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MAJOR ARTICLE

Impact of Fluoroquinolone Susceptibility Suppression on Discharge Prescribing for Acute Uncomplicated Cystitis

Dillon A. Hayden,[1] Bryan P. White,[2] Stephen Neely,[2] and Kiya K. Bennett[3]

[1]Department of Pharmacy, University of Oklahoma Medical Center, Oklahoma City, Oklahoma, USA, [2]College of Pharmacy, University of Oklahoma, Oklahoma City, Oklahoma, USA, and [3]Department of Clinical and Administration Sciences, College of Pharmacy, University of Oklahoma, Oklahoma City, Oklahoma, USA

Background. Fluoroquinolones (FQs) are associated with adverse effects and increasing resistance. However, uncomplicated cystitis remains a frequent reason for FQ use. Selective reporting involves withholding susceptibilities for select antimicrobial agents on microbiology reports, in hopes of dissuading use by providers. The purpose of this study was to investigate the impact of FQ susceptibility suppression on discharge prescribing for hospitalized patients with uncomplicated cystitis.

Methods. This retrospective quasi-experimental analysis was conducted among adult patients at a 350-bed academic medical center. Its aim was to compare the incidence of FQ prescribing for cystitis at hospital discharge, one year before and after implementation (1 March 2017–31 March 2019) of a policy to suppress FQ urinary susceptibility results for pansusceptible *Klebsiella* spp and *Escherichia coli*. FQ appropriateness and risk factors for FQ use were also examined.

Results. There was a relative risk reduction of 39% in discharge FQ prescribing when adjusted for discharge team (adjusted risk ratio, 0.61; 95% CI, .40–.93). Almost all FQ use was inappropriate, largely due to organisms' susceptibility to a guideline-preferred agent (n = 61). In multivariate analysis, odds ratios of discharge FQ prescribing were 0.22 (95% CI, .12–.39) for insured patients, 0.43 (95% CI, .21–.86) for patients with antibiotic allergy, and 57.8 (95% CI, 13.7–244) for those receiving inpatient FQ. Discharge from a medicine team was protective against discharge FQ prescribing.

Conclusions. With multidisciplinary inpatient medicine services and avoidance of inpatient FQ use, suppression of FQ susceptibilities on pansusceptible urine isolates for *Klebsiella* spp and *E coli* may represent an attractive strategy for antibiotic stewardship at hospital discharge.

Keywords. acute uncomplicated cystitis; antimicrobial stewardship; fluoroquinolone.

INTRODUCTION

Treatment of acute uncomplicated cystitis is one of the most frequent reasons for antimicrobial use today [1, 2]. Cystitis is considered "uncomplicated" in premenopausal women without any complicating factors (ie, pyelonephritis, pregnancy, or known urologic abnormalities/comorbidities) [1]. *Escherichia coli* and *Klebsiella* spp are the most common bacterial pathogens associated with uncomplicated cystitis [1, 3]. Current guidelines recommend first-line treatment with nitrofurantoin, sulfamethoxazole/trimethoprim, or fosfomycin (which is often cost prohibitive) [1]. β-Lactams (eg, cephalexin) may also be used for definitive therapy or for empiric therapy based on local antibiograms. However, clinical guidelines reserve fluoroquinolones (FQs; ie, levofloxacin and ciprofloxacin) for alternative therapy for uncomplicated cystitis, due to the inherent risks associated with these agents, such as QTc interval prolongation, *Clostridioides difficile* superinfection, tendonitis/tendon rupture, and the broader coverage that they provide [4, 5]. Despite these recommendations, treatment of uncomplicated cystitis remains one of the most frequent reasons cited for FQ use [2, 6].

Perhaps the most insidious of consequences of FQ use is the development of antimicrobial resistance through repeated and/or unnecessary use of these agents. One stewardship intervention that may mitigate overuse was termed "nudging" by Langford et al and is defined as an "antimicrobial stewardship strategy to influence decision making through the strategic reporting of microbiology results, while preserving prescriber autonomy" [7]. As one such example of nudging, selective reporting is recommended by the stewardship guidelines of the Infectious Diseases Society of America, and it involves intentionally withholding susceptibilities for select antimicrobial agents on microbiology reports in hopes of dissuading use by providers [8]. Previous studies have demonstrated the benefits of suppression of microbiological susceptibility reporting on inpatient prescribing; likewise, there is emerging evidence

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Correspondence: Kiya K. Bennett, Pharm.D., BCPS, Department of Clinical and Administrative Sciences, College of Pharmacy, University of Oklahoma Health Sciences Center, 1122 NE 13th St, Ste 4414, Oklahoma City, OK 73117 (Kiya-Bennett@ouhsc.edu); Dillon A. Hayden, Pharm.D., BCPS, Department of Pharmacy, University of Oklahoma Medical Center, 700 NE 13th St, Oklahoma City, OK 73104 (Dillon.Hayden2@ouhealth.com).

