Decreasing Treatment of Asymptomatic Bacteriuria: An Interprofessional Approach to Antibiotic Stewardship

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ABSTRACT

Objective: Asymptomatic bacteriuria (ASB) denotes asymptomatic carriage of bacteria within the urinary tract and does not require treatment in most patient populations. Unnecessary antimicrobial treatment has several consequences, including promotion of antimicrobial resistance, potential for medication adverse effects, and risk for *Clostridiodes difficile* infection. The aim of this quality improvement effort was to decrease both the unnecessary ordering of urine culture studies and unnecessary treatment of ASB.

Methods: This is a single-center study of patients who received care on 3 internal medicine units at a large, academic medical center. We sought to determine the impact of information technology and educational interventions to decrease both inappropriate urine culture ordering and treatment of ASB. Data from included patients were collected over 3 1-month time periods: baseline, post-information technology intervention, and post-educational intervention.

Results: There was a reduction in the percentage of patients who received antibiotics for ASB in the post-education intervention period as compared to baseline (35% vs 42%). The proportion of total urine cultures ordered by internal medicine clinicians did not change after an information technology intervention to redesign the computerized physician order entry screen for urine cultures.

Conclusion: Educational interventions are effective ways to reduce rates of inappropriate treatment of ASB in patients admitted to internal medicine services.

Keywords: asymptomatic bacteriuria, UTI, information technology, education, quality.

Asymptomatic bacteriuria (ASB) is a common condition in which bacteria are recovered from a urine culture (UC) in patients without symptoms suggestive of urinary tract infection (UTI), with no pathologic consequences to most patients who are not treated.[1,2] Patients with ASB do not exhibit symptoms of a UTI such as dysuria, increased frequency of urination, increased urgency, suprapubic tenderness, or costovertebral pain. Treatment with antibiotics is not indicated for most patients with ASB.[1,3] According to the Infectious Diseases Society of America (IDSA), screening for bacteriuria and treatment for positive results is only indicated during pregnancy and prior to urologic procedures with anticipated breach of the mucosal lining.[1]

An estimated 20% to 52% of patients in hospital settings receive inappropriate treatment with antibiotics for ASB.[4] Unnecessary prescribing of antibiotics has several negative consequences, including increased rates of antibiotic resistance, *Clostridioides difficile* infection, and medication adverse events, as well as increased health care costs.[2,5] Antimicrobial stewardship programs to

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improve judicious use of antimicrobials are paramount to reducing these consequences, and their importance is heightened with recent requirements for antimicrobial stewardship put forth by The Joint Commission and the Centers for Medicare & Medicaid Services.[6,7]

A previous review of UC and antimicrobial use in patients for purposes of quality improvement at our institution over a 2-month period showed that of 59 patients with positive UCs, 47 patients (80%) did not have documented symptoms of a UTI. Of these 47 patients with ASB, 29 (61.7%) received antimicrobial treatment unnecessarily (unpublished data). We convened a group of clinicians and nonclinicians representing the areas of infectious disease, pharmacy, microbiology, statistics, and hospital internal medicine (IM) to examine the unnecessary treatment of ASB in our institution. Our objective was to address 2 antimicrobial stewardship issues: inappropriate UC ordering and unnecessary use of antibiotics to treat ASB. Our aim was to reduce the inappropriate ordering of UCs and to reduce treatment of ASB.

Methods

Setting

The study was conducted on 3 IM nursing units with a total of 83 beds at a large tertiary care academic medical center in the midwestern United States, and was approved by the organization's Institutional Review Board.

Participants

We included all non-pregnant patients aged 18 years or older who received care from an IM primary service. These patients were admitted directly to an IM team through the emergency department (ED) or transferred to an IM team after an initial stay in the intensive care unit.

Data Source

Microbiology laboratory reports generated from the electronic health record were used to identify all patients with a collected UC sample who received care from an IM service prior to discharge. Urine samples were collected by midstream catch or catheterization. Data on urine Gram stain and urine dipstick were not included. Henceforth, the phrase "urine culture order" indicates that a UC was both ordered and performed. Data reports were generated for the month of August 2016 to determine the baseline number of UCs ordered. Charts of patients with positive UCs were reviewed to determine if antibiotics were started for the positive UC and whether the patient had signs or symptoms consistent with a UTI. If antibiotics were started in the absence of signs or symptoms to support a UTI, the patient was determined to have been unnecessarily treated for ASB. Reports were then generated for the month after each intervention was implemented, with the same chart review undertaken for positive UCs. Bacteriuria was defined in our study as the presence of microbial growth greater than 10,000 CFU/mL in UC.

