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# Implementation of a Pharmacist-Led Antimicrobial Time-Out for Medical-Surgery Services in an Academic Pediatric Hospital

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**OBJECTIVE** This report describes a quality improvement initiative to implement a pharmacist-led antimicrobial time-out (ATO) in a large, freestanding pediatric hospital. Our goal was to reach 90% ATO completion and documentation for eligible patients hospitalized on general pediatric medicine or surgery services.

**METHODS** A multidisciplinary quality improvement team developed an ATO process and electronic documentation tool. Clinical pharmacists were responsible to initiate and document an ATO for pediatric medicine or surgery patients on or before the fifth calendar day of therapy. The quality improvement team educated pharmacists and physicians and provided ATO audit and feedback to the pharmacists. We used statistical process control methods to track monthly rates of ATO completion retrospectively from October 2017 through March 2018 and prospectively from April 2018 through April 2019. Additionally, we retrospectively evaluated the completion of 6 data elements in the ATO note over the final 12-month period of the study.

**RESULTS** Among 647 eligible antimicrobial courses over the 19-month study period, the mean monthly documentation rate increased from 54.6% to 83.5% ($p < 0.001$). The mean ATO documentation rate increased from 32.8% to 74.2% ($p < 0.001$) for the pediatric medicine service and from 65.0% to 88.1% for the pediatric surgery service ($p = 0.006$). Among 302 notes assessed for completeness, 35.8% had all the required data fields completed. A tentative antimicrobial stop date was the data element completed least often (49.3%).

**CONCLUSIONS** We implemented a pharmacist-led ATO, highlighting the role pharmacists play in antimicrobial stewardship. Additional efforts are needed to further increase ATO completion rates and to define treatment duration.

**ABBREVIATIONS** ATO, antimicrobial time-out; EMR, electronic medical record; IRR, incidence rate ratio; QI, quality improvement

**KEYWORDS** antibiotics; antibiotic time-out; antimicrobial stewardship; clinical informatics; pediatrics; pharmacists; quality improvement

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## Introduction

In 2016 The Joint Commission published antimicrobial stewardship standards for hospitals that require the establishment of an antimicrobial stewardship program.[1] In accordance with the core elements of hospital antimicrobial stewardship programs from the Centers for Disease Control and Prevention and The Joint Commission, it is recommended that programs implement action elements such as an antibiotic (or antimicrobial) time-out (ATO).[1,2] An ATO is a reassessment of the continued need and choice of antimicrobials once results of cultures and rapid diagnostic tests have clarified the clinical picture, typically after 48 to 72 hours of therapy.[2] The ATO is clinician-led (i.e., prescriber or pharmacist) and typically the responsibility of the primary team caring for the patient. Without any specific guidance on implementation of ATOs from the Centers for Disease Control and Prevention or The Joint Commission, a variety of ATO strategies have been investigated.[3–9] Some published strategies have used paper questionnaires, whereas others have relied on documentation within the electronic medical record (EMR).[3,4,6,7,9] Furthermore, the antibiotics targeted have varied from only broad-spectrum, empiric antibiotics to any intravenous antibiotic.[3,4,6,9] Finally, the responsible party for conducting the ATO has included resident physicians, attending physicians, and clinical pharmacists.[3,5,6,9] The optimal strategy for a given institution depends on the structure of its inpatient teams, antimicrobial stewardship program resources, and institutional culture.

At our institution, we engaged clinical pharmacists to initiate and document an ATO in the EMR and included all systemic antimicrobials used for empiric or definitive treatment of an infection. Published ATO documentation rates range from 77% when completed by a variety of clinicians to 91% when completed exclusively by the primary team's clinical pharmacist.[3,7] As the medication experts, clinical pharmacists are well positioned on the patient care team to critically evaluate the appropriateness of antimicrobials and stimulate thoughtful clinical discussions. Using the data available, we sought to implement a pharmacist-led ATO within a freestanding pediatric institution that is associated with documentation in the EMR. Here we report our initial quality improvement (QI) initiative that aimed to achieve documentation of ATO completion in the EMR for 90% of eligible patients hospitalized on general pediatric medicine or surgery services. Although several studies have evaluated the impact of the ATO, herein we describe the implementation process, the barriers encountered, and quality assessment of the ATO documentation.