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suggesting the benefits of nudging on antibiotic prescribing at hospital discharge, where antimicrobial stewardship efforts are often lacking [9–14]. The purpose of our study was to investigate the impact of an FQ susceptibility suppression policy on discharge prescribing for acute uncomplicated cystitis.

METHODS

Location and Study Design

In March 2018, a policy to suppress ciprofloxacin and levofloxacin susceptibilities on pansusceptible urine isolates for *E coli* and *Klebsiella* spp was initiated at a 350-bed single-center academic medical institution. Pansusceptibility was defined as isolates susceptible to amikacin, ampicillin, ampicillin/sulbactam, aztreonam, cefazolin, cefoxitin, ceftazidime, ceftriaxone, cefuroxime, ciprofloxacin, gentamicin, imipenem, levofloxacin, meropenem, nitrofurantoin, piperacillin/tazobactam, sulfamethoxazole/trimethoprim, tigecycline, and tobramycin, with resistant isolates still being reported. Between 1 March 2017 and 31 March 2019, the primary objective of this observational, retrospective, quasi-experimental analysis was to compare the incidence of FQ prescribing at hospital discharge pre- and postimplementation of this policy to suppress FQ microbiological susceptibility results. Secondary objectives included (1) describing the appropriateness of FQ prescribing at discharge pre- and postimplementation of a policy to suppress FQ microbiological susceptibility results and (2) identifying risk factors for FQ use. For the purposes of this study and according to institutional guidance, FQ prescribing was defined as inappropriate if the patient had any of the following safety concerns at the time of treatment: prolonged QTc interval, *C difficile* superinfection, FQ allergy, or the urinary isolate was susceptible to at least 1 of 3 other preferred agents (ie, cephalexin, nitrofurantoin, or sulfamethoxazole/trimethoprim) and there were no safety concerns prohibiting their use.

Study Population

This study included adult patients (≥18 years) with: (1) a diagnosis of cystitis or urinary tract infection; (2) a positive urine culture ($\geq 10^5$ colony-forming units) for *E coli* or *Klebsiella* spp during their first hospital admission within the 2-year study time frame; and (3) prescription of any oral antibiotic at discharge [3]. Patients were excluded if: (1) it was not their first admission during the study period or they were seen and discharged directly from the emergency department; (2) they were pregnant, as indicated by serology or discharge summary; (3) they had pyelonephritis, nephrostomy tubes/stents, or indwelling urinary catheters; (4) they had other infections being treated with an FQ; (5) the organism was not susceptible to an FQ (breakpoints defined as ciprofloxacin >1 μg/mL and levofloxacin >2 μg/mL [15]) or no susceptibilities were reported.

Data Collection

The study was approved by the local institutional review board, and patients were identified through the electronic medical record system (Meditech). Retrospective chart review was conducted to collect data on antibiotic prescribing and appropriateness. Detailed patient information was collected: demographics, pertinent laboratory values, inpatient and discharge antibiotic use, and bacterial culture/sensitivity results with colony count (breakpoints defined as cefazolin ≤16 μg/mL, nitrofurantoin ≤32 μg/mL, and sulfamethoxazole/trimethoprim ≤2/38 μg/mL [15]). Data were also collected regarding risk of adverse effects, including allergies to any antibacterial agent, QTc with last date obtained (defined as prolonged if ≥490 [16]), and any positive *C difficile* result via polymerase chain reaction within the past 12 months. Patient data were deidentified prior to sending to statistician for analysis.