Interventions

Initial analysis by our study group determined that lack of electronic clinical decision support (CDS) at the point of care and provider knowledge gaps in interpreting positive UCs were the 2 main contributors to unnecessary UC orders and unnecessary treatment of positive UCs, respectively. We reviewed the work of other groups who reported interventions to decrease treatment of ASB, ranging from educational presentations to pocket cards and treatment algorithms.[8-13] We hypothesized that there would be a decrease in UC orders with CDS embedded in the computerized order entry screen, and that we would decrease unnecessary treatment of positive UCs by educating clinicians on indications for appropriate antibiotic prescribing in the setting of a positive UC.

Information technology intervention. The first intervention implemented involved redesign of the UC ordering screen in the computerized physician order entry (CPOE) system. This intervention went live hospital-wide, including the IM floors, intensive care units, and all other areas except the ED, on February 1, 2017 (**Figure 1**). The ordering screen required the prescriber to select from a list of appropriate indications for ordering a UC, including urine frequency, urgency, or dysuria; unexplained suprapubic or flank pain; fever in patients without another recognized cause; screening obtained prior to urologic procedure; or screening during pregnancy. An additional message advised prescribers to avoid ordering the culture if the patient had malodorous or cloudy urine, pyuria without urinary symptoms, or had an alternative cause of fever. Before we implemented the information technology

(IT) intervention, there had been no specific point-of-care guidance on UC ordering.

Educational intervention. The second intervention, driven by clinical pharmacists, involved active and passive education of prescribers specifically designed to address unnecessary treatment of ASB. The IT intervention with CDS for UC ordering remained live. Presentations designed by the study group summarizing the appropriate indications for ordering a UC, distinguishing ASB from UTI, and discouraging treatment of ASB were delivered via a variety of routes by clinical pharmacists to nurses, nurse practitioners, physician assistants, pharmacists, medical residents, and staff physicians providing care to patients on the 3 IM units over a 1-month period in March 2017. The presentations contained the same basic content, but the information was delivered to target each specific audience group.

Medical residents received a 10-minute live presentation during a conference. Nurse practitioners, physician assistants, and staff physicians received a presentation via email, and highlights of the presentation were delivered by clinical pharmacists at their respective monthly group meetings. A handout was presented to nursing staff at nursing huddles, and presentation slides were distributed by email. Educational posters were posted in the medical resident workrooms, nursing breakrooms, and staff bathrooms on the units.

Outcome Measurements

The endpoints of interest were the percentage of patients with positive UCs unnecessarily treated for ASB before and after each intervention and the number of UCs ordered at baseline and after implementation of each intervention. Counterbalance measures assessed included the incidence of UTI, pyelonephritis, or urosepsis within 7 days of positive UC for patients who did not receive antibiotic treatment for ASB.

Results

Data from a total of 270 cultures were examined from IM nursing units. A total of 117 UCs were ordered during the baseline period before interventions were implemented. For a period of 1 month following activation of the IT intervention, 73 UCs were ordered. For a period of 1 month

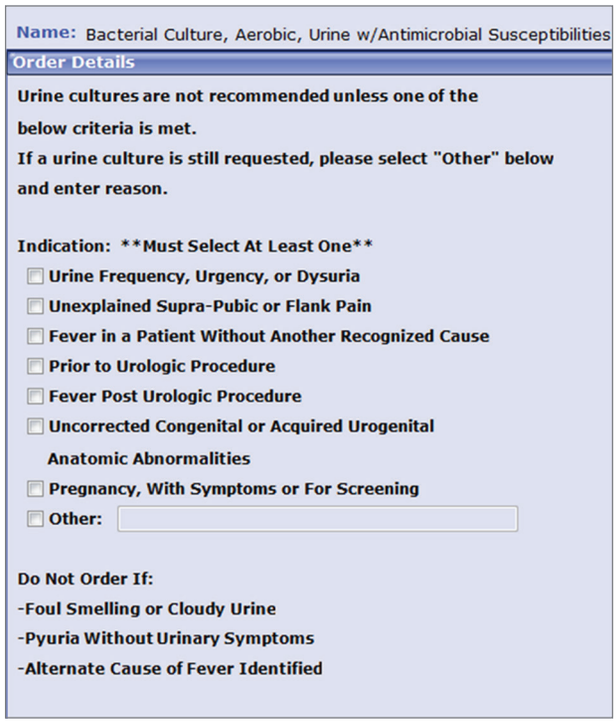

Figure 1. Redesigned computerized provider order entry screen.

