Optimizing Antibiotic Management For Acute Simple Cystitis in Women: An Evidence-Based Roadmap for the Primary Care Ambulatory Setting

Lori Guelman, Chuyun D. Hsieh, Katrina Pine, and Mary E. Lough

Uncomplicated urinary tract infection (acute simple cystitis), defined as localized bladder symptoms and bacteriuria in healthy, non-pregnant adult females with no known urological abnormalities or comorbidities is a highly prevalent diagnosis in the primary care ambulatory setting (Gupta et al., 2011; Gupta, Grigoryan, & Trautner, 2017). Although a frequently encountered condition, there remains substantial variability in antibiotic prescribing practice (Durkin et al., 2018). Accurate antibiotic prescribing is important because drug resistance is projected to cause 10 million deaths each year by 2050, surpassing cancer (O’Neil, 2016).

The purpose of this research and quality improvement initiative was to assess if antibiotic prescribing practices for acute simple cystitis at this academic primary care ambulatory setting aligned with the most recent Infectious Diseases Society of America (IDSA) guidelines (2010) (Gupta et al., 2011) as well as the local outpatient antibiogram. This article describes the process of using quality improvement and research data to guide a quality improvement process for treatment of acute simple cystitis.

Key Words: Acute simple cystitis, clinical practice guidelines, urinary tract infections, antibiotics, antibiogram, antibiotic stewardship.

Literature Review

Acute Simple Cystitis Guidelines

The 2010 IDSA guidelines recommend monohydrate macro-
Research Summary

Introduction
Uncomplicated urinary tract infection (acute simple cystitis) is a highly prevalent condition in healthy, non-pregnant females with no known urological abnormalities or comorbidities. Although a frequently encountered condition, antibiotic choices and durations are frequently inappropriate, which can lead to increased antibiotic resistance.

Purpose
To assess if antibiotic prescribing practice for acute simple cystitis at an academic primary care ambulatory setting aligned with the most recent Infectious Diseases Society of America (IDSA) guidelines as well as the local outpatient antibiogram.

Methods
A 10-question electronic survey was emailed to a convenience sample of primary care prescribers (N = 42). Additionally, a retrospective chart review was performed of the electronic health records (EHRs) of 99 female patients with acute simple cystitis and positive urine cultures diagnosed during a 6-month period (February to July 2015).

Results
Survey responses (22/40) indicated that prescribers selected nitrofurantoin as their first-choice antibiotic, while fosfomycin was the least preferred antibiotic. Fifty-five percent of survey respondents did not account for local resistance patterns when prescribing antibiotics, and 41% were not aware of the most current IDSA clinical practice guidelines for acute simple cystitis.

Based on the EHR chart review, Escherichia coli was the predominant infecting organism (81%), nitrofurantoin was the most commonly prescribed antibiotic (39%), followed by ciprofloxacin (30%) and cephalexin (9%). Patients were inappropriately prescribed prolonged durations of antibiotics 58% of the time, predominantly of nitrofurantoin and ciprofloxacin.

Per the local antibiogram, first-line antibiotics are nitrofurantoin (sensitivity = 97.2%; resistance = 2.8%), followed by cefazolin (a first-generation cephalosporin comparable to cephalexin) with a sensitivity of 88.5% and resistance of 11.5%. Second-line therapies are amoxicillin-clavulanate (sensitivity = 81.2%; resistance = 18.8%), followed by TMP/SMX (sensitivity = 74.1%; resistance = 25.9%). Ciprofloxacin (sensitivity = 80.5%; 19.5% = resistance) should only be used when there are no other treatment options.

Conclusion
Prescribers appropriately cited nitrofurantoin as first-line therapy in the survey, and this antibiotic was appropriately prescribed per the retrospective chart review. However, the lack of awareness of the local antibiogram was clearly shown in that ciprofloxacin, an antibiotic with high resistance according to the antibiogram data, was the second most commonly prescribed medication. In alignment with goals of antibiotic stewardship, interventions included standardization of antibiotic prescriptions via the EHR and education of providers by dissemination of information about best practices to improve treatment of acute simple cystitis in the primary care ambulatory setting.