Data Analysis

The preimplementation group included patients discharged with an antibiotic from 1 March 2017 to 28 February 2018. Events in March 2018 were excluded from the study to allow for a washout period after protocol implementation. Patients discharged with an antibiotic from 1 April 2018 to 31 March 2019 were included in the postimplementation group. Descriptive statistics were utilized to characterize the patient populations: continuous variables by median (IQR) or mean and categorical variables by frequency (percentage). Pre- and postgroups were compared with a Wilcoxon test for continuous variables and a chi-square, exact chi-square, or Fisher exact test for categorical variables. The primary outcome of institutional FQ use at discharge for uncomplicated cystitis was compared between time frames by a chi-square test. Additionally, a stratified analysis was performed for the discharging medical team via a Cochran-Mantel-Haenszel statistic to determine if FQ use differed by team. An adjusted risk ratio and 95% CI were calculated from the Cochran-Mantel-Haenszel approach.

An analysis based on logistic regression was performed to determine the odds of FQ use at discharge. A generalized estimating equation (GEE) was added to the model to account for patients being nested within the discharging team. This was performed through a repeated subject statement with an unstructured correlation structure. Simple GEE models were run with individual patient characteristic variables, and odds ratios with 95% CIs were reported. A multiple-variable model was constructed by backward selection if $P < .10$ and with the forced inclusion of pre– and post–time frame. Adjusted odds ratios (aORs) and 95% CIs were reported.

A post hoc interrupted time series regression was completed by a mixed model to predict the percentage change in FQ use per month in the pre– and post–time frames. Slopes and 95% CIs were reported to represent the predicted per-month change in FQ use. SAS version 9.4 (SAS Institute) was used for all analyses, with an a priori α level set at ≤.05 for statistical significance.

RESULTS

Patient screening and disposition are presented in Figure 1. There were 3921 patients identified during the 2-year study period.

Initially, 1561 patients were excluded due to admission timing or nonsusceptibility to FQ. Of the remaining 2360 patients screened, 2151 were further excluded due to no reported antibiotic at discharge, treatment of concomitant infection with an FQ, lack of hospital admittance, or other patient-specific factors. Therefore, the remaining 209 patients were included in the study: 106 in the preimplementation group and 103 in the postimplementation group.

The majority of patients were women with normal weight and renal function, were discharged from a hospitalist team, and had cystitis due to *E coli* (Table 1). Approximately one-quarter of patients had a self-reported β-lactam allergy. More patients in the preimplementation group had insurance coverage and higher median platelet counts; otherwise, there were no significant differences in baseline characteristics between the groups.

Analysis of the primary outcome revealed that discharge FQ prescribing for uncomplicated cystitis decreased from 36% to 24% ($P = .0682$; Table 2) after implementation of a policy to suppress FQ susceptibilities, which corresponded to a significant relative risk reduction of 39% when adjusted for discharge team (adjusted risk ratio, 0.61; 95% CI, .40–.93) but was not significant in multivariate analysis (aOR, 0.61; 95% CI, .21–1.75; Table 3). Monthly changes in discharge FQ utilization were erratic, with a preimplementation slope of −3.16 (95% CI, −6.50 to .17), a postimplementation slope of 1.78 (95% CI, −1.00 to 4.57), and an overall pre- to postgap of 5.32 (95% CI, −35.36 to 24.72; Figure 2). Relative inpatient FQ use for uncomplicated cystitis decreased by 43%, and relative nitrofurantoin prescribing at discharge increased by 65%. Mean duration of treatment for all patients throughout the study period was 5.8 days.

Analysis of overall use revealed that 97% of FQ use at discharge was inappropriate (Table 2). Although many patients

