacist was responsible for inpatient clinical pharmacy services.

Antimicrobial utilization data was submitted to the antimicrobial use option of the National Healthcare Safety Network (NHSN). Monthly reports of the SAAR for all antimicrobial agents were downloaded from the NHSN website.

To assess baseline characteristics and outcomes among patients who received antimicrobials, a cohort was developed that included all hospitalized patients who had received at least 1 dose of an inpatient antimicrobial during study dates.[2] All relevant data were extracted from the VA Informatics and Computing Infrastructure (VINCI) data warehouse.

To assess antimicrobial prescribing, manual chart reviews were performed on a subset of inpatients with eligible diagnostic codes from January 1, 2013, through June 30, 2015, and from October 1, 2015, through June 30, 2017. There were 4 diagnostic cohorts for this chart review: community-acquired pneumonia (CAP), acute exacerbations of chronic obstructive pulmonary disease (COPD-E), cellulitis, and cystitis (supplemental protocol).

Statistical analysis

To assess changes in the SAAR, we constructed a Poisson regression model with a generalized estimated equation using a harmonic seasonality adjustment. Observed days of therapy (DOTs) was the outcome variable, and predicted DOTs was the denominator (offset) variable. Slopes of trends and changes in intercepts were calculated as incidence rate ratios (IRRs). Model diagnostics, including autocorrelation functions and residual

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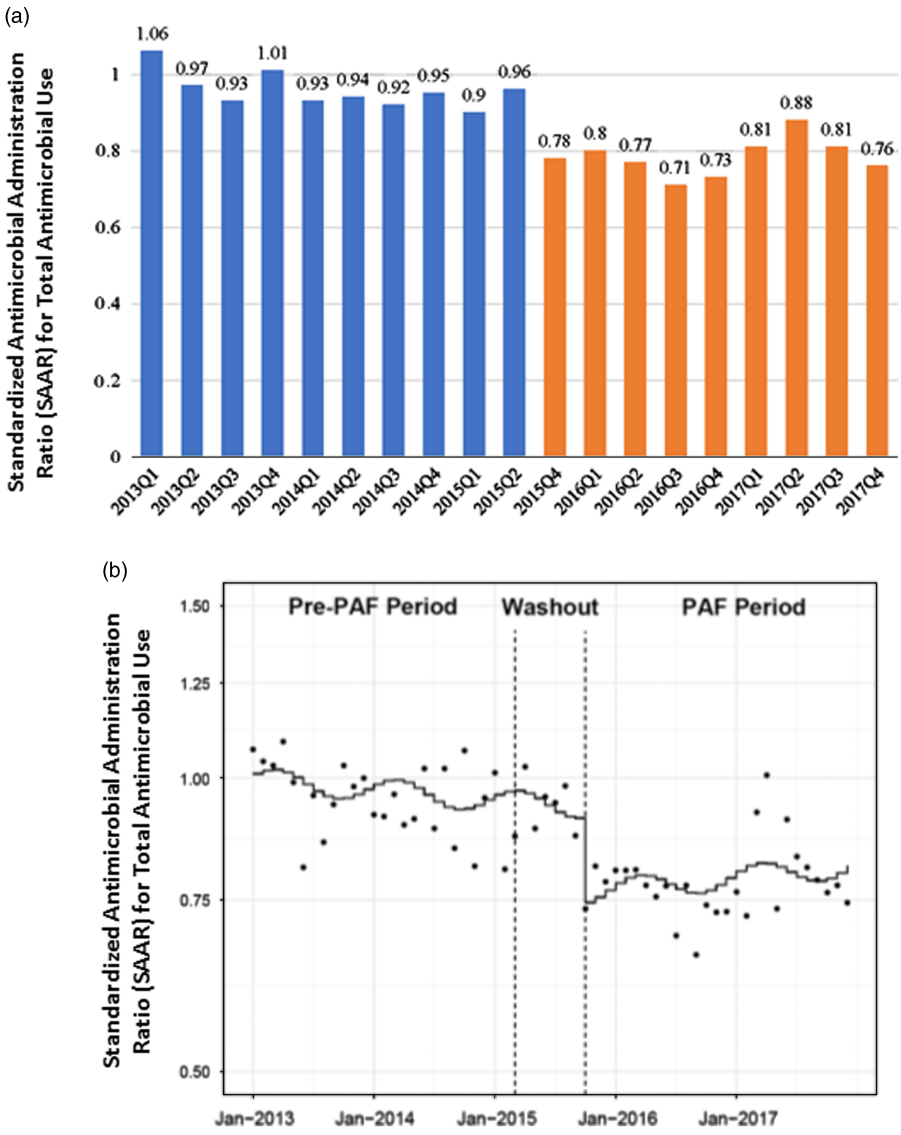

