Effectiveness of an Antimicrobial Stewardship Approach for Urinary Catheter–Associated Asymptomatic Bacteriuria

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IMPORTANCE Overtreatment of asymptomatic bacteriuria (ASB) in patients with urinary catheters remains high. Health care professionals have difficulty differentiating cases of ASB from catheter-associated urinary tract infections.

OBJECTIVES To evaluate the effectiveness and sustainability of an intervention to reduce urine culture ordering and antimicrobial prescribing for catheter-associated ASB compared with standard quality improvement methods.

DESIGN, SETTING, AND PARTICIPANTS A preintervention and postintervention comparison with a contemporaneous control group from July 2010 to June 2013 at 2 Veterans Affairs health care systems. Study populations were patients with urinary catheters on acute medicine wards and long-term care units and health care professionals who order urine cultures and prescribe antimicrobials.

INTERVENTION A multifaceted guidelines implementation intervention.

MAIN OUTCOMES AND MEASURES The primary outcomes were urine cultures ordered per 1000 bed-days and cases of ASB receiving antibiotics (overtreatment) during intervention and maintenance periods compared with baseline at both sites. Patient-level analysis of inappropriate antimicrobial use adjusted for individual covariates.

RESULTS Study surveillance included 289,754 total bed-days. The overall rate of urine culture ordering decreased significantly during the intervention period (from 41.2 to 23.3 per 1000 bed-days; incidence rate ratio [IRR], 0.57; 95% CI, 0.53-0.61) and further during the maintenance period (to 12.0 per 1000 bed-days; IRR, 0.29; 95% CI, 0.26-0.32) ($P < .001$ for both). At the comparison site, urine cultures ordered did not change significantly across all 3 periods. There was a significant difference in the number of urine cultures ordered per month over time when comparing the 2 sites using longitudinal linear regression ($P < .001$). Overtreatment of ASB at the intervention site fell significantly during the intervention period (from 1.6 to 0.6 per 1000 bed-days; IRR, 0.35; 95% CI, 0.22-0.55), and these reductions persisted during the maintenance period (to 0.4 per 1000 bed-days; IRR, 0.24; 95% CI, 0.13-0.42) ($P < .001$ for both). Overtreatment of ASB at the comparison site was similar across all periods (odds ratio, 1.32; 95% CI, 0.69-2.52). When analyzed by type of ward, the decrease in ASB overtreatment was significant in long-term care.

CONCLUSIONS AND RELEVANCE A multifaceted intervention targeting health care professionals who diagnose and treat patients with urinary catheters reduced overtreatment of ASB compared with standard quality improvement methods. These improvements persisted during a low-intensity maintenance period. The impact was more pronounced in long-term care, an emerging domain for antimicrobial stewardship.

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The need to preserve antibiotic effectiveness and avoid patient harms associated with unnecessary antibiotic use is an important health care issue. Inappropriate antimicrobial use undermines patient safety by increasing the risk of infection with a resistant organism, adverse drug events, and *Clostridium difficile* infection and contributes to increased length of stay.1,2 The public health impact of antimicrobial overuse is seen in excessive costs and increasingly drug-resistant pathogens.3 The Centers for Disease Control and Prevention estimated that more than $1.1 billion is spent annually in the United States on unnecessary antibiotics.4 Furthermore, a conservative estimate is that drug-resistant pathogens cause 2 million illnesses and 23,000 deaths annually in the United States.4 Asymptomatic bacteriuria (ASB) is a common condition in which bacteria are present in the urine without related symptoms or pathologic consequences. Use of antibiotics to treat ASB is a significant contributor to antibiotic overuse in hospitalized and nursing home patients, especially among patients with urinary catheters.5,6 The American Geriatrics Society, in conjunction with the American Board of Internal Medicine Foundation, recently identified treatment of ASB as 1 of 5 overutilized services in its Choosing Wisely campaign.7 Despite strong evidence against screening for or treating ASB in most adults,5,8 studies9-13 in hospital and nursing home settings have documented that 20% to 83% of patients with ASB are treated unnecessarily with antibiotics. Translating evidence-based guidelines on ASB and catheter-associated urinary tract infection (CAUTI)5,8,10,11 into bedside decision making when facing a patient with a positive urinalysis or urine culture can be difficult for health care professionals.