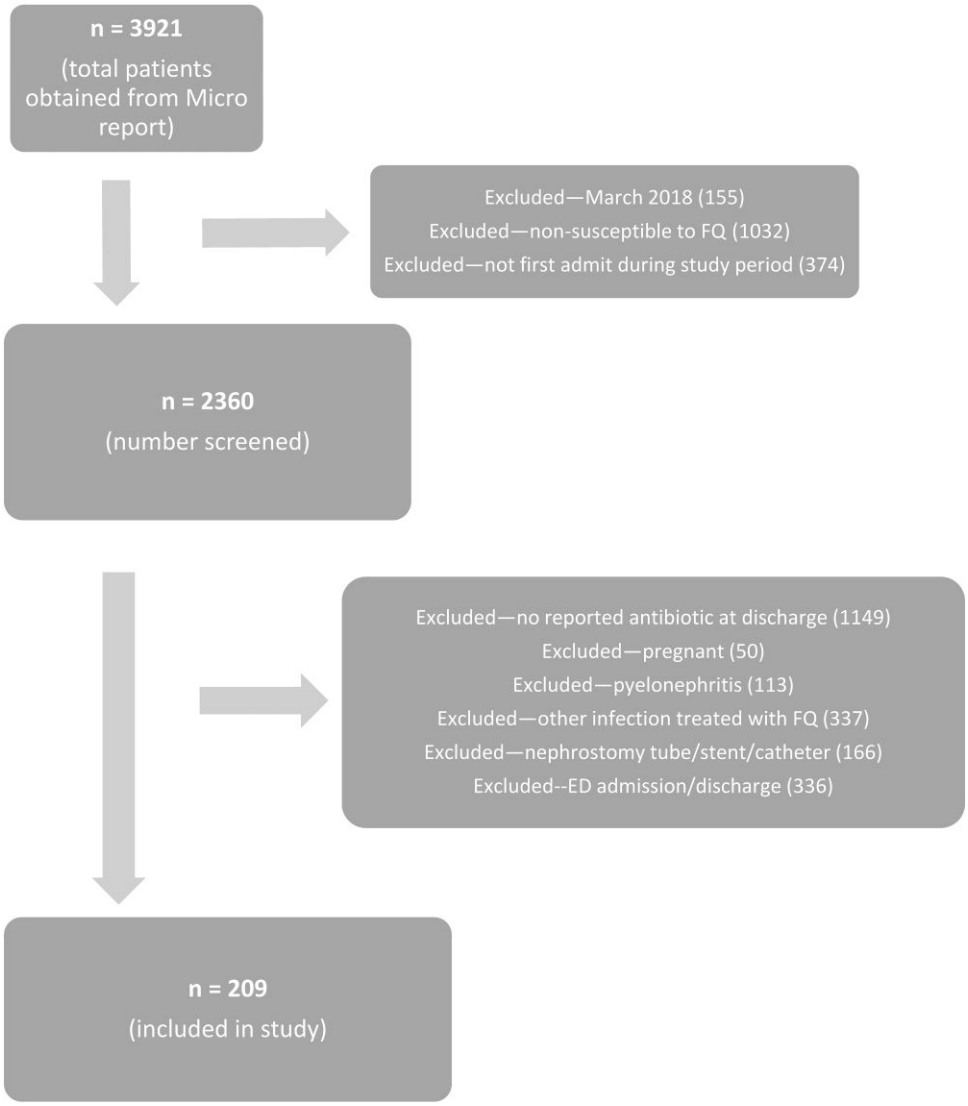

Figure 1. Patient screening and inclusion. ED, emergency department; FQ, fluoroquinolone; Micro report, microbiology report.

Table 1. Patient Characteristics

Participants, Median (IQR) or No. (%)				
Variable	Total (N = 209)	Pregroup (n = 106)	Postgroup (n = 103)	*P* Value
Age, y	64 (47–74)	66 (55–74)	62 (47–73)	.0932[a]
Female	179 (85.6)	87 (82.1)	92 (89.3)	.1353[b]
Weight, kg	73.7 (62.3–95.0)	76.4 (65.5–95.0)	71.0 (62.3–86.4)	.1167[a]
Creatinine clearance, mL/min	88.4 (50.8–125.4)	84.2 (56.3–125.4)	92.5 (50.8–125.1)	.5106[a]
White blood cells, K/μL	7.6 (5.1–10.5)	7.9 (5.8–10.5)	7.3 (5.1–9.3)	.2372[a]
Red blood cells, M/μL	3.7 (3.1–4.2)	3.7 (3.2–4.1)	3.7 (3.1–4.2)	.8008[a]
Platelets, K/μL	220.5 (148–314)	240 (187–314)	201 (148–259)	.0028[a]
Insurance coverage	178 (85.2)	98 (92.5)	80 (77.7)	.0192[b]
Drug allergy	76 (36.4)	43 (40.6)	33 (32.0)	.2001[b]
Type of allergy[c]				
β-lactam	50 (23.9)	27 (25.5)	23 (22.3)	.5946[b]
SMX/TMP	28 (13.4)	16 (15.1)	12 (11.7)	.4649[b]
Fluoroquinolone	11 (5.3)	6 (5.7)	5 (4.9)	.7942[b]
Nitrofurantoin	1 (0.5)	0 (0)	1 (1.0)	.4928[d]
Discharging team				.2906[b]
Hospitalist	60 (28.7)	27 (25.5)	33 (32.0)	
Neurology/neurosurgery	42 (20.1)	25 (23.6)	17 (16.5)	
Medicine team	33 (15.8)	12 (11.3)	21 (20.4)	
Trauma	22 (10.5)	13 (12.3)	9 (8.7)	
Family medicine	12 (5.7)	6 (5.7)	6 (5.8)	
Other[e]	40 (19.1)	23 (21.7)	17 (16.5)	
Organism				.6829[f]
Escherichia coli	151 (72.2)	76 (71.7)	75 (72.8)	
Klebsiella pneumonia	49 (23.5)	24 (22.6)	25 (24.3)	
Klebsiella oxytoca	9 (4.3)	6 (5.7)	3 (2.9)	