## Materials and Methods

**Setting.** Nationwide Children's Hospital is a 673-bed, freestanding children's hospital in Columbus, OH. Depending on the time of year, the pediatric medicine service is composed of 3 teaching teams (with medical residents) and 1 or 2 additional teams that consist only of attending physicians (sometimes with a physician assistant or nurse practitioner). One clinical pharmacist covers 2 pediatric medicine teams each weekday, rounding with each team on alternate days. The pediatric surgery service oversees management of general surgery, which consist of colorectal and pelvic reconstruction, and burn and trauma surgery patients. One clinical pharmacist rounds each weekday with the surgical team, which includes attending physicians, surgical residents and fellows, and nurse practitioners. Our institution does not have rounding clinical pharmacist coverage for these teams on weekends and holidays.

**ATO Process.** A multidisciplinary QI team that included physicians, pharmacists, clinical informaticists, and QI professionals developed an institutional process for conducting a pharmacist-led ATO. In this process, clinical pharmacists identified opportunities for an ATO by tracking which of their patients had received an antimicrobial (i.e., antibiotic, antiviral, and antifungal) for 3 to 5 calendar days. Day 1 was defined as the first calendar day antimicrobials were administered. Days 3 to 5 were chosen because the 48-hour mark of therapy would typically occur on antimicrobial day 3, and the 72-hour mark on day 4. Including day 5 allowed flexibility to perform the ATO during patient rounds the morning after the 72-hour mark was reached. The pharmacist could also initiate the ATO on therapy day 1 or 2 if the treatment plan was finalized by then. Modifications of the antimicrobial therapy, such as change of dose, frequency, or antimicrobial agent, did not reset the clock for when an ATO was expected to occur. Patients could be eligible for an ATO multiple times during a single hospitalization if antimicrobials were discontinued for ≥2 consecutive days, followed by another antimicrobial treatment course. The pharmacist was expected to conduct and document the ATO during day shift Monday through Friday, regardless of whether they were physically rounding with the team that day. If physically rounding with the medical or surgical team, the pharmacist discussed the antimicrobial indication(s) and plan during multidisciplinary rounds; otherwise, the pharmacist contacted the team for the ATO after rounds.

**ATO Components and Documentation.** The multidisciplinary QI team developed a standardized ATO note template in the EMR to guide the ATO discussion and provide documentation (Supplemental Figure). Using NoteWriter (PatientKeeper, Inc, Waltham, MA) functionality, the clinical pharmacist was guided to click buttons, with minimal free text requirements, to document components of the ATO based on the key questions suggested by the Centers for Disease Control and Prevention.[2] Within the note, current antimicrobial orders were populated automatically. The pharmacist entered values for the following standard note data fields: 1) first calendar day of effective treatment as defined by the medical/surgical team; 2) tentative stop date; 3) enteral therapy exclusions (if not on enteral antimicrobials); 4) patient-reported adverse reaction(s) or allergy affecting therapy; 5) specific treatment indication; and 6) medical or surgical team clinician with whom the ATO was discussed. For the treatment indication, the pharmacist first chose a general diagnostic category (e.g., lower respiratory tract) and then a specific indication (e.g., community-acquired pneumonia) within that category. Indications included both presumed infections (e.g., sepsis) and culture-proven infections (e.g., bacterial cystitis). Subsequent to this QI initiative, an additional field was added that asks whether therapy can be narrowed based on microbiologic results (Supplemental Figure).

**ATO Implementation.** Before October 2017, the ATO process and note template were informally introduced to clinical pharmacists during in-person antimicrobial stewardship program prospective audit and feedback rounds (i.e., handshake stewardship).[2,10] At that time, the antimicrobial stewardship program was early in the implementation of in-person rounds, focusing initially on pediatric surgery and expanding later to pediatric medicine. Formal implementation of the ATO, with tracking of completion data, began in October 2017. The QI team used 2 primary types of interventions (i.e., education; audit and feedback). In October 2017, in-person education about the ATO was provided at the hospital-wide section chiefs' meeting. Additional in-person education detailing the ATO process and note

template was provided to pediatric medicine physicians in December 2017, to clinical pharmacists in February 2018, and to pediatric surgery physicians in August 2018. Audit and feedback to the clinical pharmacists began in April 2018 and continued monthly thereafter. Based on data from an automated monthly report, the director of inpatient pharmacy sent an email to each pharmacist that detailed the number of documented ATOs and the number of eligible patients for the service that pharmacist covered. The feedback was service-specific but did not detail an individual pharmacist's performance.

