JOURNAL ARTICLE

Title: Changes in antibiotic prescribing metrics at 3 nursing homes in Atlanta collaborating on antibiotic stewardship

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Brief Summary: Antibiotic overuse can contribute to antibiotic resistance and adverse events. Results showed some improvements in UTI antibiotic prescribing. Exploring how effects may vary due to implementation differences is warranted.

Acknowledgements: We would like to express our appreciation to the staff of the nursing homes that participated in this program, particularly their infection control staff who provided the antibiotic prescribing data.

Abstract

Objective: To examine changes in nursing home (NH) antibiotic prescribing metrics for urinary tract infections (UTI) over the course of an antibiotic stewardship intervention.

Design: Three independent NHs collaborated with the Emory Antibiotic Stewardship in Long Term Care (EASIL) Initiative Team to start activities to reduce unnecessary antibiotic use for presumed UTIs. Activities included a stewardship gap analysis, launch of best practice guidance for UTI antibiotic prescribing shared with prescribing staff, and start of a data feedback system.

Setting and Participants: Three Atlanta-based NHs enrolled in the EASIL Initiative.

Methods: Comparative metrics included facility-specific proportions of UTI antibiotic prescriptions over the recommended duration and days of therapy (DOT) per 1,000 resident days (RD). Risk and rate ratios were calculated to compare prescribing metrics between the peri-intervention period to an early intervention and late intervention period.

Results: Average monthly RD at the three NHs ranged from 3,535 to 5,981. During the peri-intervention period, 96 (28.2%) antibiotic prescriptions were for UTIs, of which, 51 (53.1%) were new antibiotic starts. Metrics did not differ significantly between peri- and early intervention periods; however, one facility reported a significant reduction in new UTI prescriptions over recommended duration in late-intervention compared to peri-intervention period (Risk Ratio = 0.35, 95% CI 0.13-0.93, P = 0.033), while the other two reported non-significant declines. One facility reported a significant reduction in DOT/1000 RD between late-intervention period compared to peri-intervention period (Rate Ratio = 0.52, 95% CI 0.40-0.67, P < .001), while another experienced a significant increase in DOT/1,000 RD (Rate Ratio = 2.05, 95% CI 1.52-2.76, P < .001).

Conclusions and Implications: While we observed some significant improvements in antibiotic prescribing metrics over the study period, changes were inconsistent across facilities. Exploring how effects of the intervention may vary due to differences in implementation or facility staffing between facilities is warranted.

Introduction

The unnecessary use of antibiotics is a growing public health challenge due to the rapid emergence of multi-drug resistant organisms across the globe.[1,2] According to the Centers for Disease Control and Prevention (CDC), more than 2.8 million antibiotic-resistant infections occur in the United States annually.[3] Antibiotic resistance is a particular concern for nursing home residents, as antibiotics are one of the most commonly prescribed medications in this setting, and an estimated 25% to 75% of these prescriptions may be inappropriately or unnecessarily prescribed.[4] The unnecessary use of antibiotics in this population can lead to increased rates of adverse side effects, such as *Clostridioides difficile* infections (CDI); increased costs; and further contribute to antibiotic resistance.[4,5]

Ensuring accurate and appropriate prescribing of antibiotics in nursing homes is particularly challenging, as nursing home residents commonly present with symptoms that are difficult to diagnose due to comorbidities and cognitive impairment.[6] Historically, urinary tract infections (UTIs) are the most common indication for starting antibiotics among nursing home residents, with over one third of all antibiotics prescribed in this setting targeting UTIs.[7-10] Studies of antibiotic prescriptions for UTIs suggest that antibiotics are often used in the absence of clinical evidence of infection; one study identified that one third of antibiotic prescriptions for UTIs started before a laboratory test was even performed.[11,12] These studies also found that the use of antibiotics for UTIs often continues for prolonged durations, despite negative laboratory tests (e.g., urinalysis, urine culture, blood culture).[11,12]