Fig. 1. (a) Quarterly standardized antimicrobial administration ratios (SAAR) for total antimicrobial use at the Iowa City VA Medical Center before and after implementation of prospective audit and feedback, January 1, 2013, to December 31, 2017. (b) Trends in the monthly Standardized Antimicrobial Administration Ratio (SAAR) for total antimicrobial use at the Iowa City VA Medical Center based on a Poisson regression model with a generalized estimated equation, January 1, 2013, to December 31, 2017.

plots, were considered to ensure the appropriateness of the model. All analyses were performed using Statistical Analysis System version 9.4 software (SAS Institute, Cary, NC).

Results

Changes in the SAAR

During the first 3 months of PAF, 269 recommendations were made by the ASP team. The mean numbers of PAF recommendations per quarter were 195 during 2016 and 154 during 2017.

Quarterly SAARs ranged from 0.90 to 1.06 during the pre-PAF period and from 0.71 to 0.88 during the PAF period. On average, quarterly SAARs were 18.0% lower during the PAF period (0.96 vs 0.78; $P < .01$) (Fig. 1a).

Based on a Poisson regression model, the monthly SAAR decreased by 0.2% per month (IRR, 0.998; 95% confidence interval [CI], 0.997–0.999) during the pre-PAF period ($P = .01$). With the implementation of PAF, the SAAR immediately decreased by 18.6% (IRR, 0.8143; 95% CI, 0.785–0.845; $P < .01$). The SAAR subsequently increased by 0.2% per month through December 31, 2017 (IRR, 1.002; 95% CI, 1.001–1.004; $P = .01$) (Fig. 1b).

Baseline characteristics and outcomes in inpatients who received antimicrobials

During the pre-PAF period, 4,947 of 9,817 (50.4%) unique patient admissions received ≥1 dose of an inpatient antimicrobial compared to 4,180 of 9,169 (45.6%) during the PAF period ($P < .01$). Additional differences were noted between the pre-PAF and PAF cohorts (Supplemental Table 2).

Certain clinical outcomes did not change after PAF implementation in patients who received at least 1 dose of an inpatient

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Table 1. Clinical Outcomes in Patients Who Received at Least 1 Dose of an Inpatient Antimicrobial Before and During the Period of Prospective-Audit-and-Feedback at the Iowa City VA Medical Center, January 1, 2013 to December 31, 2017

Clinical Outcome	Pre-PAF (n = 4,974)	PAF (n = 4,159)	*P* Value[a]
Length-of-stay, median (IQR)	4.0 (3–7)	4.0 (3–7)	.71
Inpatient mortality, %	2.1	2.3	.59
Clostridium difficile infections within 30 days of hospital discharge, %	0.7	0.6	.60
Readmission within 30 days of hospital discharge, %	15.2	13.5	.02

Note. PAF, prospective audit and feedback; SD, standard deviation.
[a]The Wilcoxon rank-sum test was used to compare median length of stay between periods. A χ^2 test was used for all categorical variables.

Table 2. Antimicrobial Prescribing Outcomes for 4 Clinical Conditions Before and During the Period of Prospective-Audit-and-Feedback: Antimicrobial Appropriateness on Day 3 of Therapy and Total Duration of Therapy

	Antimicrobial Appropriateness			Duration of Therapy, Days		
Cohort (Sample Size for Pre-PAF, Sample Size for PAF)	Pre-PAF, No. (%)	PAF, No. (%)	*P* Value	Pre-PAF, Mean (SD)	PAF, Mean (SD)	*P* Value
CAP (42, 40)	33 (78.6)	27 (67.5)	.26	9.0 (3.0)	7.0 (2.3)	<.01
COPD-E (48, 40)	24 (50.0)	25 (62.5)	.24	7.1 (2.5)	5.3 (1.2)	<.01
Cellulitis (40, 25)	19 (47.5)	20 (80.0)	<.01	13.2 (4.5)	12.1 (3.9)	.48
Cystitis (40, 36)	15 (37.5)	26 (72.2)	<.01	11.4 (4.4)	8.4 (2.8)	<.01