Abbreviations: SMX, sulfamethoxazole; TMP, trimethoprim.

[a]Wilcoxon 2-sample test.

[b]Chi-square test.

[c]Some patients had multiple allergies.

[d]Fisher exact test.

[e]Bone marrow transplant, cardiology, gynecologic oncology, gynecology, oncology, outpatient surgery, urology.

[f]Exact chi-square test.

had multiple reason for inappropriateness, this was largely due to the organisms' susceptibility to another preferred agent (n = 61). Of the 63 study patients who received discharge FQ, 10 had concomitant scheduled QTc-prolonging medications and/or prolonged QTc interval, while 1 patient actually had an FQ allergy.

Five variables were included in the final multivariate GEE logistic regression model, with 3 being significant (Table 3). Patients with an antibiotic allergy had 57% lower adjusted odds of FQ use at discharge ($P = .0165$); insured patients had 78% lower adjusted odds ($P < .0001$); and those taking FQ during inpatient stay had 58-times greater adjusted odds ($P < .0001$). Neither gender ($P = .0688$) nor FQ susceptibility policy time frame ($P = .3545$) was significant in the final model.

DISCUSSION

This study found that suppression of FQ susceptibilities for pansusceptible urine isolates for *Klebsiella* spp and *E coli* was associated with a 32% relative reduction in overall FQ prescribing at discharge for patients diagnosed with acute uncomplicated cystitis. Although this outcome was not initially significant ($P = .0682$), we emphasize that this does not necessarily undermine the clinical benefits of a decreasing trend. After adjusting for discharging team, our primary endpoint became statistically significant with a relative risk of 0.61 (95% CI, .40–.93; Table 2). The variability in month-to-month trends of FQ use was likely confounded by inadequate powering of the interrupted time series analysis (normally the gold standard for assessing stewardship interventions), which did not include stratification data for team as in the adjusted analysis and was therefore insignificant, similar to our primary unadjusted analysis (Figure 2).

Despite the modest reduction, 97% of FQ prescribing was still considered inappropriate according to our definition. This was primarily due to the ability to utilize other preferred agents (ie, cephalexin, nitrofurantoin, and/or sulfamethoxazole/trimethoprim). Patients who were uninsured were 4.6 times more likely to be discharged with an FQ (insured aOR,

Table 2. Total Antibiotic Use

Variable	Participants, No. (%)			*P* Value
	Total (N = 209)	Pregroup (n = 106)	Postgroup (n = 103)	
Inpatient FQ	59 (28.2)	38 (35.8)	21 (20.4)	.0130[a]
Discharge antibiotic				.1415[a]
Fluoroquinolone	63 (30.1)	38 (35.9)	25 (24.3)	
β-Lactam[b]	51 (24.4)	26 (24.5)	25 (24.3)	
Nitrofurantoin	52 (24.9)	20 (18.9)	32 (31.1)	
SMX/TMP	43 (20.6)	22 (20.8)	21 (20.4)	
Discharge FQ antibiotic[c]	63 (30.1)	38 (35.9)	25 (24.3)	.0682[a]
FQ use stratified by discharge team				.0192[d]
Hospitalist	23/60 (38.3)	11/27 (40.7)	12/33 (36.4)	.7286[a]
Neurology/neurosurgery	7/42 (16.7)	3/25 (12)	4/17 (23.5)	.4133[e]
Medicine team	14/33 (42.4)	10/12 (83.3)	4/21 (19.1)	.0003[a]
Trauma	6/22 (27.3)	5/13 (38.5)	1/9 (11.1)	.3330[e]
Family medicine	3/12 (25)	1/6 (16.7)	2/6 (33.3)	>.9999[e]
Other	10/40 (25)	8/23 (34.8)	2/17 (11.8)	.1450[e]
Appropriate discharge FQ use	2/63 (3.2)	2/38 (5.3)	0/25 (0)	.5136[e]
Reason for FQ inappropriateness[f]	63	38	25	
Prolonged QTc	9 (14.3)	4 (10.5)	5 (20)	.4634[e]
Clostridioides difficile	0 (0)	0 (0)	0 (0)	…
Allergy	1 (1.6)	1 (2.6)	0 (0)	>.9999[e]
Susceptible to preferred agent	61 (96.8)	36 (94.7)	25 (100)	.5136[e]
Tizanidine use	1 (1.6)	0 (0)	1 (4)	.3968[e]