In order to reduce inappropriate prescribing of antibiotics in healthcare settings, in 2014 the Centers for Disease Control and Prevention (CDC) released guidelines for developing and implementing antibiotic stewardship programs that incorporate seven core elements: leadership, accountability, drug expertise, action, tracking, reporting, and education.[13] While these guidelines were originally developed for acute-care settings, CDC adapted these core elements for nursing homes to provide practical ways facilities can initiate antibiotic stewardship activities aimed at improving antibiotic use, reducing adverse events, and preventing the emergence of antibiotic resistance. Additionally, in response to the growing emphasis on antibiotic stewardship in nursing homes, as of November 28, 2017, the Centers for Medicare and Medicaid Services (CMS) began requiring that nursing homes implement an antibiotic stewardship program that incorporates the CDC's Core Elements for Antibiotic Stewardship.[14] Despite these new requirements, many nursing homes still do not such comprehensive antibiotic stewardship programs.[15-17]

As the CDC's guidelines for antibiotic stewardship were initially developed for acute-care settings, there is a critical need for further evaluation of the effectiveness of antibiotic stewardship program implementation in this setting as well as the facilitators and barriers to implementation.[7] The purpose of this study is to examine the impact of the Emory Antibiotic Stewardship in Long Term Care (EASIL) Initiative, a quality improvement initiative designed to support the antibiotic stewardship programs of three Atlanta-based nursing home facilities. Our study aimed to estimate the effect of the initiative on several UTI antibiotic prescribing metrics over the course of the intervention and how these changes varied between facilities.

Methods

Design/Setting

This study employed a multi-site repeated measures design with a 15-month data collection period. Three large, independent nursing homes, with bed sizes ranging from 150 to 250 beds,[18] collaborated with the EASIL Initiative aimed to reduce unnecessary antibiotic use for presumed UTIs. Activities included a stewardship gap analysis, launch of best practice guidance for UTI antibiotic prescribing shared with prescribing staff, and start of an antibiotic prescribing data feedback system.

As part of the initial stewardship gap analysis, the EASIL team met with leadership at each facility to review the CDC's antibiotic stewardship guidelines and identify gaps in stewardship programs. The EASIL team conducted interviews with leadership and staff during which possible areas of improvement were identified. Over the subsequent 5 months, the EASIL team worked with the medical directors to develop a set of standardized best practices for treating UTIs as well as the most appropriate methods for promoting these best practices within the facility (e.g., best practice guidelines, communication materials). Best practices were shared with prescribing staff through initial presentations on antibiotic stewardship and as pocket cards to guide daily antibiotic prescribing. Each facility was also provided posters demonstrating leadership commitment with information about the program to display in their facilities. The EASIL team engaged in outreach with family members and residents by providing pamphlets on "active monitoring" for antibiotic stewardship. The educational posters and outreach pamphlets were informed by focus groups with residents and family members. Finally, the EASIL team worked with consultant pharmacists to obtain and process antibiotic prescribing data. These data were provided to each facility through monthly feedback reports which continued for 12 months after completion of the initial activities.

Data

Data on facility characteristics were collected from the CMS Nursing Home Compare website.[18] Antibiotic prescribing data were collected via standardized prescribing logs submitted to the EASIL team monthly by each nursing home. The standardized prescribing logs included the following data for each antibiotic prescription: start date; antibiotic name; treatment site (modified from Agency for Healthcare Research and Quality [AHRQ] treatment codes); indication (e.g., active infection, prophylaxis); prescriber attribution; days of therapy (DOT); adherence to Loeb's Minimum Criteria, a standardized diagnostic tool for initiation of antibiotics in long-term care settings;[19] and completion of the Situation-Background-Assessment-Recommendation (SBAR) communication tool, which provides a framework for communicating about a patient's condition.[20,21] Each facility also provided monthly resident-days (RDs).

The start of the study period for each facility was defined as the month of initial implementation of the best practices educational initiative informed by the gap analysis. The end of the study period for each facility was defined as March 2020, in an effort to prevent bias in the data due to effects of the COVID-19 pandemic. The study period was then divided into three intervention periods for comparison: peri-intervention, defined as the first three months of initial implementation of a best practices educational initiative at each facility; early intervention, defined as the subsequent six months after the peri-intervention period; and late intervention, defined as the period following the peri-intervention period through March 2020 (six months for Facilities A and B; four months for Facility C).

IRB approval was obtained through expedited review by the Emory University Institutional Review Board (IRB number: IRB00104059).