Level of Evidence – III-B
Source: Johns Hopkins Hospital/Johns Hopkins University (2016).

crystalline (nitrofurantoin), trimethoprim-sulfamethoxazole (TMP-SMX), and fosfomycin as first-line therapy for acute simple cystitis in the United States. Second-line antibiotic recommendations include fluoroquinolones (ciprofloxacin and levofloxacin) and beta-lactams (amoxicillin-clavulanate, cephalexin) (see Table 1) (Gupta et al., 2011). To limit antibiotic-related secondary infections, the IDSA guidelines recommend a treatment duration from 3 to 7 days depending on the antibiotic selected. A shorter duration is intended to provide equivocal antibiotic efficacy, improved compliance, decreased cost, and fewer adverse effects (Gupta et al., 2011). A review of the literature was performed using the Cumulative Index to Nursing and Allied Health (CINAHL) and PubMed databases, and guided by the search terms acute simple cystitis, clinical practice guidelines, urinary tract infections, antibiotics, antibiogram, antibiotic stewardship, collateral damage, and uncomplicated cystitis. Eight studies were published in the years following publication of the IDSA guidelines. First-line antibiotics (nitrofurantoin and TMP-SMX) were appropriately prescribed in the smaller studies conducted at primary care ambulatory clinics with fewer than 150 patients (Kim, Lloyd, Condren, & Miller, 2015; Lindback, Lindback, & Melhus, 2017; Sigler, Leal, Bliven, Cogdill, & Thompson, 2015). However, two other small studies (less than 200 patients), both done in urban emergency department (ED) settings, showed that fluoroquinolones were predominantly prescribed prior to any intervention (Hecker et al., 2014; Zatorski et al., 2016). Fluoroquinolones were also the most commonly used class of antibiotics in the three largest studies (greater than 1,000 patients) up to 51% of the time (see Table 2) (Durkin et al., 2018; Grigoryan, Zoorob, Wang, & Trautner, 2015; Kobayashi, Shapiro, Hersh, Sanchez, & Hicks, 2016). Additionally, the duration of antibiotics was inappropriate and prolonged, and not one study assessed local antibiograms (see Table 2).

According to Durkin and colleagues (2018), the 2010 IDSA guidelines failed to change prescribing habits, with ciprofloxacin leading as the most prescribed antibiotic before and
Table 1.
IDSA Acute Simple Cystitis Guidelines
(Listed in order of IDSA prescribing preference.)

<table>
<thead>
<tr>
<th>Medications Recommended</th>
<th>Dose</th>
<th>Correct Antibiotic Duration (Days)</th>
<th>First Line; Second Line</th>
<th>Efficacy</th>
<th>Collateral Damage/Safety Risk</th>
<th>Local Antibiogram Sensitivity to E. Coli (1,692 isolates)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrofurantoin monohydrate macrocrystalline</td>
<td>100 mg BID</td>
<td>5</td>
<td>F</td>
<td>+++</td>
<td>Low Risk</td>
<td>97.2%</td>
<td>On Beers criteria, recommendation to avoid using in adults &gt;65 years old; avoid use in patients with severe renal insufficiency.</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole (TMP-SMX)</td>
<td>160/800 mg BID</td>
<td>3</td>
<td>F</td>
<td>+++</td>
<td>Low Risk</td>
<td>74.1%</td>
<td>Caution with elderly, can increase serum creatinine; increased risk for resistance.</td>
</tr>
<tr>
<td>Fosfomycin</td>
<td>3 g</td>
<td>Single dose</td>
<td>F</td>
<td>++</td>
<td>Low Risk</td>
<td>n/a</td>
<td>Expensive, not always available.</td>
</tr>
<tr>
<td>Fluoroquinolones Ciprofloxacin</td>
<td>250 mg BID</td>
<td>3</td>
<td>S</td>
<td>+++</td>
<td>High Risk</td>
<td>80.5%</td>
<td>FDA Black Box warning for increased risk of tendinitis and tendon rupture, risk of worsening symptoms with myasthenia gravis, potential for irreversible peripheral neuropathy and risks of mental health side effects and serious blood sugar disturbances. Damage to commensal bacteria.</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>250 mg Extended Release daily</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 mg</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta-lactams</td>
<td>500 mg BID</td>
<td>5-7</td>
<td>S</td>
<td>++</td>
<td>High Risk</td>
<td>81.2%</td>
<td>Lower efficacy, increased risk of vancomycin-resistant enterococci and Clostridium difficile.</td>
</tr>
<tr>
<td>Amoxicillin-clavulanate</td>
<td>500 mg BID</td>
<td>5-7</td>
<td>S</td>
<td>++</td>
<td>High Risk</td>
<td>88.5%</td>
<td></td>
</tr>
<tr>
<td>Cephalexin</td>
<td>500 mg BID</td>
<td>5-7</td>
<td>S</td>
<td>++</td>
<td>High Risk</td>
<td>88.5%</td>
<td></td>
</tr>
</tbody>
</table>