following the educational interventions, 80 UCs were ordered. Of these, 61 (52%) UCs were positive at baseline, 37 (51%) after the IT intervention, and 41 (51%) after the educational intervention. Patient characteristics were similar between the 3 groups (**Table**); 64.7% of patients were female in their early to mid-seventies. The majority of UCs were ordered by providers in the ED in all 3 periods examined (51%-70%). The percentage of patients who received antibiotics prior to UC for another indication (including bacteriuria) in the baseline, post-IT intervention, and post-education intervention groups were 30%, 27%, and 45%, respectively.

The study outcomes are summarized in **Figure 2**. Among patients with positive cultures, there was not a reduction in inappropriate treatment of ASB compared to baseline after the IT intervention (48% vs 42%). Following the education intervention, there was a reduction in unnecessary ASB treatment as compared both to baseline (35% vs 42%) and to post-IT intervention (35% vs 48%). There was no difference between the 3 study periods in the percentage of total UCs ordered by IM clinicians. The counterbalance measure showed that 1 patient who

Table. **Patient and Urine Culture Characteristics**

	Baseline (n = 61)	Post-IT Intervention (n = 37)	Post-Education Intervention (n = 41)
Patient age, yr	71	76	75
		No. (%)	
Patient sex, female	43 (70)	23 (62)	24 (59)
Indwelling catheter	17 (28)	9 (24)	15 (37)
Antibiotics received for another indication	18 (30)	10 (27)	18 (45)
Service ordering UC			
IM	24 (39)	9 (24)	14 (34)
ED	31 (51)	26 (70)	25 (61)
ICU	4 (7)	2 (6)	2 (5)
Other	2 (3)	0 (0)	0 (0)
Organism obtained from UC	25 (41)	17 (46)	16 (39)
E. coli	9 (15)	8 (22)	2 (5)
Enterococcus species	9 (15)	3 (8)	6 (15)
Klebsiella species	0 (0)	4 (10.8)	1 (2)
Pseudomonas species	2 (3)	3 (8)	6 (15)
Staphylococcus species	7 (11)	2 (5.4)	6 (15)

ED, emergency department, ICU, intensive care unit; IM, internal medicine; IT, information technology; UC, urine culture.

did not receive antibiotics within 7 days of a positive UC developed pyelonephritis, UTI, or sepsis due to a UTI in each intervention group.

Discussion

The results of this study demonstrate the role of multimodal interventions in antimicrobial stewardship and add to the growing body of evidence supporting the work of antimicrobial stewardship programs. Our multidisciplinary study group and multipronged intervention follow recent guideline recommendations for antimicrobial stewardship program interventions against unnecessary treatment of ASB.[14] Initial analysis by our study group determined lack of CDS at the point of care and provider knowledge gaps in interpreting positive UCs as the 2 main contributors to unnecessary UC orders and unnecessary treatment of positive UCs in our local practice culture. The IT component of our intervention was intended to provide CDS for ordering UCs, and the education component focused on informing clinicians' treatment decisions for positive UCs.

It has been suggested that the type of stewardship intervention that is most effective fits the specific needs and resources of an institution.[14,15] And although the IDSA does not recommend education as a stand-alone intervention,[16] we found it to be an effective intervention for our clinicians in our work environment. However, since the CPOE guidance was in place during the educational study periods, it is possible that the effect was due to a combination of these 2 approaches. Our pre-intervention ASB treatment rates were consistent with a recent meta-analysis in which the rate of inappropriate treatment of ASB was 45%.[17] This meta-analysis found educational and organizational interventions led to a mean absolute risk reduction of 33%. After the education intervention, we saw a 7% decrease in unnecessary treatment of ASB compared to baseline, and a 13% decrease compared to the month just prior to the educational intervention.