Note. CAP, community-acquired pneumonia; COPD-E, acute exacerbations for chronic obstructive pulmonary disease; PAF, prospective audit and feedback; SD, standard deviation.

antimicrobial, including inpatient mortality (2.1% vs 2.3%; $P = .59$), length-of-stay (median, 4.0 vs 4.0 days; $P = .71$), and *Clostridium difficile* infections as defined by a positive enzyme immunoassay for toxins A and B (0.7% vs 0.6%; $P = .60$) (Table 1). However, hospital readmissions within 30 days of discharge significantly declined during the PAF period (15.2% vs 13.5%; $P = .02$).

During the PAF period, the same proportion of patients were discharged on oral antimicrobials (38.6% vs 36.9%; $P = .08$) but the mean duration of antimicrobials on discharge decreased (5.2 days vs 4.5 days; $P = .01$). There was no change in the placement of peripherally inserted central catheters for outpatient parental antimicrobial therapy (2.8% vs 2.9%; $P = .58$).

Antimicrobial-prescribing outcomes

In total, 1,145 patient admissions from the entire cohort were eligible for chart review. Overall, 1,003 charts were reviewed to assess antimicrobial-appropriateness and duration of therapy (Supplemental Fig. 2), and 311 (31.0%) met inclusion criteria. PAF implementation was associated with increased antimicrobial appropriateness in cellulitis (47.5% vs 80.0%; $P < .01$) and cystitis (37.5% vs 72.2%; $P < .01$) but no change in appropriate prescribing for CAP (78.6% vs 67.5%; $P = .26$) and COPD-E (50.0% vs 62.5%; $P = .24$) (Table 2). Reasons for inappropriate antimicrobial prescribing can be found in Supplemental Table 3. PAF implementation was also associated with a decreased mean duration of therapy in CAP (9.0 vs 7.0 days; $P < .01$), COPD-E (7.1 vs 5.3; $P < .01$), and cystitis (11.4 vs 8.4; $P < .01$), but not cellulitis (13.2 vs 12.1; $P = .48$) (Table 2).

Discussion

In this single-center study, the SAAR for total antimicrobial use significantly and immediately decreased in response to PAF implementation, a finding described in at least 1 other study.[6] Before PAF, the baseline SAAR at the facility was <1, which indicates that antimicrobial use was already lower than the predicted utilization for a comparable hospital. Nevertheless, the SAAR decreased even further upon implementation of PAF, while antimicrobial-prescribing outcomes and patient safety outcomes remained stable or improved. Although the optimal SAAR for a hospital has not been defined, our findings suggest that values substantially <1.0 can be safely achieved.

After the initial decrease in the SAAR, it started to minimally but significantly rise over time despite the continuation of PAF. There are several potential explanations for this finding. First, the initial reduction in the SAAR may have been too extreme, and the changes seen through the remainder of the PAF period may reflect a recalibration. Second, the ASP team was increasingly encouraged to give clinical team pharmacists opportunities to make their own stewardship recommendations. This is reflected by a decrease over time in the number of PAF recommendations.

Our study has several limitations. First, without a control group, we were unable to prove that changes in any metrics were due to PAF and not an alternate process. For example, patient case-mix changed after PAF implementation, which may have contributed to changes in the SAAR. Second, although our regression model evaluated monthly SAARs, quarterly SAARs may be more meaningful, especially at small facilities like ours. Third, these study results may not be generalizable to hospitals with fewer ASP resources. Finally, we excluded many patients from chart review to identify a cohort for which established guidelines would apply.

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In conclusion, our study found that a SAAR of ~0.8 for total antimicrobial usage can be achieved without harming, and in some ways even improving, antimicrobial appropriateness and patient safety. Future studies are needed to replicate these results.

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Conflicts of interest. All authors report no conflicts of interest.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2018.248

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