+++ High efficacy
++ Medium efficacy
+ Low efficacy
* Antibiogram from local outpatient clinics for acute simple cystitis from E. coli (1692 isolates).

Notes: F = first-line, S = second-line, mg = milligrams, g = grams, BID = twice daily. E. coli = Escherichia coli, FDA = Federal Drug Administration, IDSA = Infectious Diseases Society of America.
Efficacy: Cure rates 5-9 days following treatment.
Pivmecillinam, an IDSA recommended first-line antibiotic, is not available in the United States and is not included for that reason.
Source: Gupta et al., 2011.
### Table 2.
Literature Review: Acute Simple Cystitis Adherence to 2010 IDSA Clinical Practice Guidelines

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Design/ Study Date</th>
<th>Sample Size</th>
<th>First-Line Antibiotics/ Percentage Used</th>
<th>Second-Line Antibiotics/ Percentage Used</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lindback, Lindback, &amp; Melhus (2017)</td>
<td>Retrospective chart review of patients’ medical records in primary care centers in California, Jan-Feb 2008.</td>
<td>133</td>
<td>Pivmecillinam – 51% Nitrofurantoin – 23% Trimethoprim – 17%</td>
<td>FQ – 6% Cephalosporins – 3%</td>
<td>Prolonged duration 3d – 5% 5d – 27% 7d – 63% &gt; 7d – 5%</td>
</tr>
<tr>
<td>Sigler, Leal, Bliven, Cogdill, &amp; Thompson (2015)</td>
<td>Retrospective chart review of patients receiving antibiotics for acute uncomplicated cystitis at a public hospital, 7/2012-6/2013.</td>
<td>128</td>
<td>TMP-SMX – 59% Nitrofurantoin – 9%</td>
<td>FQ – 30% B-lactam – 0.8%</td>
<td>Prolonged duration</td>
</tr>
<tr>
<td>Hecker et al. (2014)</td>
<td>Before and after study of patients treated at an urban trauma center/ER, 2010 and 2012.</td>
<td>200</td>
<td>TMP-SMX – 14% and 20% Nitrofurantoin – 4% and 8%</td>
<td>FQ – 17% and 10%</td>
<td>Mean duration of therapy: 6 d and 4 d</td>
</tr>
<tr>
<td>Zatorski et al. (2016)</td>
<td>Prospective, observational study of patients treated with antibiotics for acute uncomplicated cystitis in a large urban ED, 2012-2014.</td>
<td>103</td>
<td>Nitrofurantoin – 19.4% TMP-SMX – 14.9%</td>
<td>FQ – 65.7%</td>
<td></td>
</tr>
<tr>
<td>Durkin et al. (2018)</td>
<td>Retrospective observational cohort study of patients treated with antibiotics for acute uncomplicated cystitis in an urban ED, 1/2009-12/2013.</td>
<td>654,432</td>
<td>TMP-SMX – 27% Nitrofurantoin – 24% Fosfomycin – 1%</td>
<td>FQ – 42% B-lactams – 5%</td>
<td>Prolonged duration, most common was 7d FQ – 35% TMP-SMX – 66% Nitrofurantoin – 42%</td>
</tr>
<tr>
<td>Grigoryan, Zoorob, Wang, &amp; Trautner (2015)</td>
<td>Retrospective chart review of patients treated with antibiotics for acute uncomplicated cystitis in two private family medicine faculty clinics in a large urban area, 2011-2014.</td>
<td>1546</td>
<td>TMP-SMX – 12% Nitrofurantoin – 33%</td>
<td>FQ – 51%</td>
<td>Prolonged duration</td>
</tr>
<tr>
<td>Kobayashi, Shapiro, Hersh, Sanchez, &amp; Hicks (2016)</td>
<td>National Ambulatory Medical Care and National Hospital Ambulatory Medical Care Survey Data sets from 2002-2011.</td>
<td>7111</td>
<td>TMP-SMX – 23% Nitrofurantoin – 19%</td>
<td>FQ – 49% Cephalosporins – 4%</td>
<td>Not addressed</td>
</tr>
</tbody>
</table>