**Assessment of ATO Completion.** We tracked monthly ATO completion by assessing the percent of eligible pediatric medicine or surgery patients who had the ATO documented in the EMR. An ATO was considered to be appropriately documented if a pharmacist entered the note into the patient's EMR anytime from day 1 through 5 of therapy. Information Services developed an automated, monthly report of all patients who received at least 5 consecutive calendar days of a systemic antimicrobial. The report indicated whether an ATO was documented during treatment days 1 to 5 and the medical or surgical service caring for the patient. This report was manually audited monthly to ensure accuracy, identify barriers to ATO documentation, and generate data for the aforementioned feedback. For data collection, the patient's medical or surgical service was determined by the midnight census between antimicrobial days 3 and 4. Although pharmacists were expected to perform and document ATOs for prophylactic and non-infectious uses of antimicrobials (e.g., gastrointestinal hypomotility), for this report we excluded antimicrobial courses for indications other than treatment of a presumed or confirmed infection.

In addition, we retrospectively evaluated the quality of the documentation over the final 12-month period of the study (May 2018 through April 2019), specifically the completion of each of the 6 aforementioned standardized note components. A tentative stop date was considered to be completed if the pharmacist documented a specific date, clinical parameters for stopping, or a specific hospital protocol that was being followed to determine duration of therapy (e.g., appendicitis).

**Data Analysis.** We tracked ATO completion rates (as indicated by completion of the standardized note in the EMR) from October 2017 through April 2019 for all patients who received antimicrobials for at least 5 consecutive calendar days and who were admitted to the pediatric medicine or pediatric surgery services. Monthly rates were plotted by using statistical process control methods and Shewhart p-charts, enabling us to define sequential process stage means and illustrate improvement over time.[11] Calculation of control limits was based on process mean and the subgroup size, based on a binomial distribution of the data. Group comparisons were performed using the $\chi^2$ test or Student *t* test, as appropriate. Poisson regression models using log counts as offsets were used to estimate mean monthly overall ATO documentation rates and compare estimates between study periods. In addition, to evaluate whether day of the week impacted ATO completion, we fit a logistic regression model predicting note completion as the dependent variable, with day of the week on which therapy was initiated and service (pediatric medicine vs pediatric surgery) as independent variables. Because we expected holidays to be a barrier to ATO completion, we designated a separate day of the week category for antimicrobial courses for which day 4 of therapy occurred on a holiday. Two-sided p values <0.05 were considered statistically significant. We followed the Standards for Quality Improvement Reporting Excellence 2.0 guidelines in reporting this QI initiative.[12]

## Results

**ATO Completion.** Over the 19-month study period, 647 qualifying antimicrobial courses met inclusion criteria: 219 for pediatric medicine and 428 for pediatric surgery. During the initial process stage, the mean monthly overall ATO documentation rate was 54.6%. The center line shifted in September 2018 to a new process stage mean of 83.5% (Figure A) (Poisson regression model: incidence rate ratio [IRR], 0.65 [95% CI, 0.54–0.79], p < 0.001). The mean ATO documentation rate for the pediatric medicine service increased from 32.8% to 74.2% (Figure B) (Poisson regression model: IRR, 0.44 [95% CI, 0.30–0.65], p < 0.001), and the mean ATO documentation rate for the pediatric surgery service increased from 65.0% to 88.1% (Figure C) (Poisson regression model: IRR 0.74 [95% CI, 0.59–0.92], p = 0.006). The mean hospital monthly census from October 2017 to August 2018 was 13,144, compared with 13,513 from September 2018 to April 2019 (difference: −369 [95% CI, −1092–53], Student *t* test p = 0.296).

In the logistic regression analysis, both day of the week on which therapy was initiated (p < 0.001) and service (p < 0.001) exhibited independent effects on the odds of ATO completion (Table 1). Compared with therapy initiation on Sunday, the odds of ATO completion were highest when therapy was initiated on Thursday. The odds were also increased when therapy was initiated on Tuesday or Wednesday. The odds were significantly decreased when day 4 of therapy occurred on a holiday.