Abbreviations: DT, discharging team; FQ, fluoroquinolone; SMX, sulfamethoxazole; TMP, trimethoprim.

[a]Chi-square test.

[b]Mostly cephalexin; also includes cefdinir and amoxicillin ± clavulanate.

[c]Risk ratio, adjusted for discharging team: 0.61 (95% CI, .40–.93) per Cochran-Mantel-Haenszel test.

[d]Cochran-Mantel-Haenszel test.

[e]Fisher exact test.

[f]Several patients had multiple reasons for inappropriateness.

0.22; 95% CI, .12–.39). At the time of this study, Oklahoma had the second-highest rate of uninsured patients in the United States [17]. Since FQs are often a lower-priced option when compared with alternative agents, it is likely that patient affordability considerations played a contributing factor during this time frame; however, the subsequent expansion of Medicaid may have mitigated this effect in more recent years. Additionally, patients who received an FQ as inpatients were much more likely to be discharged with an FQ; conversely, those discharged from a medicine team were less likely to be prescribed an FQ at discharge. We speculate that the latter is potentially due to the nature of our inpatient medicine service, which comprises collaborative teaching teams staffed with faculty, residents, and students from medical and pharmacy professions.

Institution-specific studies have documented a 29.3% higher *E coli* resistance rate to levofloxacin for hospital- vs community-acquired cystitis; other large-scale surveillance studies have noted an increase in ciprofloxacin resistance rates by 14.1% among *Enterobacteriaceae* strains and 5.4% among *Pseudomonas aeruginosa* strains over 10 years. As such, FQs represent prime targets for hospital antimicrobial stewardship efforts [2, 3]. While surveys have shown that a majority (87%) of laboratories in New Zealand and Australia have already implemented selective reporting practices for FQ on pansusceptible urine cultures, many European laboratories have not, and it is an emerging trend in the United States [18, 19].

Previous studies have demonstrated the benefits of suppression of microbiological susceptibility reporting. Langford et al found a significant decrease in ciprofloxacin use that was sustained over 2 years and, in a more recent review, reported an overall benefit of nudging across several antimicrobial use outcomes, including overall utilization, appropriateness, de-escalation, cost, and decreased resistance [7, 20]. Similarly, several studies have noted a commiserate shift toward use of preferred oral agents, such as nitrofurantoin and cephalexin, and our study likewise showed that relative nitrofurantoin prescribing at discharge increased by 65% [6, 11–13]. Tran et al observed an immediate reduction in discharge FQ use (−7.2%; 95% CI, −8.6% to −5.8%) after the US Food and Drug Administration removed systemic quinolone indications for uncomplicated cystitis, as well as an overall reduction from 41.6% to 19.2% over the duration of the study period [6]. However, our 43% relative decrease in inpatient FQ use and 39% absolute reduction in discharge FQ use (after controlling for discharge team) were different from findings in a large

Table 3. Generalized Estimating Equation Logistic Regression of FQ Use at Discharge

