

## CONCISE COMMUNICATION

## An Evaluation of Antibiotic Prescribing Practices Upon Hospital Discharge

Sarah J. Scarpato, MD;<sup>1</sup> Daniel R. Timko, PharmD;<sup>2</sup> Valerie C. Cluzet, MD;<sup>3</sup> Jillian P. Dougherty, PharmD;<sup>2</sup> Jonathan J. Nunez, MD;<sup>4</sup> Neil O. Fishman, MD;<sup>3</sup> Keith W. Hamilton, MD<sup>3</sup> for the CDC Prevention Epicenters Program

We conducted a retrospective study of the appropriateness of antimicrobial agents prescribed on discharge from an acute care hospital. Seventy percent of discharge antibiotics were inappropriate in antibiotic drug choice, dose, or duration. Our findings suggest there is a significant need for antimicrobial stewardship at transitions in care.

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Until now, antibiotic stewardship has focused mostly on inpatient care. However, medication errors are especially likely during transitions of care. Fifteen percent of patients experience medication discrepancies at discharge, and these patients are twice as likely to be readmitted as patients who do not.<sup>1</sup> Despite successes of inpatient antimicrobial stewardship programs (ASPs), antimicrobial stewardship is often neglected during transitions of care, and to our knowledge no published studies have evaluated the appropriateness of antibiotics prescribed at patient discharge. This study aims to characterize and determine rates of inappropriate antibiotic prescribing at discharge from an acute care hospital.

### METHODS

We conducted a descriptive study of adult patients prescribed systemic antibiotics at discharge from the Hospital of the University of Pennsylvania, a 776-bed academic quaternary care hospital, from January 1 through December 31, 2014. Patient demographic characteristics, discharge medications, inpatient service, discharge weight, discharge creatinine level, and readmission status at 7 and 30 days after discharge were obtained using a clinical data warehouse. Medical charts were abstracted on a random sample of 190 patients to determine antibiotic regimen, indication for antibiotic use, microbiology results, and imaging results.

Patients were excluded if they had incomplete medical records, were discharged against medical advice, or were prescribed an antibiotic for prophylaxis for an acceptable indication. The study was approved by the institutional review board at the University of Pennsylvania.

Two infectious diseases pharmacists (D.R.T. and J.P.D.) and 2 physicians (S.J.S. and K.W.H.) determined the appropriateness of antibacterial agents prescribed on discharge. When there was uncertainty or disagreement, the case was reviewed as a group until consensus was reached. Appropriateness of therapy was determined using a method previously described and was based on indication, duration, spectrum, dose, and frequency.<sup>2</sup> Duration was characterized as longer or shorter than necessary if the length of therapy was in excess of or fell short of standard recommendations for the upper or lower range of recommended treatment duration, respectively. If a patient had characteristics such as delayed treatment response or presence of graft material that prevented definitive determination of duration, that patient was excluded from the duration analysis. Spectrum was deemed inappropriate if it was too broad, too narrow, or redundant. Determination of appropriateness of spectrum was based on microbiology. If no microbiologic data were available, investigators referred to local empirical treatment guidelines.<sup>3</sup> If no local guidelines existed, investigators referred to national guidelines.<sup>4</sup> Appropriateness of dose and frequency was determined on the basis of indication, weight, creatinine clearance, and manufacturer recommendations.

Categorical variables were summarized by frequencies, whereas continuous variables were summarized by mean, median, standard deviation, and range.

### RESULTS

During the study period, 9,750 discharge prescriptions were written for 7,313 unique patients. Fluoroquinolones were most common, making up 23.5% of antibiotic prescriptions (Figure 1). Oral antibiotics represented 86.0% of all prescriptions, whereas 14.0% were parenteral.

Seven-day and 30-day readmission rates for patients discharged on antibiotics were 6.4% and 19.4%, respectively, compared with hospital-wide readmission rates of 3.7% and 13.8%. Patients discharged on parenteral or intramuscular antibiotics had 7-day and 30-day readmission rates of 5.6% and 16.4%, whereas patients discharged on oral antibiotics had rates of 6.5% and 19.9%, respectively (Figure 1).

Of the 190 prescriptions randomly selected for more detailed analysis, 150 met inclusion criteria (Table 1). Fourteen prescriptions were excluded because they were for prophylaxis with an acceptable indication, and 26 were excluded because they were redacted before discharge. Seven prescriptions were excluded from duration analysis because patients had characteristics that prevented determination of definitive duration. Patients completed a median (interquartile range) of 3.5 (2–5.5) days of their antibiotic course as an inpatient and 8 (6–14) days as an outpatient.