**ATO Note Quality.** During the 12-month period for which we assessed documentation quality, 302 ATOs were documented, including 78 pediatric medicine and 224 pediatric surgery ATOs. Rates of data field completion are presented in Table 2. Overall, 108 (35.8%) ATOs had all the required data fields completed. The data field that was most likely to be completed was "patient-reported adverse reaction or allergy effecting therapy" (97.7% completion rate), whereas the tentative

**Figure.** Shewhart p-charts of antimicrobial time-out (ATO) documentation rates for (A) all patients, (B) pediatric medicine patients, and (C) pediatric surgery patients. Diamonds represent monthly rates of ATO documentation among eligible patients. The thick black line displays the process stage means. The dotted lines represent the control limits. Interventions are listed below the charts with arrows indicating the time when each intervention occurred.

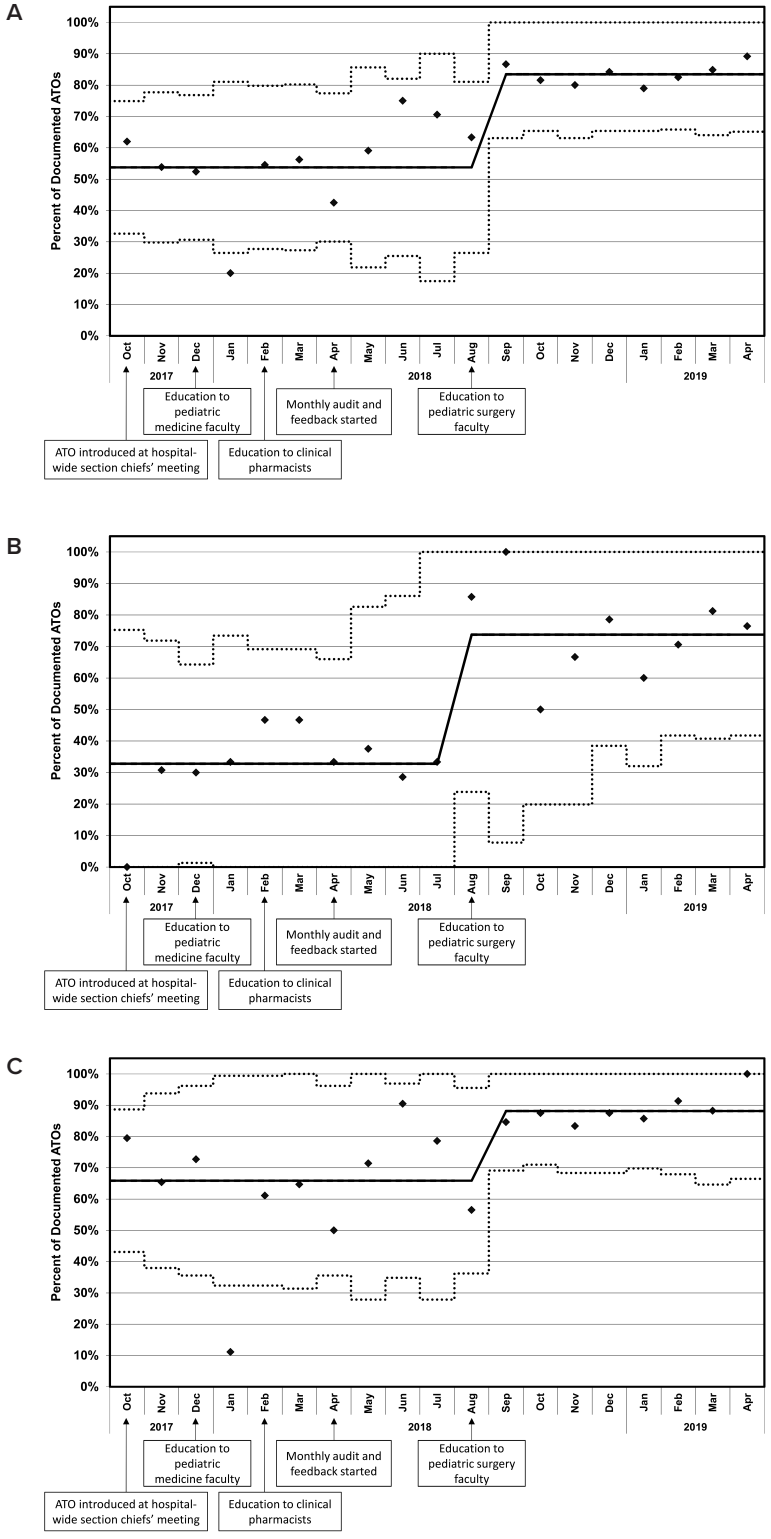

**Table 1.** Adjusted Rates and Odds Ratios of Note Documentation by Day of Antimicrobial Initiation and Service

| Variable | Adjusted Documentation Rate, % (95% CI) | Adjusted Odds Ratio (95% CI) | p value |
|---|---|---|---|
| Day of the week | | | |
| Sunday | 52.1 (41.6–62.4) | Reference | |
| Monday | 64.9 (54.1–74.3) | 1.70 (0.92–3.12) | 0.089 |
| Tuesday | 71.5 (60.4–80.6) | 2.31 (1.20–4.44) | 0.012 |
| Wednesday | 78.8 (69.3–86.0) | 3.42 (1.78–6.57) | <0.001 |
| Thursday | 82.8 (73.0–89.6) | 4.42 (2.17–9.02) | <0.001 |
| Friday | 62.0 (50.9–71.9) | 1.50 (0.81–2.77) | 0.196 |
| Saturday | 46.5 (35.9–57.4) | 0.80 (0.44–1.46) | 0.464 |
| Any (day 4 is holiday)* | 28.9 (9.0–62.7) | 0.37 (0.09–1.63) | 0.191 |
| Service | | | |
| Pediatric surgery | 72.9 (67.1–78.0) | Reference | |
| Pediatric medicine | 49.9 (41.9–58.0) | 0.37 (0.26–0.53) | <0.001 |

* Antimicrobial initiated on any day, when day 4 of therapy occurred on a holiday.

stop date was the least likely to be completed or was marked unknown (49.3% completion rate). Compared with pediatric surgery, pediatric medicine ATOs were more likely to have all data fields completed and to document a tentative stop date. However, pediatric surgery ATOs were more likely to document the clinician with whom the ATO was discussed.