Interventional studies12-14 have addressed the issue of inappropriate treatment of ASB. The Kicking CAUTI: The No Knee-Jerk Antibiotics Campaign built on previous interventions, with a novel focus on reducing urine culture ordering because positive urine cultures are powerful stimuli for antibiotic use.19,20 The 2 key features of the intervention were case-based audit and feedback and an actionable algorithm.21 The aims of this study were to evaluate (1) the effectiveness of the Kicking CAUTI intervention on reducing inappropriate urine culture ordering, (2) the maintenance of this effect after cessation of the active intervention, and (3) the impact of the intervention on antibiotic prescribing for catheter-associated ASB and CAUTI.

**Methods**

**Study Design and Setting**

A preintervention and postintervention comparison with a contemporaneous control group was used to determine the effects of health care professional audit and on screening and treatment of ASB compared with standard quality improvement efforts occurring at a matched comparison health system. The intervention site (Michael E. DeBakey Veterans Affairs Medical Center) and comparison site (South Texas Veterans Health Care System) are similar in terms of inpatient ward organization, long-term care units, patient populations, infection control programs and software, and clinician and medical resident involvement in patient care. At the intervention site, 5 general medicine wards and 5 long-term care units were selected. The corresponding units at the comparison site included 3 medicine wards and 2 long-term care wards. The study design was approved by the institutional review board and the research and development committee at both sites (NCT01052545) and was performed under waiver of consent.

**Participants**

The study population for the clinical outcomes included all catheterized inpatients in the study wards at the intervention and comparison sites. Exclusion criteria included pregnancy and planned urologic procedures. Our intervention was directed at health care professionals who make decisions to order a urine culture and to prescribe antibiotics. In the internal medicine wards, this decision is made by internal medicine residents. In the long-term care wards, the intervention targeted nurses, physician assistants, and staff physicians. In both settings, the decision to prescribe or not to prescribe antibiotics is often a team effort.

**Intervention**

Baseline Surveillance and Intervention Development

Our study was conducted from July 2010 to June 2013 as per published protocol (intervention activities in the eTable in the Supplement).22 During the first year (baseline period), we observed the baseline incidences of screening and overtreatment of ASB at both sites. Year 1 activities also included the development and validation of a criterion standard method for documenting guideline-defined diagnoses for CAUTI and ASB, as well as piloting and validation of our study materials.21,23 Study materials included the CAUTI diagnostic algorithm (eAppendix in the Supplement), the audit and feedback intervention and script (eAppendix in the Supplement), and surveys administered before and after the intervention.22-24 The conceptual model for our intervention was adapted from work by Cabana et al.25 with key theoretical updates by Trautner et al.21 and Glasgow et al.26 Domains that impact on health care professionals’ adherence to guidelines are knowledge (awareness and familiarity) and attitudes (acceptance and outcome expectancy).24 The audit and feedback component of the intervention (based on feedback intervention theory27) addresses 2 points in the chain of events that lead from a patient at risk of overtreatment. These points include the decision to order a urine culture (unnecessary screening) and the decision to treat a positive urine culture (overtreatment).

**Intervention Deployment**

During the second year (intervention period) at the intervention site, we distributed a streamlined diagnostic algorithm for CAUTI vs ASB (based on the Infectious Diseases Society of America guidelines) and used case-based audit and feedback to train clinicians to use the algorithm. Feedback was delivered to clinicians on selected cases that illustrated teaching points after a positive urine culture result had been managed appropriately or inappropriately. The research team (B.W.T., S.H., and A.D.N.) created an interactive slide presentation.
Catheter-Associated Urinary Tract Infection

We used the Infectious Diseases Society of America guidelines to define CAUTI and ASB. Therefore, we included indwelling (Foley), external (condom), suprapubic, and intermittent catheters. Catheter-associated urinary tract infection was defined by the presence of at least 1 of the following signs and symptoms with no other recognized cause: fever (≥100°F), urgency, frequency, dysuria, suprapubic tenderness, pelvic discomfort, costovertebral angle tenderness, hematuria, rigors, or delirium in a patient with a positive urine culture who had a urinary catheter within the past 48 hours. Management of CAUTI was defined as appropriate if the patient was prescribed an antimicrobial and as inappropriate (undertreatment) if no antimicrobial was prescribed. For purposes of this study, report of any organism growth of at least 10^3 CFU/mL in the urine was considered a positive urine culture, corresponding to the Infectious Diseases Society of America guidelines, because we were most interested in how health care professionals responded to urine culture results.