Measurement

Antibiotic Start Characteristics

Antibiotic start characteristics, including start date, antibiotic name, treatment site, indication, prescriber attribution, and DOT were assessed at the aggregate level for each facility. Antibiotic start characteristics were further examined for antibiotics prescribed for UTIs. These antibiotic starts for UTIs were also stratified by prescriber attribution (whether the antibiotic was prescribed within the facility [new start] or through a transfer order). DOT were used to identify whether each antibiotic was prescribed for the recommended duration for that specific antibiotic based on clinical practice guidelines developed by the Infectious Disease Society of America (IDSA) and consultation from facility leadership.[22-24] We further considered adherence to Loeb's criteria for appropriate and necessary prescription of antibiotics for UTIs as well as completion of the SBAR communication tool. Adherence to Loeb's criteria and SBAR completion (Yes, No, Not Applicable, and Unknown) was indicated by infection prevention staff for each antibiotic start on the prescribing logs.

Outcome Measures

Two key comparative metrics were calculated to examine changes in antibiotic prescribing practices for UTIs prescribed within facility over the duration of the intervention: (1) facility-specific proportions of UTI antibiotic prescriptions that were over the recommended duration and (2) facility-specific rates of DOT per 1,000 RD for UTI antibiotic prescriptions.

Statistical Analyses

Data were analyzed using RStudio Version 1.2.5042, the tidyverse, ggplot2, lubridate, and table1 packages.[25-28] The analyses were intended to examine the effect of the newly implemented antibiotic stewardship activities on the appropriateness of antibiotic prescribing for suspected UTIs.

Basic characteristics of antibiotic starts, including treatment site, prescriber attribution, rationale for prescription, and DOT, were first compared across facilities during the peri-intervention period, as this time period served as the reference period for changes across the course of the intervention. Frequencies and proportions were calculated for categorical data, and medians and quartiles were calculated for continuous data. Antibiotic starts for UTI's were then stratified by prescriber attribution to compare the basic characteristics of new UTI antibiotic starts with transfer orders for UTIs within each facility. Finally, temporal trends in key antibiotic prescribing metrics were calculated, including number of prescriptions per 1,000 RD, DOT per 1,000 RD, and proportion of antibiotic starts that were over the recommended duration for the antibiotic prescribed (antibiotics for which recommendations on duration of therapy were not available were excluded from this metric).

Facility specific changes in antibiotic prescribing practices for suspected UTIs over the study period were assessed by calculating risk and rate ratios comparing prescribing metrics between intervention periods. The peri-intervention period (first three months after initial stewardship gap analysis) was treated as the baseline reference period. Risk ratios (RR) and their 95% confidence intervals (CIs) were calculated to compare proportions of new antibiotic prescriptions for UTIs that were over the recommended duration between the peri-intervention period to the early intervention and late intervention periods.[29] Incidence rate ratios (IRR) and their 95% CIs were calculated to compare DOT per 1,000 RDs between the peri-intervention period to the early intervention and late intervention periods.[29] Statistical significance was defined as $P < .05$ and CIs were calculated using mid-p exact methods and Wald approximation.

Results

Bed size at the three participating NHs ranged from 150 to 250. A total of 1,578 recorded antibiotic prescriptions were included in the analytic dataset, with facility-level counts of prescriptions over the course of the intervention period ranging from 369 to 666.

During the peri-intervention period, 51.8% (n=176) of prescriptions were new starts and 93.8% (n=319) were prescribed empirically for an active infection (Table 1). As expected, UTIs were the most common indication for an antibiotic during the peri-intervention period, comprising 28.2% (n=96) of all prescriptions across the three facilities. Approximately 53.1% (n=51) of antibiotic prescriptions for UTIs during this period were new starts.

Among new UTI starts during the peri-intervention period (n=51), 4 (7.8%) prescriptions were for a quinolone antibiotic, 36 (70.6%) antibiotic prescriptions met Loeb's Minimum Criteria, and 43 (84.3%) were prescribed using the SBAR communication tool (Table 2). Additionally, 18 (35.3%) prescriptions were over the recommended duration for the prescribed antibiotic (Table 2).