## Discussion

In this QI initiative, we implemented a pharmacist-led ATO that was documented in the EMR in a freestanding pediatric institution. Although we did not reach our initial aim of an ATO in 90% of eligible patients, we did achieve a significant increase over the 19-month study period with a center-line shift to 83.5%. This documentation rate compares favorably among other ATO literature that ranges from 70% to 91%.[3,7,9] At the beginning of the formal ATO implementation, completion rates were higher on the pediatric surgery service compared with pediatric medicine. We suspect the reason for this difference was the informal introduction of the ATO during the antimicrobial stewardship program's face-to-face prospective audit and feedback rounds (i.e., handshake stewardship), which focused first on pediatric surgery and later on pediatric medicine. For both services, nearly a year passed before we saw an upward center-line shift in ATO completion. During that time, we provided formal education and began audit and feedback to the pharmacists, but we cannot be confident which of these interventions accounted for the improvement. Our approach aligns with antimicrobial stewardship guidelines that suggest pairing education with other strategies such as audit and feedback.[2,13]

Documentation of the ATO in the EMR communicates the antimicrobial plan to all medical providers, facilitates the antimicrobial stewardship program's prospective audit and feedback, and provides discrete data that can be collated and used to assess patterns of antimicrobial use in the institution. This can only be done if ATOs are adequately documented, which is a current reporting gap in the literature. Our assessment of note quality revealed that less than half the notes had all 6 data fields completed. ATOs were less often completely documented on the pediatric surgery service, driven primarily by failure to document a tentative stop date. It is unclear to us whether this difference was driven by the habits of the individual pharmacists or particular barriers to defining stop dates for surgical patients. However, even when a specific date could not be established at the time of the ATO, documenting a protocol being followed (e.g., ruptured appendicitis protocol) or clinical parameters that determined the stop date would have satisfied the requirement. Difficulty defining a stop date is not unique to our institution. In a large adult health system, an electronic ATO alert to providers at 72 hours resulted in defining a stop date in only 0.5% of patients.[14] These data suggest that efforts to define the treatment duration, or at least the clinical parameters upon which the duration depends, is an important opportunity for antimicrobial stewardship.