Catheter-Associated ASB

Asymptomatic bacteriuria was defined by a positive urine culture without signs and symptoms, consistent with the definition of CAUTI. Management of ASB was defined as appropriate if no systemic antimicrobial was prescribed and as inappropriate (overtreatment) when any antimicrobial was prescribed.

Our protocol specified a rigorous classification for whether a case of bacteriuria was ASB or CAUTI and whether management was appropriate or inappropriate. Each member of the research team used the validated classification algorithm to classify cases independently, and 5% to 10% of all cases were classified by 2 parties throughout the project. Especially difficult cases were resolved by review of the medical record by the research team at the other site. The κ statistic for the level of agreement between the research teams at the 2 sites regarding independent classification of these difficult cases was 0.68 (68.4%), or substantial agreement.

Outcome Measures

The primary outcome was the number of urine cultures ordered and reported by the microbiology laboratory per 1000 bed-days. All urine cultures reported by the microbiology laboratory were included in the total number of urine cultures, whether positive or negative or catheter associated or not. Secondary outcomes included the number of cases of ASB overtreatment per 1000 bed-days and the number of cases of CAUTI undertreatment per 1000 bed-days.

Statistical Analysis

Descriptive statistics were used to estimate the incidence rates per 1000 bed-days and 95% CIs for urine cultures ordered, ASB overtreatment, and CAUTI undertreatment in each study period. Incidence rate ratios (IRRs) and 95% CIs were calculated that compared incidence rates in the intervention period or the maintenance period with the baseline period (reference group). We performed longitudinal linear regression analysis to test whether there was a significant difference in urine cultures ordered per month between the 2 study sites over time.

Patient-level analysis of inappropriate antimicrobial use was performed on patients with positive urine cultures. We used χ² test, Fisher exact test, and t-way analysis of variance to determine whether patient-level covariates (age, sex, Deyo Comorbidity Score, urinary catheter type, and site of care [acute medical vs long-term care]) differed across the baseline, intervention, and maintenance periods at each study site. Multivariable logistic regression analyses determined intervention effectiveness using the following 2 key outcomes variables: inappropriate use of antibiotics for ASB (overtreatment) and no antibiotic use for CAUTI (undertreatment) after adjusting for patient-level characteristics. We tested the interaction between study site and study period (baseline, intervention, and maintenance) to test the hypothesis that ASB overtreatment would decrease at the intervention site and would remain un-
changed at the comparison site. We also performed stratified analysis to determine whether the effect of the intervention differed in long-term care vs acute care wards after adjusting for these patient-level characteristics. All tests were 2-sided, and \( P \leq .05 \) was considered statistically significant. Analyses were performed using statistical software (SAS, version 9.2; SAS Institute Inc).

### Results

**Urine Culture Ordering**

This study included surveillance of 289,754 total bed-days, with 179,345 occurring at the intervention site and 119,409 at the comparison site. Table 1 summarizes the rates of urine cultures ordered per 1000 bed-days in each study year stratified by study site. At the intervention site, the overall rate of urine culture orders decreased from 41.2 per 1000 bed-days at baseline to 23.3 per 1000 bed-days during the intervention period \((IRR, 0.57; 95\% CI, 0.53-0.61; P < .001)\). In the maintenance period, ordered urine cultures dropped further at the intervention site to 12.0 per 1000 bed-days \((IRR, 0.29; 95\% CI, 0.26-0.32; P < .001)\). At the comparison site, the incidence rates of urine culture orders were similar in the intervention and maintenance periods compared with baseline. The Figure shows monthly rates of urine culture orders per 1000 bed-days at the intervention vs comparison sites across the 3 study periods. There was a significant difference in the number of urine cultures ordered per month over time when comparing the 2 sites using longitudinal linear regression \((P < .001)\).

**Antimicrobial Use**

Table 2 summarizes the rates of ASB overtreatment and CAUTI undertreatment per 1000 bed-days in each study year. The overall rate of ASB overtreatment at the intervention site decreased from 1.6 per 1000 bed-days at baseline to 0.6 per 1000 bed-days through the intervention period \((IRR, 0.35; 95\% CI, 0.22-0.55)\) and to 0.4 per 1000 bed-days during maintenance \((IRR, 0.24; 95\% CI, 0.13-0.42; P < .001\) for both). At the comparison site, the rates of ASB overtreatment were similar in all 3 periods. The rates of CAUTI undertreatment were similar in all 3 periods at the intervention and comparison sites.