Facility-specific monthly values across the study period varied greatly for UTI prescribing rates (median 1.32, range 0.167-3.18) and DOT per 1,000 RD (median 6.18, range 0.50-14.45). Changes in proportions of new prescriptions for UTIs that were over the recommended duration and changes in rates of DOT per 1,000 RD were inconsistent across facilities over the course of the study period (Figure 1). None of the participating nursing homes reported significant changes in either metric between the peri- and early-intervention periods (Tables 3 and 4). However, one facility reported a significant reduction in new prescriptions for UTIs that were over the recommended duration in the late-intervention compared to the peri-intervention period (RR = 0.35, 95% CI = [0.13-0.93]). The other two facilities reported non-significant declines in new prescriptions for UTIs that were over the recommended duration; however, one of these facilities did report a significant reduction in DOT/1,000 RD between late-intervention period compared to peri-intervention period (IRR = 0.52, 95% CI = [0.40-0.67]). Another facility experienced a significant increase in DOT/1,000 RD (IRR = 2.05, 95% CI = [1.52-2.76]).

Discussion

Despite consistent efforts to implement a multi-modal antibiotic stewardship intervention aligned with the CDC's Core Elements for Antibiotic Stewardship across three large nursing homes, improvement in antibiotic prescribing metrics were inconsistent across facilities.

Overall, changes in antibiotic prescribing rates for UTIs per 1,000 RD varied considerably between facilities. This variability in changes over time for the number of new antibiotic starts for UTIs after program implementation could be attributed to the relatively high proportions of antibiotic prescriptions that adhered to Loeb's Minimum Criteria for initiation of an antibiotic for UTI (70.6%) and were prescribed using the SBAR communication tool (84.3%) during the peri-intervention period. Assuming the process metrics of compliance with Loeb's Minimum Criteria are accurate, these findings indicate that there may not have been much room for improvement in prescribing rates for UTIs at these facilities, as over 70% of antibiotics already adhered to Loeb's Minimum Criteria at the start of the intervention, and the median rate of new starts for UTI per month was only 1.32 starts per 1,000 RD.

However, another important element of antibiotic stewardship is ensuring that, when an antibiotic is prescribed, the correct antibiotic is chosen with the right dose, at the right time, and for the right duration.[13] Duration of antibiotic course is particularly important to consider, as shorter antibiotic courses have been found to be nearly as effective as longer courses in eliminating the infecting organism.[30] Furthermore, the longer the antibiotic exposure, the greater the selection pressure for antibiotic resistant bacteria, such as *C. difficile*, that may cause serious infection.[30] The first of two metrics evaluated that we would expect to be influenced by duration of treatment was DOT per 1,000 RD. However, only one facility reported a significant decrease in this metric between the late-intervention period and peri-intervention period, indicating that, while DOT per 1,000 RD is commonly used to assess the impact of antibiotic stewardship programs, this may not be the most suitable metric for assessing stewardship programs in facilities where the majority of antibiotic starts are meeting the Loeb's Minimum Criteria for initiation.

We also examined duration of antibiotic courses by indicating whether or not an antibiotic was prescribed over the recommended duration for that specific antibiotic type. We found that, during the peri-intervention period, over one third of antibiotics prescribed for a UTI were prescribed for longer than the recommended duration. Over the course of the intervention period all three facilities reported reductions in this metric between the late-intervention period and the peri-intervention period, with only one of these facilities reporting significant results. While the significance of these findings is limited, the results suggest that examining whether an antibiotic course is longer than recommended may be a useful metric for assessing adherence to antibiotic prescribing guidelines over the course of an antibiotic stewardship intervention.

This study has several limitations that should be taken into account when interpreting results. First, the small sample size of the antibiotic stewardship initiative limits the generalizability of the results to other facilities, as the study was conducted in only three nursing homes located within the Atlanta metropolitan area. Additionally, the study period was limited to 15 months of data, ending in March 2020, due to the emergence of COVID-19, the infection caused by SARS-CoV-2. We ultimately decided not to include data after March 2020 in order to minimize confounding due to prioritization of COVID-19 treatment and prevention in nursing homes. Finally, we were unable to include data from a pre-intervention period in our data set, as our team did not have access to complete and sufficient data from each facility prior to implementation of the antibiotic stewardship activities. Therefore, our analysis relies on comparisons between intervention periods using the first three months of the intervention, i.e., the peri-intervention period, as the most representative baseline period, as this was the time period during which each facility first began implementing best practice guidelines and a data feedback system. Due to the small sample size, limited time points available in the data set, and lack of a pre-intervention period, we were unable to conduct a more traditional time series analysis to evaluate the impact of the intervention.