**Notes:** TMP-SMX = trimethoprim-sulfamethoxazole, FQ = fluoroquinolones, d = days, IDSA = Infectious Diseases Society of America, ED = emergency department, ER = emergency room.

None of the studies utilized an antibiogram.
after the updated guidelines. To assess the rationale for how prescribers determined antibiotic choice and duration, Grigoryan and colleagues (2019) interviewed 18 primary care providers in a qualitative research study. Results highlight prescriber preference for fluoroquinolones due to their belief that the medication is more effective than other comparable antibiotics, despite their risks. Other findings were that most prescribers were not familiar with fosfomycin as first-line therapy and were unaware that nitrofurantoin is a 5-day course. A local antibiogram was not available for participants in this study.

**Antibiograms**

The IDSA guidelines encourage prescribers to incorporate active surveillance of antibiotic resistance patterns using a local antibiogram (Gupta et al., 2011). The antibiogram is a clinical tool prepared by the local clinical laboratory to analyze bacterial susceptibility to antimicrobials in specific geographic locations and clinical settings. In some hospitals, antibiogram susceptibility differs between the ED and inpatient settings for the same antibiotic because acutely ill patients have more comorbidities and greater likelihood of antibiotic resistance (Etani et al., 2017; Hines et al., 2015). The antibiogram typically lists the sensitivity of each antibiotic to a specific microorganism. Sensitivity less than 80% suggests a high local level of resistance to an antibiotic (resistance greater than 20%), and that antimicrobial might no longer be considered a first-line treatment in that setting when more effective alternatives are available (Gupta et al., 2011).

Local antibiogram results for this academic setting are listed beside the IDSA recommended first-line therapies in Table 1. Any sensitivity below 80% indicates that local resistance is greater than 20%. Based on the low sensitivity to TMP/SMX (sensitivity = 74.1%; resistance = 25.9%), the most appropriate first-line antibiotics are nitrofurantoin (sensitivity = 97.2%; resistance = 2.8%), followed by cefazolin (a first-generation cephalosporin comparable to cephalaxin that is not included in the IDSA guidelines), with a sensitivity of 88.5% and resistance of 11.5%.

The recommended treatment order for second-line therapies based on the resistance in this setting is amoxicillin-clavulanate (sensitivity = 81.2%; resistance = 18.8%), followed by TMP/SMX (sensitivity 74.1%; resistance 25.9%). Ciprofloxacin (sensitivity = 80.5%; resistance = 19.5%) should only be used when there are no other treatment options due to the high resistance and high risk of collateral damage as identified in a U.S. Food and Drug Administration (FDA) (2016) Black Box warning.

Because of the global rise of antibiotic resistance and in alignment with the principles of antibiotic stewardship, we examined adherence to the 2010 IDSA acute simple cystitis guidelines and adherence to the local antibiogram in this academic setting’s primary care ambulatory clinics. The tools were a survey sent to providers and a retrospective chart review of antibiotics prescribed for acute simple cystitis. Results of this study were then disseminated to physicians, nurse practitioners, physician assistants, and nurses employed in the primary care ambulatory setting.

**Methods**

**Survey**

A 10-question electronic survey was emailed to a convenience sample of primary care prescribers (N = 42) who represented all prescribers within primary care ambulatory clinics in February 2015. The goal of the survey was to assess prescriber knowledge of the IDSA guidelines and prescribing practices, and establish a baseline for a quality improvement initiative. Question topics included antibiotic choice, antibiotic duration, and consideration of local resistance patterns per the antibiogram, when prescribing for acute simple cystitis. Survey respondents had two weeks to complete the survey and were sent one email reminder. Data responses were collected anonymously in REDCap (Harris et al., 2009).