**Patient-Level Analysis**

Table 3 summarizes the characteristics of patients who had positive catheter-associated urine cultures (both ASB and CAUTI).

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### Table 1. Incidence Rates of Urine Culture Orders in Each Study Year

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention Site</th>
<th></th>
<th></th>
<th></th>
<th>Comparison Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed-days, No.</td>
<td>92,541</td>
<td>40,958</td>
<td>36,846</td>
<td>35,726</td>
<td>40,923</td>
</tr>
<tr>
<td>Total urine culture orders</td>
<td>3,810</td>
<td>957</td>
<td>442</td>
<td>1,760</td>
<td>2,228</td>
</tr>
<tr>
<td>Total urine culture orders per 1000 bed-days (95% CI)</td>
<td>41.2 (37.0-45.3)</td>
<td>23.3 (17.5-28.9)</td>
<td>12.0 (8.8-15.1)</td>
<td>49.3 (46.0-52.6)</td>
<td>54.4 (51.4-57.5)</td>
</tr>
</tbody>
</table>

* During the baseline period, bed-days are twice as high at the intervention site because 10 wards were included in baseline surveillance in contrast to 5 wards in the subsequent intervention and maintenance periods.

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### Figure. Monthly Rates of Urine Culture Orders per 1000 Bed-days

The baseline characteristics of patients were similar within each site across study periods. The overall proportion of ASB cases among the positive urine cultures remained constant across study periods and sites. For the baseline, intervention, and maintenance periods, respectively, these values were 61.3%, 60.7%, and 63.2% for the intervention site \((P = .93)\) and 48.6%, 42.4%, and 49.4% for the comparison site \((P = .23)\) (Table 4). Multivariable regression analysis of ASB overtreatment demonstrated a significant interaction between study site and study period \((P = .04)\) after adjusting for patient-level covariates. At the intervention site, the likelihood of ASB overtreatment decreased by half (odds ratio [OR], 0.47; 95% CI, 0.28-0.78) during the intervention period. There was no significant change in ASB overtreatment at the comparison site \((OR, 1.32; 95\% CI, 0.69-2.52)\). Failure to treat CAUTI was not significantly different between sites during the intervention or maintenance period compared with baseline in multivariable analyses.

In the multivariable analysis restricted to long-term care (middle section of Table 4), there was a significant interaction between study site and study period \((P = .001)\). At the intervention site, the likelihood of ASB overtreatment in long-term care was significantly lower during the intervention \((OR, 0.23; 95\% CI, 0.08-0.65)\) and maintenance \((OR, 0.10; 95\% CI, 0.01-0.84)\) periods compared with baseline. At the comparison site, the likelihood of ASB overtreatment increased in the...
intervention period (OR, 9.67; 95% CI, 1.43-65.38) and was not significantly different during maintenance (OR, 3.45; 95% CI, 0.61-19.53) compared with baseline. The effectiveness of the intervention on ASB overtreatment on the acute medical wards was modest and not statistically significant (P = .25) in multivariable analysis of the interaction between study site and study period (bottom section of Table 4).

**Discussion**

At the intervention site, the Kicking CAUTI intervention successfully decreased inappropriate screening for ASB as measured by overall rates of urine cultures ordered and successfully decreased ASB overtreatment with an antimicrobial. In stratified analysis, the effect of the intervention was more significant on long-term care wards and was modest on acute medicine wards. Overall, ASB overtreatment decreased without increasing undertreatment of CAUTI. In addition, the effectiveness of the intervention did not diminish during the maintenance period at the intervention site. These improvements occurred against a background of concerted efforts at both sites to implement a bladder bundle to decrease CAUTI and standard quality improvement education about CAUTI and ASB at the comparison site.

Quality improvement programs that encourage clinicians to do more for patients rather than less are typically more successful. Nonetheless, we successfully implemented and sustained a quality improvement campaign that targeted overuse of urine cultures and antimicrobials, particularly in long-term care units, where antimicrobial stewardship is urgently needed. One key emphasis of Kicking CAUTI was decreased ordering of urine cultures in the setting of ASB. A recent study that suppressed urine culture results, requiring health care professionals to call to obtain the results, led to a 36% reduction in treatment of ASB.