This assessment of an antibiotic stewardship initiative in three nursing homes demonstrates the practical challenges of implementing, monitoring, and evaluating stewardship activities in long-term care settings. Limited on-premises physician oversight and reliance on communication between nurses and prescribers may impact the influence of decision support tools (e.g., SBAR, education, pocket cards) regarding antibiotics.[7,12] An added challenge to influencing antibiotic prescribing practices in nursing homes relates to frequent staff turnover, making one-time investment in educational material as was done in EASIL less effective.[31] Despite excellent collaboration and monthly consultation and quarterly feedback of data, complex dynamics between prescribers and nursing staff create a difficult setting for implementing effective antibiotic stewardship activities.

Conclusions and Implications

While we observed some statistically significant improvements in antibiotic prescribing metrics over the study period, these changes were inconsistent both within and across facilities. Future evaluations of antibiotic stewardship programs should thus explore how effects of the intervention may vary due to differences in facility characteristics, staffing, and resident populations. Future studies should also consider the most appropriate metric for assessing changes in antibiotic prescribing, taking into account both antibiotic prescribing rates and duration of therapy. For those planning to implement antibiotic stewardship programs in nursing homes, these findings suggest a need for further investment in enhancing program uptake and maintenance that persists even when there is high staff turnover. This could be achieved by gaining buy-in from administrative staff and identifying a "champion" to lead implementation at the facility; regularly educating staff, residents, and families on antibiotic stewardship; and developing clear protocols on antibiotic stewardship practices.

Conflicts of Interest: The authors have no conflicts of interest to report.

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Table 1. Comparison of Antibiotic Start Characteristics by Intervention Period (January 2019 - March 2020)

	Peri Intervention (N=340)	**Early Intervention (N=705)**	**Late Intervention (N=533)**	**Overall (N=1578)**
Treatment Site				
UTI	96 (28.2%)	216 (30.6%)	183 (34.3%)	495 (31.4%)
LRI	40 (11.8%)	110 (15.6%)	76 (14.3%)	226 (14.3%)
SST	65 (19.1%)	87 (12.3%)	119 (22.3%)	271 (17.2%)
Other	139 (40.9%)	291 (41.3%)	155 (29.1%)	585 (37.1%)
Missing	0 (0%)	1 (0.1%)	0 (0%)	1 (0.1%)
Start Status				
New Start	176 (51.8%)	339 (48.1%)	267 (50.1%)	782 (49.6%)
Transfer Order	164 (48.2%)	365 (51.8%)	266 (49.9%)	795 (50.4%)
Missing	0 (0%)	1 (0.1%)	0 (0%)	1 (0.1%)
Rationale				
Active Infection	320 (94.1%)	669 (94.9%)	510 (95.7%)	1499 (95.0%)
Prophylaxis	14 (4.1%)	34 (4.8%)	22 (4.1%)	70 (4.4%)
Other	6 (1.8%)	2 (0.3%)	1 (0.2%)	9 (0.6%)
Quinolone				
Yes	33 (9.7%)	82 (11.6%)	49 (9.2%)	164 (10.4%)
No	307 (90.3%)	623 (88.4%)	484 (90.8%)	1414 (89.6%)
Over Recommended Duration				
Yes	106 (31.2%)	205 (29.1%)	158 (29.6%)	469 (29.7%)
No	73 (21.5%)	161 (22.8%)	157 (29.5%)	391 (24.8%)
No Recommended Duration Available	148 (43.5%)	328 (46.5%)	210 (39.4%)	686 (43.5%)
Missing	13 (3.8%)	11 (1.6%)	8 (1.5%)	32 (2.0%)
Days of Therapy				
Median (Q1, Q3)	7.00 (5.00, 10.0)	7.00 (5.00, 10.0)	5.00 (5.00, 10.0)	6.00 (5.00, 10.0)
Missing	30 (8.8%)	40 (5.7%)	20 (3.8%)	90 (5.7%)