**Retrospective Chart Review**

A retrospective chart review of electronic health records (EHRs) was conducted to assess actual prescribing practices in a convenience sample of non-pregnant, adult female patients diagnosed with acute simple cystitis. This study was approved by the local Institutional Review Board (IRB). A 6-month timeframe was reviewed (February to July 2015). Records were selected based on cystitis-specific ICD-9 codes (acute cystitis = 595.0; UTI = 599.0; unspecified cystitis = 595.9) and documented acute simple cystitis symptoms (see Figure 1).

From this convenience sample of 397, we excluded 167 records because the patients were hospitalized (inpatient), had a complex UTI, or had duplicate records. From the 230 patients meeting the clinical criteria, 118 were excluded because the urine culture was non-diagnostic, contaminated by mixed flora (≥ 100,000 colony-forming units/mL) or inconclusive containing low numbers of atypical organisms not typically found in the genitourinary tract, or the findings confirmed yeast.

Ultimately, the records of 112 adult women diagnosed with acute simple cystitis who had provided a mid-stream, clean-catch urine sample met the clinical and urine culture criteria: 13 women had a negative urine
Figure 1.
Study Cohort Flowchart

EHR Total UTI Records for Non-Pregnant Adult Females \((N = 397)\)

Clinical Exclusion Criteria \((n = 167)\)
- Inpatient (127)
- Complex UTI* (26)
- Duplicate Record (14)

Clinical Inclusion Criteria Met \((n = 230)\)

Urine Culture Exclusion Criteria \((n = 118)\)
- Contaminated (74)
- Inconclusive (41)
- Yeast (3)

Clinical and Urine Culture Inclusion Criteria Met \((n = 112)\)

Notes: EHR = electronic health record, UTI = urinary tract infection.
* Complex UTI:
  - Diagnosed with neurogenic bladder.
  - Recent UTI in the past 2 weeks per patient report and chart review.
  - Treated with antibiotics for a duration greater than 10 days during study period.
  - Recurrent UTIs (3 or more per year) within the past 3 years.
  - Take immunotherapy for organ transplant, cancer, autoimmune conditions.
  - Indwelling catheter or clean intermittent catheterization.
  - Resident in a care facility.
culture and were excluded. A final total of 99 records was available for analysis (see Figure 1).

Results

Survey

Of the 42 primary care prescribers invited to complete the emailed survey, 52% (22/40) responded. Survey responses indicated that prescribers selected nitrofurantoin as their first-choice antibiotic while fosfomycin was the least preferred antibiotic. Duration of treatment varied from 3 to 7 days. Fifty-five percent of the survey respondents did not account for local resistance patterns when prescribing antibiotics and 41% were not aware of the most current IDSA clinical practice guidelines for acute simple cystitis.

Retrospective Chart Review

Results from the retrospective chart review of women with a positive urine culture (n = 99) are described by urine culture results, antibiotic selection, and duration of antibiotics.

Urine culture results. Escherichia coli was the predominant infecting organism (n = 81; 81%), followed by Enterococcus (n = 7; 7%) and Klebsiella (n = 6; 6%).

Antibiotic selection. Nitrofurantoin was the most commonly prescribed antibiotic (39/99; 39%), followed by ciprofloxacin (30/99; 30%) and cephalaxin (9/99; 9%) (see Table 3). Despite their high resistance, TMP-SMX was used 9% of the time (9/99), and amoxicillin-clavulanate and ampicillin were used 7% of the time (7/99). Fosfomycin was only used 2% (2/99) of the time. Thus, 48% (47/99) of first-line treatments were appropriate per the local antibiogram (see Table 3).