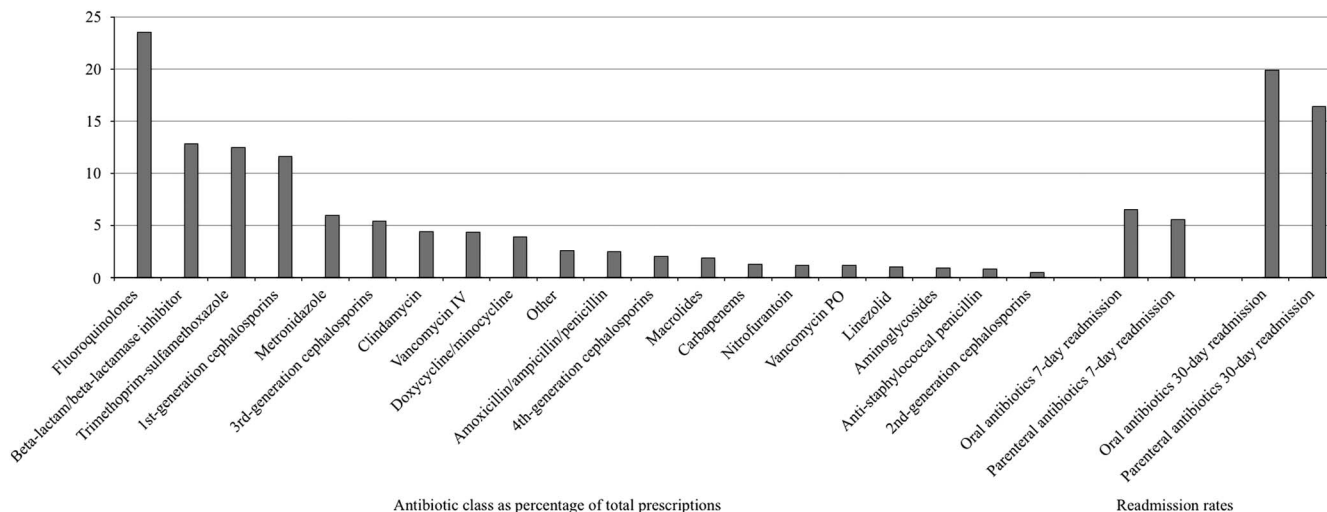


FIGURE 1. Antibiotic classes prescribed and 7- and 30- day readmission rates for patients prescribed oral vs parenteral antibiotics. IV, intravenous; PO, per os (oral).

TABLE 1. Antibiotic Indications and Description of Inappropriate Antibiotic Prescriptions Upon Hospital Discharge

Variable	Medicine (n = 85)	Surgery (n = 65)	All services (n = 150)
Antibiotic prescription by indication, n (%)			
Bloodstream	4 (4.7)	1 (1.5)	5 (3.3)
Bone/joint	3 (3.5)	4 (6.2)	7 (4.7)
Central nervous system	0	1 (1.5)	1 (0.7)
Endocarditis	1 (1.2)	4 (6.2)	5 (3.3)
Gastrointestinal	9 (10.6)	1 (1.5)	10 (6.7)
Genitourinary	19 (22.4)	7 (10.8)	26 (17.3)
Intra-abdominal	6 (7.1)	2 (3.1)	8 (5.3)
Neutropenic fever	3 (3.5)	0	3 (2.0)
Respiratory	20 (23.5)	5 (7.7)	25 (16.7)
Skin/soft tissue	8 (9.4)	12 (18.5)	20 (13.3)
Other	5 (5.9)	1 (1.5)	6 (4.0)
No infection	7 (8.2)	27 (41.5)	34 (22.7)
Extended surgical prophylaxis	0	27 (41.5)	27 (18.0)
Extended treatment of neutropenic fever	5 (5.9)	0	5 (3.3)
Inappropriate antibiotic choice, n (%) <sup>a</sup>	10 (12.8)	6 (15.8)	16 (13.7)
Inappropriate dose, n (%) <sup>a</sup>	11 (14.1)	9 (23.7)	20 (17.2)
Inappropriate duration <sup>b</sup>			
Too long, n (%)	32 (40.5)	50 (78.1)	82 (54.6)
Too short, n (%)	6 (7.6)	5 (7.8)	11 (7.3)
Days of unnecessary antibiotics per patient, mean (SD)	2.3 (5.2)	5.8 (7.0)	3.8 (6.3)
Any error, n (%)	49 (57.6)	57 (87.7)	106 (70.7)

<sup>a</sup>Denominator for % includes infected patients only.  
<sup>b</sup>Denominator for % includes patients eligible for recommended duration only. Six medicine patients and one surgical patient were not eligible based on clinical history.