Lessons learned from our work included how clear review of local processes can inform quality improvement interventions. For instance, we initially hypothesized that

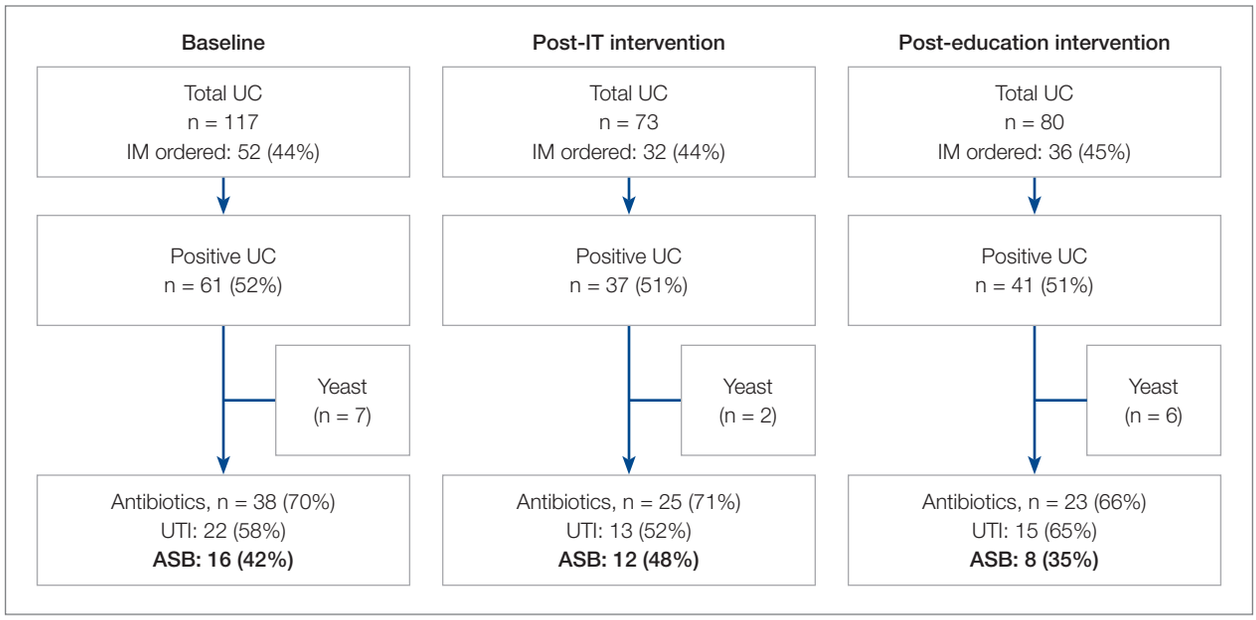

Figure 2. Number of urine cultures (UCs) ordered and cases of asymptomatic bacteriuria (ASB) treated at baseline and after interventions. UTI, urinary tract infection.

IM clinicians would benefit from point-of-care CDS guidance, but such guidance used alone without educational interventions was not supported by the results. We also determined that the majority of UCs from patients on general medicine units were ordered by ED providers. This revealed an opportunity to implement similar interventions in the ED, as this was the initial point of contact for many of these patients.

As with any clinical intervention, the anticipated benefits should be weighed against potential harm. Using counterbalance measures, we found there was minimal risk in the occurrence of UTI, pyelonephritis, or sepsis if clinicians avoided treating ASB. This finding is consistent with IDSA guideline recommendations and other studies that suggest that withholding treatment for asymptomatic bacteriuria does not lead to worse outcomes.[1]

This study has several limitations. Data were obtained through review of the electronic health record and therefore documentation may be incomplete. Also, antimicrobials for empiric coverage or treatment for other infections (eg, pneumonia, sepsis) may have confounded our results, as empirical antimicrobials were given to 27% to 45% of patients prior to UC. This was a quality improvement project carried out over defined time intervals, and thus our sample size was limited and not adequately powered to show statistical significance. Additionally, given the bundling of interventions, it is difficult to determine the impact of each intervention independently. Although CDS for UC ordering may not have influenced ordering, it is possible that the IT intervention raised awareness of ASB and influenced treatment practices.

Conclusion

Our work supports the principles of antibiotic stewardship as brought forth by IDSA.[16] This work was the effort of a multidisciplinary team, which aligns with recommendations by Daniel and colleagues, published after our study had ended, for reducing overtreatment of ASB.[14] Additionally, our study results provided valuable information for our institution. Although improvements in management of ASB were modest, the success of provider education and identification of other work areas and clinicians to target for future intervention were helpful in consideration of further studies. This work will also aid us in developing an expected effect size for future studies. We plan to provide ongoing education for IM providers as well as education in the ED to target providers who make first contact with patients admitted to inpatient services. In addition, the

CPOE UC ordering screen message will continue to be used hospital-wide and will be expanded to the ED ordering system. Our interventions, experiences, and challenges may be used by other institutions to design effective antimicrobial stewardship interventions directed towards reducing rates of inappropriate ASB treatment.

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