Table 2. Comparison of New UTI Antibiotic Start Characteristics by Intervention Period (January 2019 - March 2020)

	Peri Intervention (N=51)	Early Intervention (N=108)	Late Intervention (N=95)	Overall (N=254)
Rationale				
Active Infection	49 (96.1%)	107 (99.1%)	94 (98.9%)	250 (98.4%)
Prophylaxis	1 (2.0%)	1 (0.9%)	1 (1.1%)	3 (1.2%)
Other	1 (2.0%)	0 (0.0%)	0 (0.0%)	1 (0.4%)
Quinolone				
Yes	4 (7.8%)	11 (10.2%)	7 (7.4%)	22 (8.7%)
No	47 (92.2%)	97 (89.8%)	88 (92.6%)	232 (91.3%)
Over Recommended Duration				
Yes	18 (35.3%)	25 (23.1%)	21 (22.1%)	64 (25.2%)
No	24 (47.1%)	59 (54.6%)	54 (56.8%)	137 (53.9%)
No Recommended Duration Available	8 (15.7%)	22 (20.4%)	18 (18.9%)	48 (18.9%)
Missing	1 (2.0%)	2 (1.9%)	2 (2.1%)	5 (2.0%)
Loeb's Criteria Met				
Yes	36 (70.6%)	91 (84.3%)	76 (80.0%)	203 (79.9%)
No	10 (19.6%)	9 (8.3%)	15 (15.8%)	34 (13.4%)
Not Applicable	1 (2.0%)	3 (2.8%)	2 (2.1%)	6 (2.4%)
Unknown	4 (7.8%)	5 (4.6%)	2 (2.1%)	11 (4.3%)
SBAR Used				
Yes	43 (84.3%)	92 (85.2%)	82 (86.3%)	217 (85.4%)
No	8 (15.7%)	16 (14.8%)	13 (13.7%)	37 (14.6%)
Not Applicable	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Unknown	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Days of Therapy				
Median (Q1, Q3)	5.00 (3.00, 7.00)	5.00 (3.00, 6.00)	5.00 (3.75, 5.25)	5.00 (3.00, 6.00)
Missing	1 (2.0%)	7 (6.5%)	3 (3.2%)	11 (4.3%)

Figure 1. Percentage of New UTI Starts with Days of Therapy (DOT) over the Recommended Duration and DOT/1,000 Resident Days (RD), by Intervention Period (January 2019 - March 2020)