Other implementation programs have decreased antibiotic overuse for ASB by using education, pocket cards, audit
Antimicrobial Stewardship Approach for Urinary Catheter–Associated Asymptomatic Bacteriuria

Table 4. Antimicrobial Therapy of Patients With Positive Urine Cultures During Baseline, Intervention, and Maintenance Periods

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No./Total No. (%)</th>
<th>Comparison Site*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention Site</td>
<td></td>
</tr>
<tr>
<td>Cases of ASB</td>
<td>(n = 218)</td>
<td></td>
</tr>
<tr>
<td>Intervention Site</td>
<td>(n = 247)</td>
<td>106 (46.8)</td>
</tr>
<tr>
<td>Cases of CAUTI</td>
<td>(n = 218)</td>
<td></td>
</tr>
<tr>
<td>Maintenance Site</td>
<td>(n = 247)</td>
<td>112 (51.4)</td>
</tr>
<tr>
<td>Overtreatment of ASB</td>
<td>146/382 (38.2)</td>
<td>21/106 (19.8)</td>
</tr>
<tr>
<td>Overtreatment of CAUTI</td>
<td>18/241 (7.5)</td>
<td>4/112 (3.6)</td>
</tr>
<tr>
<td>Under treatment of ASB</td>
<td>76/247 (30.8)</td>
<td>22/96 (23.4)</td>
</tr>
<tr>
<td>Under treatment of CAUTI</td>
<td>13/168 (7.7)</td>
<td>5/123 (3.1)</td>
</tr>
<tr>
<td>Long-term Care Patients Only</td>
<td>135 (64.9)</td>
<td>25 (69.4)</td>
</tr>
<tr>
<td>Cases of ASB</td>
<td>73 (35.1)</td>
<td>4 (28.6)</td>
</tr>
<tr>
<td>Cases of CAUTI</td>
<td>70/135 (51.9)</td>
<td>5/25 (20.0)</td>
</tr>
<tr>
<td>Cases of CAUTI</td>
<td>9/73 (12.3)</td>
<td>2/11 (18.2)</td>
</tr>
<tr>
<td>Cases of ASB</td>
<td>247/413 (59.5)</td>
<td>77 (58.3)</td>
</tr>
<tr>
<td>Cases of CAUTI</td>
<td>168 (40.5)</td>
<td>55 (41.7)</td>
</tr>
<tr>
<td>Cases of ASB</td>
<td>76/247 (30.8)</td>
<td>13/38 (34.2)</td>
</tr>
<tr>
<td>Cases of CAUTI</td>
<td>9/168 (5.4)</td>
<td>4/55 (2.7)</td>
</tr>
<tr>
<td>Cases of ASB</td>
<td>0/114 .98</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: ASB, asymptomatic bacteriuria; CAUTI, catheter-associated urinary tract infection; NA, not applicable.

* Data missing for 5 patients from the comparison site on location (acute medical or long-term care).

* Adjusted for age, sex, Deyo Comorbidity Score, urinary catheter type, and location.

d Adjusted for age, sex, Deyo Comorbidity Score, and urinary catheter type.

b For interaction between study group and study period.

and feedback, and computer-based reminders.134,35 Our study used a decision algorithm based on fast and frugal heuristics theory that had been piloted with end users and revised accordingly.24 The intervention was based on an implementation science model and was designed to maximize the effectiveness of audit and feedback.25,36,37 We were meticulous in establishing the validity of our medical record review process,23 the reliability in our case classification across sites, and the fidelity of the intervention delivery across time. Finally, our program had a contemporary comparison site and assessed intervention maintenance through analysis of outcomes in an entire year after the active phase of the intervention. The ongoing improvement in urine cultures ordered during the maintenance year may have related to the ongoing diffusion of innovation and knowledge over time, plus the advancement of junior residents to more senior decision-making roles over the 3 years of the study.

We hypothesize that the significant improvement seen in long-term care as opposed to acute medical care relates to the fact that the overtreatment rate was higher in long-term care at baseline. Audit and feedback are typically more successful when baseline performance is worse.38 The 30.8% overtreatment rate of ASB seen in acute care is in line with 2 prior studies39,40 from our institution, in which 32.3% of episodes of ASB in general and 32.8% of cases of enterococcal ASB were overtreated. In contrast, ASB overtreatment at baseline in long-term care at the intervention site was 51.8%. Another reason the effect may have been greater in long-term care is that health care professionals in long-term care wards were staff physicians and other stably employed clinicians, in contrast to residents in acute medical wards, who rotate to other sites.