We believe there are important advantages to using clinical pharmacists to initiate ATOs. Clinical pharmacists are highly regarded as experts in medication therapy and monitoring. In addition, unlike medical and surgical trainees and attending physicians who rotate on and off service, pharmacists are more consistent, longitudinal members of the patient care team. This allows for continued communication about a course of therapy, which aids members of the patient care team who may not have been present when antimicrobials were initiated. Further, the logistics of educating clinical pharmacists to initiate and document the ATO

**Table 2.** Completion Rates of the Antimicrobial Time-Out Note Data Fields

| Data Field | Number (Percent) Completed | | | p value* |
|---|---|---|---|---|
| | Total (N = 302) | Pediatric Medicine (n = 78) | Pediatric Surgery (n = 224) | |
| First date of effective therapy | 293 (97.0) | 76 (97.4) | 217 (96.9) | 0.802 |
| Tentative stop date | 149 (49.3) | 70 (89.7) | 79 (35.3) | <0.001 |
| Adverse reaction/allergy | 295 (97.7) | 77 (98.7) | 218 (97.3) | 0.480 |
| Enteral therapy exclusion | 232 (91.0)† | 36 (85.7)† | 196 (92.0)† | 0.192 |
| Treatment indication | 286 (94.7) | 74 (94.9) | 212 (94.6) | 0.601 |
| Clinician documented | 267 (88.4) | 57 (73.1) | 210 (93.8) | <0.001 |
| All data fields completed‡ | 108 (35.8) | 42 (53.8) | 66 (29.5) | <0.001 |

* Chi-square test, comparing pediatric medicine to pediatric surgery

† Excludes patients already receiving enteral therapy at the time of the ATO. Total n=255, pediatric medicine n=42, pediatric surgery n=213

‡ Patients already receiving enteral therapy at the time of ATO were considered to have all data fields completed if the other five data fields were completed

are simpler than attempting to educate the many and various medical trainees who rotate on a given service.

Despite these advantages, we encountered barriers to the implementation of an ATO, which is another knowledge gap in the literature. First, our pharmacist staffing model does not provide clinical coverage to the medical and surgical teams on weekends and holidays, creating a 2-day gap each week when the ATO does not occur. Allowing the ATO to occur as late as day 5 of therapy accounted for the weekend and holiday gaps, a strategy also used by Thom et al.[7] While we speculated that more ATOs would be missed when days 3 and 4 of therapy fell on a weekend, our logistic regression analysis found the inverse to be true: ATO completion occurred less often when antimicrobials were started on the weekend. We speculate that it is more difficult for pharmacists to recognize the opportunities for ATOs when not present on the day of therapy initiation. To remove this barrier, we are currently pursuing an automated reminder in the EMR when the ATO is due. Second, although pediatric surgery pharmacists round on all patients every weekday, pediatric medicine pharmacists cover 2 teams simultaneously and thus are not present during rounds with 1 team each day. Informal feedback from the pharmacists suggested that performing an ATO with the team after rounds is more difficult. This may account for the difference in ATO completion rates between pediatric medicine and pediatric surgery, as well as pediatric medicine's lower rate of documenting the clinician with whom the ATO was discussed. These barriers likely contributed to our inability to reach our goal of 90% ATO completion.

Our study has some limitations. First, we did not include balancing measures such as the time pharmacists spend documenting ATOs. However, the note template facilitates rapid documentation, and we believe the time impact on the pharmacists was minimal. Second, the close proximity of our interventions prevents us from being able to distinguish which intervention was most integral in increasing documentation rates. Third, this report focused on the implementation process of the ATO and not on changes in antimicrobial use or economic impact. Future work will assess the impact of our ATO strategy on antimicrobial days of therapy and appropriateness. Fourth, the experience with ATO implementation on our pediatric medicine and surgery services may not reflect those of other services, particularly intensive care units. Finally, our findings may not be generalizable to institutions with different structures of clinical pharmacy integration into patient care teams.

## Conclusion

In summary, we successfully implemented a pharmacist-led ATO within a large freestanding pediatric hospital. Our initiative highlights the opportunity for pharmacists to play an active role in antimicrobial stewardship. Challenges of a pharmacist-led ATO include coverage of multiple medical teams and decreased weekend staffing. Even so, with education and performance feedback, our ATO documentation rates increased over time to 83.5%. Since the completion of this QI study, the pharmacist-led ATO has been implemented for all clinical services within our institution. Finally, it is important to assess both completion and quality of the ATO. For us, defining a treatment duration or clinical criteria for discontinuing antimicrobials was the major barrier to complete documentation.

### Article Information

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