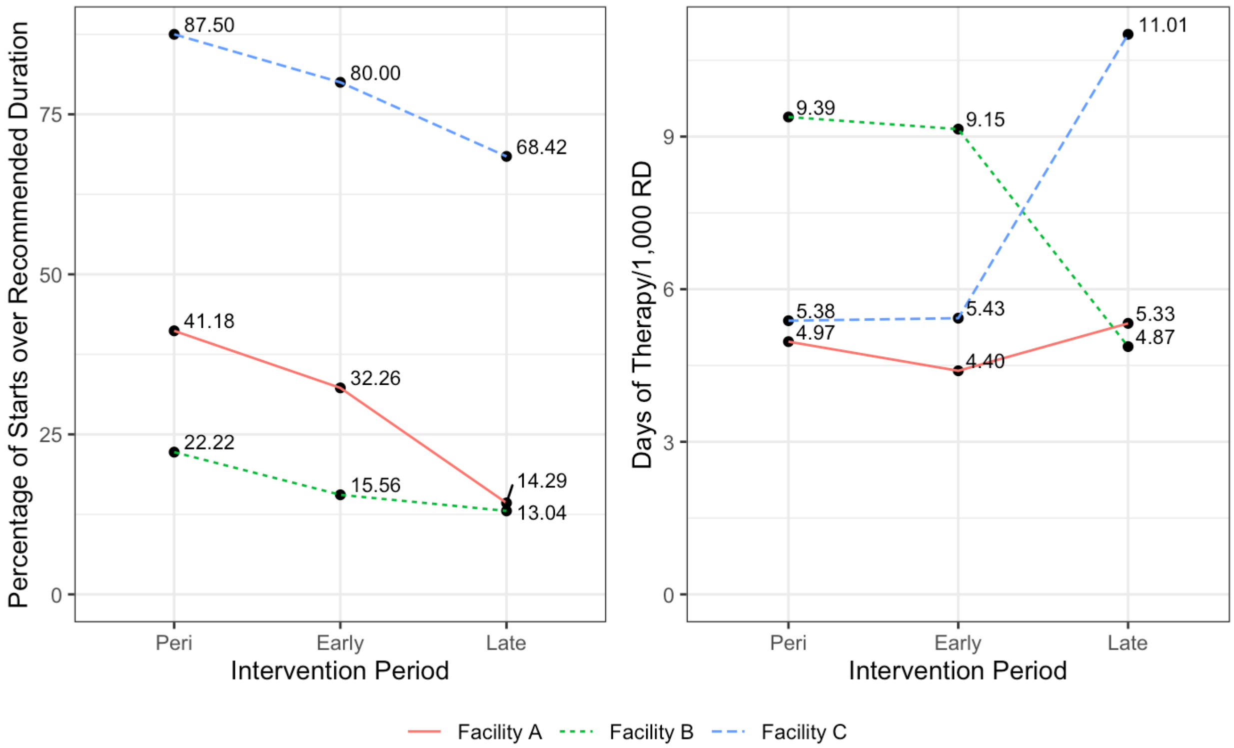

Table 3. New UTI Starts Over Recommended Duration, by Facility and Intervention Period, EASIL Study*

Facility	Metric	Peri-Intervention Period	Early Intervention Period	Late Intervention Period
Facility A	% (No./starts) Over Recommended Duration	41.2 (7/17)	32.3 (10/31)	14.3 (5/35)
	Risk Ratio	-	0.78	0.35**
	95% Confidence Interval		0.37-1.68, P = 0.54	0.13-0.93, P = 0.033
Facility B	% (No./starts) Over Recommended Duration	22.2 (4/18)	15.6 (7/45)	13.0 (3/23)
	Risk Ratio	-	0.70	0.59
	95% Confidence Interval		0.23-2.10, P = 0.53	0.15-2.30, P = 0.44
Facility C	% (No./starts) Over Recommended Duration	87.5 (7/8)	80.0 (8/10)	68.4 (13/19)
	Risk Ratio	-	0.91	0.78
	95% Confidence Interval		0.61-1.37, P = 0.68	0.52-1.17, P = 0.31

*Denominator values include only antibiotic starts for which guidelines for duration of therapy were available for the prescribed antibiotic

** Indicates statistically significant results

Table 4. Rate of New UTI Starts as Days of Therapy/1000 Resident Days by Facility and Intervention Period, EASIL Study

Facility	Metric	Peri-Intervention Period	Early Intervention Period	Late Intervention Period
Facility A	DOT/1000 RDs	4.97 (90/18,113)	4.40 (159/36,171)	5.33 (190/35,659)
	Rate Ratio	-	Rate Ratio = 0.88	Rate Ratio = 1.07
	95% Confidence Interval		0.68-1.15, P = 0.35	0.83-1.38, P = 0.59
Facility B	DOT/1000 RDs	9.39 (1087/11,507)	9.15 (223/24,380)	4.87 (121/24,841)
	Rate Ratio	-	Rate Ratio = 0.97	Rate Ratio = 0.52*
	95% Confidence Interval		0.77-1.23, P = 0.83	0.40-0.67, P < .001
Facility C	DOT/1000 RDs	5.38 (60/11,152)	5.43 (116/21,363)	11.01 (148/13,441)
	Rate Ratio	-	Rate Ratio = 1.01	Rate Ratio = 2.05*
	95% Confidence Interval		0.74-1.38, P = 0.95	1.52-2.76, P < .001

* Indicates statistically significant results

Table A1. Comparison of New UTI Antibiotic Start Characteristics by Facility and Intervention Period (January 2019 - March 2020)