			Simple Model[a]		Multiple Variable Model[b]	
Variable	Contrast Level	Reference Level	OR (95% CI)	*P* Value	aOR (95% CI)	*P* Value
FQ susceptibility suppression policy time frame	Postimplementation (n = 103)	Preimplementation (n = 106)	0.53 (.22–1.27)	.1511	0.61 (.21–1.75)	.3545
Antibiotic allergy	Allergic (n = 76)	Not allergic (n = 133)	1.08 (.62–1.88)	.7853	0.43 (.21–.86)	.0165
Medical insurance	Insured (n = 175)	Not insured (n = 34)	0.41 (.28–.60)	<.0001	0.22 (.12–.39)	<.0001
Inpatient antibiotic	FQ used (n = 59)	FQ not used (n = 150)	30.29 (6.71–136.67)	<.0001	57.79 (13.68–244.20)	<.0001
Gender	Male (n = 30)	Female (n = 179)	1.47 (.26–1.77)	.4284	0.26 (.06–1.11)	.0688
Age	Mean = 62.6	Any 1.0-y increase	0.99 (.98–1.00)	.0399	…	…
Serum creatinine	Mean = 1.0	Any 1.0-unit increase	1.31 (1.05–1.65)	.0188	…	…
Creatinine clearance	Mean = 100.9	Any 1.0-unit increase	1.00 (1.00–1.01)	.4132	…	…
White blood cells	Mean = 8.3	Any 1.0-unit increase	1.03 (.96–1.10)	.4568	…	…
Platelets	Mean = 236.0	Any 1.0-unit increase	1.00 (1.00–1.00)	.2337	…	…

Abbreviations: aOR, adjusted odds ratio; FQ, fluoroquinolone; OR, odds ratio.

[a]Simple models included specified variable and time frame with discharge team in a repeated subject statement to control for clustering in department.

[b]Multiple-variable model was formed by using all variables with backward selection if $P < .10$ and forced inclusion of time frame. Discharge team was included by a repeated subject statement in the generalized estimating equation model.

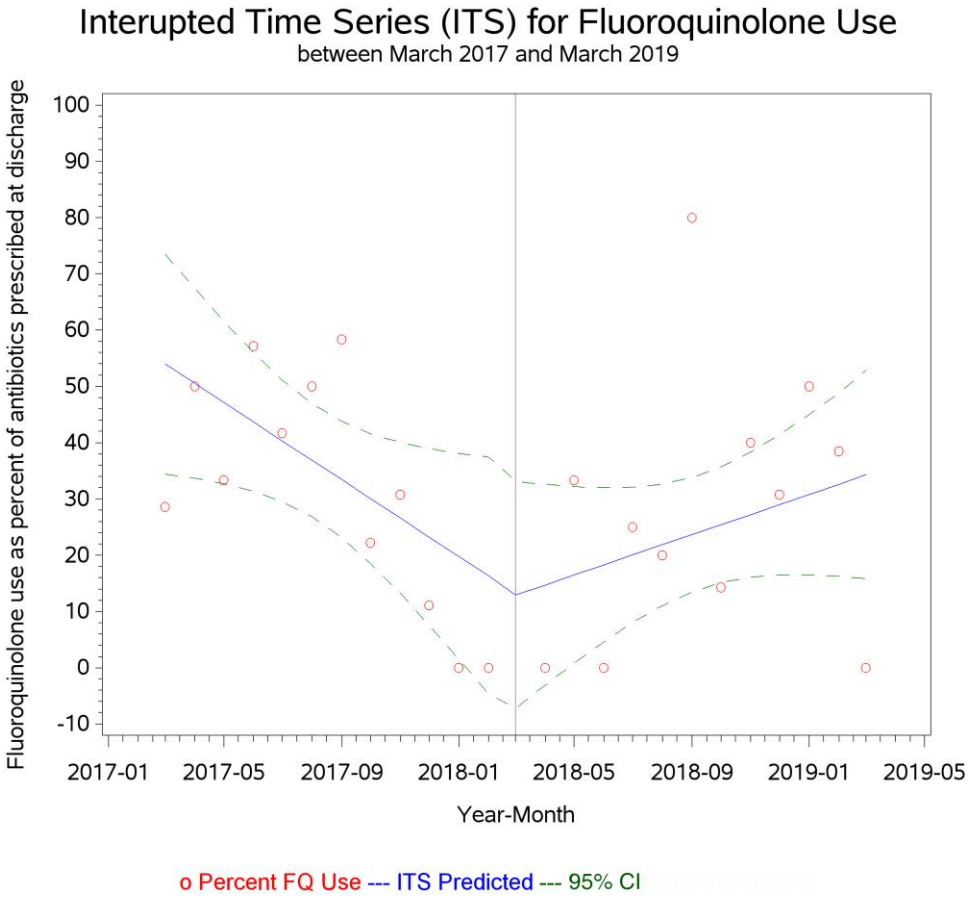

Figure 2. Antibiotic use by month. FQ, fluoroquinolone.