Duration of antibiotic treatment. Treatment duration varied regardless of the antibiotic, and 7 days was the most common duration, prescribed 43% (41/96) of the time. This excluded three urine cultures that were not treated. Nitrofurantoin was correctly prescribed for 5 days, 27% of the time; cephalaxin was appropriately prescribed for 7 days, 51% of the time; TMP/SMX and ciprofloxacin were appropriately prescribed for a duration of 3 days, 56% and 31% of the time, respectively. Overall, patients were inappropriately prescribed prolonged durations of antibiotics 58% (56/96) of the time, predominantly of nitrofurantoin and ciprofloxacin (see Table 3).

Dissemination of Findings To Clinicians

Study findings were first presented to primary care prescribers who were initially sent the survey, and then presented via an in-service to peers and members of the antibiotic stewardship committee. Additionally, a one-page summary of survey results, prescribing practices, antibiogram data, and best practice recommendations was emailed to all providers in primary care ambulatory clinics (see Appendix 1).

Table 3. Antibiotic Prescriptions for Acute Simple Cystitis in a Primary Care Ambulatory Setting

<table>
<thead>
<tr>
<th>Antibiotic Presence</th>
<th>Correct Duration (Days)</th>
<th>Correct Duration of Antibiotics Prescribed</th>
<th>Local Antibiogram Sensitivity E. Coli (1,692 isolates)*</th>
<th>Does it meet local antibiogram criteria?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrofurantoin monohydrate macrocrystalline</td>
<td>5</td>
<td>27%</td>
<td>97.2%</td>
<td>Yes</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>3</td>
<td>31%</td>
<td>80.5%</td>
<td>No</td>
</tr>
<tr>
<td>Cephalexin</td>
<td>7</td>
<td>51%</td>
<td>88.5%</td>
<td>Yes</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole (TMP-SMX)</td>
<td>3</td>
<td>56%</td>
<td>74.1%</td>
<td>No</td>
</tr>
<tr>
<td>Amoxicillin-clavulanate or ampicillin</td>
<td>5 to 7</td>
<td>43%</td>
<td>81.2%</td>
<td>Yes</td>
</tr>
<tr>
<td>Fosfomycin</td>
<td>Single dose</td>
<td>100%</td>
<td>n/a</td>
<td>Unknown</td>
</tr>
<tr>
<td>No treatment</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*If sensitivity is below 80%, resistance is above 20%, and the antibiotic should not be used.
Appendix 1.

RESEARCH QUESTION: Are prescribers in the SHC primary care ambulatory setting utilizing best practices and adhering to the most current Infectious Disease and Society of America (IDSA) guidelines for acute simple cystitis in premenopausal women?

Methods:
Electronic survey to SHC primary care prescribers and patient chart review assessing prescribing practices for acute simple cystitis. Study cohort consisted of 99 non-pregnant females (>18 y/o) diagnosed with UTI. Exclusion factors included: presence of urinary catheter, residence in nursing home, diagnosis of pyelonephritis, immunocompromised patients or patients with a urological abnormality. Chart review conducted through STRIDE.

Results:
1. Patients were prescribed antibiotics for excessive durations 58% of the time.
   a. Nitrofurantoin was prescribed in accordance with best practices (5 days) 27% of the time
   b. Cephalexin was prescribed in accordance with best practices (7 days) 51% of the time
   c. Ciprofloxacin was prescribed in accordance with best practices (3 days) 31% of the time
2. 2015 SHC PCP Electronic Survey results indicate 55% of providers do not rely on local resistance patterns (antibiograms) in making their treatment decision

<table>
<thead>
<tr>
<th>Ideal</th>
<th>Less Ideal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrofurantoin</td>
<td>Ciprofloxacin</td>
</tr>
<tr>
<td>• High efficacy</td>
<td>• High efficacy</td>
</tr>
<tr>
<td>• Low resistance</td>
<td>• High collateral damage</td>
</tr>
<tr>
<td>• Low collateral damage</td>
<td>• Poor safety profile</td>
</tr>
<tr>
<td>Cephalexin</td>
<td>Trimethoprim-sulfamethoxazole (TMP-SMX)</td>
</tr>
<tr>
<td>• High efficacy</td>
<td>• High resistance (&gt;20%) in SHC community</td>
</tr>
<tr>
<td>• Low resistance</td>
<td></td>
</tr>
<tr>
<td>Fosfomycin</td>
<td></td>
</tr>
<tr>
<td>• Not on SHC formulary</td>
<td></td>
</tr>
</tbody>
</table>