	Facility A			**Facility B**			**Facility C**			**Overall**		
	Peri (N=18)	**Early (N=38)**	**Late (N=44)**	**Peri (N=23)**	**Early (N=51)**	**Late (N=25)**	**Peri (N=10)**	**Early (N=19)**	**Late (N=26)**	**Peri (N=51)**	**Early (N=108)**	**Late (N=95)**
Rationale												
Active Infection	18 100.0%	38 100.0%	44 100.0%	23 100.0%	50 98.0%	24 96.0%	8 80.0%	19 100.0%	26 100.0%	49 96.1%	107 99.1%	94 98.9%
Prophylaxis	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 2.0%	1 4.0%	1 10.0%	0 0.0%	0 0.0%	1 2.0 %	1 0.9%	1 1.1 %
Other	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 10.0%	0 0.0%	0 0.0%	1 2.0%	0 0.0%	0 0.0%
Quinolone												
Yes	2 11.1%	4 10.5%	0 0.0%	2 8.7%	4 7.8%	0 0.0%	0 0.0%	3 15.8%	7 26.9%	4 7. %	11 10.2%	7 7.4%
No	16 88.9%	34 89.5%	44 100.0%	21 91.3%	47 92.2%	25 100.0%	10 100.0%	16 84.2%	19 73.1%	47 92.2%	97 89.8%	88 92.6%
Over Recommended Duration												
Yes	7 38.9%	10 26.3%	5 11.4%	4 17.4%	7 13.7%	3 12.0%	7 70.0%	8 42.1%	13 50.0%	18 35.3%	25 23.1%	21 22.1%
No	10 55.6%	19 50.0%	30 68.2%	14 60.9%	38 74.5%	20 80.0%	0 0.0%	2 10.5%	4 15.4%	24 47.1%	59 54.6%	54 56.8%
No Recommended Duration Available	1 5.6%	7 18.4%	9 20.5%	5 21.7%	6 11.8%	2 8.0%	2 20.0%	9 47.4%	7 26.9%	8 15.7%	22 20.4%	18 18.9%
Missing	0 0%	2 5.3%	0 0%	0 0%	0 0%	0 0%	1 10.0%	0 0%	2 7.7%	1 2.0%	2 1.9%	2 2.1%
Loeb's Criteria Met												

	Facility A			Facility B			Facility C			Overall		
	Peri (N=18)	**Early (N=38)**	**Late (N=44)**	**Peri (N=23)**	**Early (N=51)**	**Late (N=25)**	**Peri (N=10)**	**Early (N=19)**	**Late (N=26)**	**Peri (N=51)**	**Early (N=108)**	**Late (N=95)**
Yes	13 72.2%	34 89.5%	37 84.1%	16 69.6%	41 80.4%	19 76.0%	7 70.0%	16 84.2%	20 76.9%	36 70.6%	91 84.3%	76 80.0%
No	1 5.6%	4 10.5%	5 11.4%	7 30.4%	2 3.9%	4 16.0%	2 20.0%	3 15.8%	6 23.1%	10 19.6%	9 8.3%	15 15.8%
Not Applicable	0 0.0%	0 0.0%	0 0.0%	0 0.0%	3 5.9%	2 8.0%	1 10.0%	0 0.0%	0 0.0%	1 2.0%	3 2.8%	2 2.1%
Unknown	4 22.2%	0 0.0%	2 4.5%	0 0.0%	5 9.8%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	4 7.8%	5 4.6%	2 2.1%
SBAR Used												
Yes	14 77.8%	34 89.5%	38 86.4%	23 100.0%	39 76.5%	20 80.0%	6 60.0%	19 100.0%	24 92.3%	43 84.3%	92 85.2%	82 86.3%
No	4 22.2%	4 10. %	6 13.6%	0 0.0%	12 23.5%	5 20.0%	4 40.0%	0 0.0%	2 7.7%	8 15.7%	16 14.8%	13 13.7%
Not Applicable	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Unknown	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
Days of Therapy												
Median (Q1, Q3)	5.00 (3.50, 6.75)	4.50 (3.00, 5.25)	5.00 (3.00, 5.00)	5.00 (3.00, 5.00)	5.00 (4.75, 5.00)	5.00 (5.00, 5.00)	7.00 (7.00, 9.00)	7.00 (5.00, 10.0)	7.00 (5.00, 7.00)	5.00 (3.00, 7.00)	5.00 (3.00, 6.00)	5.00 3.75, 5.25)
Missing	0 0%	2 5.3%	0 0%	0 0%	3 5.9%	1 4.0%	1 10.0%	2 10.5%	2 7.7%	1 2.0%	7 6.5%	3 3.2%