retrospective cohort by Vaughn et al, which compared differences in FQ use in hospitals with and without audit. Notably, for patients with a positive urine culture, feedback on inpatient FQ use reported a smaller decrease in inpatient-only prescribing (10.8% vs 8.5%, $P = .31$), less inpatient prescribing that was continued after discharge (20.1% vs 9.7%, $P < .001$), and increased prescribing after discharge only (9.7% vs 12.8%, $P = .4$) [9]. Interestingly, this study also determined that most FQ treatment days (66.6%) occurred after hospital discharge and that hospitals with FQ stewardship interventions had twice as many new starts after discharge (8.4% vs 15.6%, $P = .003$), which is in direct contrast with our study.

Our study had several limitations. First, patient data were obtained exclusively from retrospective chart review and therefore subject to any inaccurate documentation. For example, it is unknown whether 49% of patients screened had no reported antibiotic at discharge due to completing treatment as inpatients, not requiring treatment of asymptomatic bacteriuria, or having incomplete discharge medication reconciliation. Second, we included adult men and women, which is outside the proper definition of uncomplicated cystitis; however, we included these patients because non-FQ options are still preferred in these populations in the absence of other complications [4]. While previous guidelines do indicate that either cephalexin or an FQ could be used to treat isolates resistant to nitrofurantoin and sulfamethoxazole/trimethoprim, a more recent Food and Drug Administration warning recommends reserving FQ for those patients who have no other options [1, 4]. Third, we did not perform ad hoc power calculations for the statistical analysis; therefore, it is unknown whether the initial insignificance of the primary outcome was true or due to inadequate sample size. Fourth, our rate of 24% β-lactam allergy is much higher than the 10% normally referenced [21, 22]. Many patient allergies were self-reported, and it is unknown if the allergy and/or reaction was verified before documentation in the medical record. Yet, there was no statistical difference in β-lactam allergy between pre- and postgroups at baseline (26% vs 22%, $P = .5946$; Table 1), but allergies overall were significantly correlated with FQ use in multivariate analysis (aOR 0.43; 95% CI, .21–.86; Table 3). Fifth, our patients had a statistically significant disparity in insurance coverage at baseline (92.5% vs 77.7%, $P = .0192$), which may have confounded the significance of this secondary outcome. Finally, there was a change in FQ susceptibility breakpoints for *Enterobacteriaceae* during the course of the 2-year study. The breakpoints for ciprofloxacin and levofloxacin decreased from ≤1 to ≤0.25 μg/mL and from ≤2 to ≤0.5 μg/mL, respectively [15]. The breakpoints in our laboratory did not change, but these results may not apply to laboratories utilizing the lower susceptibility limits. Similarly, the nitrofurantoin creatinine clearance cutoff of 60 mL/min decreased to became no longer recommended with creatinine clearance <30 mL/min [23]. Nevertheless, there was no statistical difference in creatinine clearance between pre- and postgroups, as seen in subgroup analysis (84.2 vs 92.5 mL/min, $P = .5106$); thus, it is unlikely that this change affected the results of our study.

Despite regulatory indication changes and guideline recommendation updates, recent research demonstrates that antibiotic de-escalation initiatives continue to be needed at the institutional level and indeed should be considered "critical infrastructure" [10, 24]. The current study serves to continue such discussions, and the high incidence of inappropriate FQ use observed clearly demonstrates the opportunity for focused stewardship efforts at discharge. With multidisciplinary inpatient medicine services and avoidance of inpatient FQ use, suppression of FQ susceptibilities on pansusceptible urine cultures could provide a simple method of decreasing FQ prescribing for acute uncomplicated cystitis in the discharge setting, while preserving prescriber autonomy. Therefore, these interventions may represent an attractive, resource-friendly strategy for antibiotic stewardship in hospitals.

Notes

Author contributions. All authors have seen and approved the manuscript and contributed significantly to the work.

Patient consent statement. This deidentified retrospective study did not necessitate patient consent. Study design approved by the University of Oklahoma Medical Center institutional review board.

Potential conflicts of interest. B. P. W. is on the advisory board for Gilead Pharmaceuticals. All other authors report no potential conflicts.

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