Source: Used with permission from Stanford Health Care.
**Electronic Health Record Pre-Filled Smart Set**

Study findings were used to create a pre-filled “smart set” template of orders for acute simple cystitis in the primary care ambulatory setting that prescribers can access from within the EHR. When the prescriber clicks on the pre-created smart set, nitrofurantoin appears as the first-choice antibiotic with a default to the IDSA recommended dose and duration. If nitrofurantoin is not appropriate as the first choice due to allergies, local resistance, or other factors, then the prescriber can click on the second recommended choice antibiotic per the institution best practices. In this institution, the second recommended antibiotic is cephalexin, and again, the smart set defaults to the IDSA recommended dosing and duration (see Appendix 1). Unfortunately, the authors of this study were unable to obtain data about how often the smart set is used, or whether access to a smart set has changed overall prescribing practice for acute simple cystitis in the primary care ambulatory setting.

**Discussion**

Prescribing antibiotics for prolonged or insufficient duration can lead to bacterial resistance, recurrence of acute simple cystitis, and increased morbidity. Applying antibiotic stewardship principles and incorporating at least one core element outlined by the Centers for Disease Control and Prevention (CDC) (commitment, action, tracking/reporting, and education/expertise) to align with evidence-based guidelines can significantly improve prescribing practice and patient outcomes in acute simple cystitis (Sanchez, Fleming-Dutra, Roberts, & Hicks, 2016). Findings in this study correlate with previously published studies that address lack of adherence to the 2010 IDSA guidelines, in reporting that fluoroquinolones are still being over-prescribed (see Table 3) (Durkin et al., 2018).

This study differs from many others in that we combined a research methodology (retrospective chart review) with quality improvement processes (survey, smart set creation, widespread local dissemination of findings) to align provider antibiotic prescriptions for acute simple cystitis with the IDSA 2010 guidelines and the local antibiogram. This supports recent qualitative findings that primary care prescribers prefer an electronic resource accessible within the EHR to help guide prescribing for acute simple cystitis (Grigoryan et al., 2019). Although we were unable to obtain outcome data on prescriptions resulting from the use of the smart set, we are hopeful that broad dissemination will raise awareness for physician providers, nurse practitioners, and physician assistants at this institution.

**Nursing Implications**

Nurse practitioners and nurses can help fulfill the specific antibiotic stewardship core principles of commitment and education by providing resources, guidance, and expertise regarding acute simple cystitis management to the health care team and patients. The importance of the nurse’s role in promoting antibiotic stewardship is emphasized in the White Paper (report) entitled, “Redefining the Antibiotic Stewardship Team,” written jointly by the American Nurses Association (ANA) and the CDC (ANA, 2017). The White Paper highlights the importance of nurse education about appropriate antibiotic selection and duration to curb antibiotic resistance (ANA & CDC, 2017).

As frontline providers and leaders, nurse practitioners and nurses can encourage outpatient clinics to use the IDSA acute simple cystitis guidelines and the local antibiogram. Nurses can encourage hospitals to develop an EHR smart set and work with the hospital infection control department to monitor prescribing patterns and trends in antibiotic resistance. Finally, both nurse practitioners and nurses can educate our patients about antibiotic safety profiles and optimal duration of treatment.

**Limitations**

This study has several limitations. These include a small survey sample size of primary care providers who may not be representative of all prescribers, a limited time period of retrospective chart review at a single academic institution, and absence of data about antibiotic prescriptions for acute simple cystitis following creation of the smart set ordering mechanism.

**Conclusion**

Prescribers appropriately cited nitrofurantoin as first-line therapy in the survey, and this antibiotic was properly utilized as a first-line treatment per the retrospective chart review. However, the lack of awareness of the local antibiogram was clearly shown in that ciprofloxacin, an antibiotic with high resistance according to antibiogram data, was the second most commonly prescribed medication. In alignment with goals of antibiotic stewardship, standardization of antibiotic prescriptions via the EHR, and education of providers by dissemination of information about best practices may improve treatment of acute simple cystitis in the primary care ambulatory setting.

**References**