Our study had some limitations. The study was conducted at 2 Veterans Affairs health care systems, and modification of certain aspects might be necessary for private sector facilities. The intervention period was high intensity and delivered in part by a trusted local expert (B.W.T.). However, the persistence of intervention effectiveness during the maintenance period suggests that focused effort during implementation may be sufficient for longer-term benefit. We do not know what aspect of our intervention had the greatest impact or whether the entire bundle is necessary. Other literature suggests that multifaceted interventions for antimicrobial stewardship are most likely to succeed.39 Preintervention rates of ASB overtreatment differed across the study sites. The unmeasured differences in the CAUTI prevention activities might have been a factor, but the bladder bundles as implemented at both sites did not address appropriateness of urine cultures or antibiotics. To avoid bias due to the regression to the mean, we incorporated a prolonged baseline period before the intervention to assess the natural fluctuation rates of the outcome over time. Although we cannot guarantee that the fidelity of case classification was the same at both sites, we applied a validated, standardized approach with good interrater agreement between the sites.
Conclusions

Overtreatment of ASB endangers the future effectiveness of all antimicrobials. Increased attention to antimicrobial stewardship has led to a national Veterans Affairs mandate that all facilities must adopt antimicrobial stewardship. The Centers for Disease Control and Prevention, the National Institutes of Health, the World Health Organization, and the White House have voiced similar concerns and recommendations.

Our study demonstrated that a guidelines implementation intervention grounded in behavioral theory led to sustainable improvements in antimicrobial overuse, without underutilization when indicated. Further dissemination nationally and outside of Veterans Affairs settings should incorporate existing antimicrobial stewardship resources within acute and long-term care settings using similar standardized processes for case classification, modification of health care professionals’ decision heuristics, and expert-guided audit and feedback with patients.

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Author Contributions: Drs Grigoryan and Petersen had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Trautner, Petersen, Hysong, Patterson, Naik. Acquisition, analysis, or interpretation of data: All authors. Drafting of the manuscript: Trautner, Grigoryan. Critical revision of the manuscript for important intellectual content: All authors. Obtaining funding: Trautner. Administrative, technical, or material support: Trautner, Hysong, Cadena, Patterson, Naik. Study supervision: Trautner, Cadena, Naik.

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Additional Contributions: Scott Holmes, member of the Baylor College of Medicine Michael E. DeBakey Department of Surgery Research Core Team, assisted with preparing the figure for the manuscript. Deborah Horwitz, Ashley Gendrett, MPH, Cynthia Kelly, RN, and Allison Burns, JD, delivered the implementation and collected data.

REFERENCES


**Invited Commentary**

**Changing Clinicians’ Behavior**

**To Order or Not to Order a Urine Culture**

Manisha Juthani-Mehta, MD

**Asymptomatic bacteriuria (ASB)** is one of the most common reasons for inappropriate antimicrobial use.1 Despite the recommendation for decades that patients with indwelling urinary catheters should not be screened for ASB or treated with antimicrobial therapy, this practice is still commonplace.2 In an effort to have physicians and patients work collaboratively to reduce unnecessary antimicrobial prescriptions, the first evidence-based recommendation made by the Infectious Diseases Society of America in conjunction with the American Board of Internal Medicine in the Choosing Wisely campaign is “Don’t treat asymptomatic bacteriuria with antibiotics.”3

Changing the behavior of clinicians is fraught with challenges, but change is possible. Some of the components that have been successfully shown to facilitate a change in behavior include education, feedback, participation by clinicians in the change effort, and administrative interventions.4 In this issue of *JAMA Internal Medicine,* Trautner and colleagues5 report on the effectiveness and sustainability of a multifaceted guidelines implementation intervention to reduce urine culture ordering and antimicrobial prescriptions for ASB among patients with indwelling urinary catheters. The outlined key components that can facilitate a change in behavior were used in this intervention.

To date, most interventions to reduce antimicrobial prescriptions for ASB have focused on assessing patients for signs and symptoms of catheter-associated urinary tract infection (CAUTI) and educating clinicians to withhold antibiotics in their absence despite a urine culture positive for bacteria. Such efforts have yielded limited success because clinicians often will identify another clinical indication to initiate antimicrobial therapy.6 Because it is difficult to withhold antimicrobials in the face of a urine culture positive for bacteria, urine studies should not be ordered in patients with nonspecific signs and symptoms to avoid the therapeutic dilemma of whether or not to prescribe antimicrobial therapy.7 Because cultures posi-