Seventy percent of discharge antibiotics were inappropriate in antibiotic drug choice, dose, or duration. Of patients with documented infection, 13% received a drug that was too broad or too narrow for the given indication. Seventeen percent of patients with documented infection received the incorrect dose. Fifty-five percent of patients received an antibiotic course that was too long, whereas 7.3% were prescribed a course that was too short. On average, patients received 3.8 days of unnecessary antibiotics. When broken down by service, 87.7% of surgical patients and 57.6% of medical patients received inappropriate antibiotic prescriptions.

DISCUSSION

Despite a robust inpatient ASP at our institution, which includes restricted antibiotic formulary, prior authorization for many antibiotics, prospective audit and feedback, and clinical decision support services, most discharge antibiotics were inappropriate on the basis of indication, duration, spectrum, dose, or frequency. A prior study demonstrated only 14% of inpatients treated for pneumonia receive therapy with recommended duration.<sup>5</sup> Our study yielded similar results when combining all conditions at discharge. Inappropriate dosing and spectrum of antibiotic activity accounted for smaller proportions of inappropriate prescriptions, likely owing to our inpatient ASP. Clinicians may have prescribed antibiotics for an inappropriate duration because they did not account for antibiotics given as an inpatient, were unfamiliar with a patient's course because of hand-offs, wrote the prescription with a given duration expecting discharge on a different day, or were not familiar with recommended durations. Inappropriate prescribing at discharge evades traditional inpatient ASP monitoring. However, these excess days of

antibiotics may predispose patients to medical complications, such as antimicrobial resistance or *Clostridium difficile* infection.<sup>6,7</sup>

Patients discharged on oral antibiotics were more likely to be readmitted at 7 and 30 days than those discharged on outpatient parenteral antimicrobial therapy. At our institution, patients discharged on outpatient parenteral antimicrobial therapy are followed up by a team of infectious diseases physicians and pharmacists, whereas patients discharged on oral antibiotics are not routinely monitored. Unpublished data at our institution indicate that there was a 14% decrease in 7-day readmissions and a 17% reduction in 30-day readmissions for patients on outpatient parenteral antimicrobial therapy after this team was created. Conversely, higher readmission rates in patients discharged on oral antibiotics may be an unintended consequence of ASP effort to switch patients from parenteral to oral therapy on discharge. Patients discharged on outpatient parenteral antimicrobial therapy may have higher rates at other institutions, and further study would be necessary to better delineate this finding.

Improving discharge antibiotic prescribing will require understanding how the process leads to errors in order to best target interventions. Possible interventions include medication reconciliation by unit-based staff, prescriber education, and prospective audit and feedback. Medication reconciliation performed by trained pharmacists at discharge has been shown to decrease errors and readmission rates.<sup>8</sup> Antimicrobial stewardship focused on provider education and prospective feedback has been shown to decrease the duration of unnecessary inpatient antibiotics by 30%.<sup>9</sup> One challenge to prospective audit and feedback is intervening after a prescription is written but before the patient is discharged. In order to intervene successfully, prescribers and unit-based staff will likely have to become more engaged in antimicrobial stewardship.

Limitations to this study include its retrospective nature. Furthermore, this study was conducted at a teaching hospital where a large number of the prescribers were residents. We did not address the level of training of the prescriber in our analysis, which may affect rates of inappropriate prescriptions. However, the findings suggest that there is a significant and unmet need for antimicrobial stewardship at transitions of care, even at institutions like ours with substantial ASPs. Future efforts should focus on reducing inappropriate antibiotic prescriptions, specifically decreasing prescriptions without an acceptable indication and those with an inappropriate duration.

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*Affiliations:* 1. Department of Internal Medicine, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania; 2. Pharmacy Department, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania; 3. Division of Infectious Diseases, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania; 4. Philadelphia FIGHT, Philadelphia, Pennsylvania.

Address correspondence to Sarah J. Scarpato, MD, 3400 Spruce St, Philadelphia, PA 19104 (sarah.scarpato@uphs.upenn.edu).

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