HHS Public Access
Author manuscript
Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2019 September 01.

Published in final edited form as:
Infect Control Hosp Epidemiol. 2019 March ; 40(3): 281–286. doi:10.1017/ice.2018.356.

Effect of changing urine testing orderables and clinician order sets on inpatient urine culture testing: Analysis from a large academic medical center

Satish Munigala, MBBS, MPH[1], **Rebecca Rojek, MPH**[2], **Helen Wood, RN, MA, CIC**[2], **Melanie L Yarbrough, PhD**[3], **Ronald R Jackups Jr., MD, PhD**[3], **Carey-Ann D Burnham, PhD**[3], and **David K Warren, MD, MPH**[1]

(1) Division of Infectious Diseases, Department of Medicine, Washington University School of Medicine, Saint Louis, Missouri, USA

(2) Department of Hospital Epidemiology and Infection Prevention, Barnes-Jewish Hospital, Saint Louis, Missouri, USA

(3) Department of Pathology and Immunology, Washington University School of Medicine, Saint Louis, Missouri, USA

Abstract

Objective: To evaluate the impact of changes to urine testing orderables in computerized physician order entry (CPOE) system on urine culturing practices.

Design: Retrospective before (January 2015 to April 2016) and after (May 2016 to August 2017) study.

Setting: A 1,250-bed academic tertiary referral center.

Patients: Hospitalized adults who had ≥1 urine culture performed during their stay.

Intervention: The intervention (implemented in April 2017) consisted of notifications to providers, changes to order sets and inclusion of the new urine culture reflex tests in commonly used order sets. We compared the urine culture rates before and after intervention, adjusting for temporal trends.

Results: During the study period, 18,954 inpatients (median age 62 years, 68.8% white and 52.3% female) had 24,569 urine cultures ordered. Twenty-seven percent (n=6642) of the urine cultures were positive. Urine culturing rate decreased significantly in the post-intervention period for any specimen type (38.1 pre-vs. 20.9 per 1000 patient days post-intervention, p<0.001), clean catch (30.0 vs. 18.7, p<0.001) and catheterized urine (7.8 vs. 1.9, p<0.001). Using an interrupted time series model, urine culture rates decreased for all specimen types (p<0.05).

Corresponding Author: David K. Warren, MD, MPH, Washington University School of Medicine, 4523 Clayton Ave., Campus Box 8051, Saint Louis, MO 63110, dwarren@wustl.edu, Phone: +1 314-454-8354, Fax: +1 314-454-5392.

Potential conflict of interests:
All authors report no conflict of interest related to this manuscript.

Conclusions: Our intervention of changes to order sets and inclusion of the new urine culture reflex tests resulted in a 45% reduction in the urine cultures ordered. CPOE system format plays a vital role in reducing the burden of unnecessary urine cultures and should be implemented in combination with other efforts.

Keywords

urinalysis; urine culture; asymptomatic bacteriuria; computerized physician order entry; antimicrobial resistance

Introduction

Urinalysis and urine culture are commonly ordered tests among hospitalized patients suspected of urinary tract infection (UTI). However, these tests are often ordered on patients for whom no clinical suspicion of UTI exists, leading to unnecessary testing and increased hospital costs (1–3). Positive urine cultures are a major driver for antibiotic treatment (4–11). Several studies have reported that the treatment of asymptomatic bacteriuria (ASB) does not affect patient outcomes and leads to unnecessary antibiotic use, increasing the prevalence of antibiotic-resistant organisms and *Clostridium difficile* infection (12–14). Despite Infectious Disease Society of America and other professional societies' recommendations to avoid antibiotic prescriptions for asymptomatic bacteriuria (14–17), its treatment is still common.

Previous interventions to prevent unnecessary urine testing have included provider education, use of pocket cards, antimicrobial stewardship efforts, reflex urine culture cancellation and two-step urine culture ordering (6, 7, 12, 13, 18–22). However, there is limited data on the effect of changes in electronic order sets and its role on inpatient urine testing practices.

In this study, we evaluated the impact of changes to the inpatient urine orders in computer physician order entry (CPOE) system on urine culturing practices of a large urban, academic medical center.

Methods

Setting

This was a retrospective before and after study of patients admitted to Barnes-Jewish Hospital (BJH), a 1250-bed teaching hospital, from January 1st 2015 to August 31st 2017, who had ≥1 urine culture ordered during their stay. Patients who were admitted during the study period but did not have a urine culture ordered during their stay and patients who had their urine cultures obtained at an outpatient settings or the emergency department (ED) were excluded.

Intervention

A staged intervention was performed to clarify test names and to reduce the number of reflex urine cultures performed for non-specific indications (e.g. isolated proteinuria), by making changes to the urine reflex test panel at BJH (Table 1). This intervention was initiated in CPOE system on January 28, 2016. Email notification to providers with the new urine reflex tests was sent prior to initiation. The inclusion of the new reflex tests in commonly used order sets within the CPOE system (e.g., medical intensive care unit admission orders) was completed on April 19 2016; therefore, April 2016 was used as the intervention month. January 2015 through April 2016 was the pre-intervention period and May 2016 through August 2017 was the post-intervention period.

Data collection

Patient and laboratory data were abstracted from the hospital medical informatics database. Data included patient demographics (age, race and sex), laboratory test results (urinalysis, microscopic exam and urine culture), and discharge disposition (home, other facility, etc.). For urine cultures with accompanying urinalysis or microscopy, the time between the urine culture and urinalysis and/or microscopy was calculated. Type of urine culture specimen was also noted (i.e., clean catch, catheterized, and procedure-related) as indicated by the ordering clinician. For patients with multiple urine cultures during an admission, each sample was treated as an independent observation.

Definitions

Urine cultures with growth of ≥100,000 colony forming units (cfu)/ ml for clean catch specimen and ≥10,000 cfu/ ml for catheterized specimens were treated as positive results. Urine cultures that were negative for significant growth or contaminated were considered negative for this analysis. Leukocyte esterase ≥1 identified on urinalysis and >5 white blood cells per high power field on urine microscopy were treated as abnormal/positive test results. We defined an isolated urine culture as a culture without an associated urinalysis and/or urine microscopy performed within one calendar day before or after the culture was performed. Catheter-associated urinary tract infections (CAUTI) surveillance was independently conducted by the hospital infection prevention department during the study period. CAUTI was defined according to National Healthcare Safety Network definitions (23) as an UTI where an indwelling urinary catheter was in place for >2 calendar days on the date of event, with day of device placement being Day 1, and an indwelling urinary catheter was in place on the date of event or the day before. If an indwelling urinary catheter was in place for > 2 calendar days and then removed, the UTI criteria must be fully met on the day of discontinuation or the next day.

Cost assessment

Unit cost of a urine culture was obtained from the Medicare Clinical Laboratory Fee Schedule using national median Medicare payment rate of $15.00 per urine culture (not adjusted to inflation) (24). Total laboratory charges for urine cultures during the pre-intervention and post-intervention periods were calculated and cost difference was estimated.

Statistical Analysis

Patient demographics and characteristics were reported on a per admission basis. Urine cultures rates were reported per 1000 patient days (i.e., the total patient days for all patients admitted during the study period). CAUTI rates were reported per 1000 patient days and catheter days. Demographic characteristics and urine culture data were compared for pre-intervention period and post-intervention period using Wilcoxon Rank Sum test, χ^2 or univariable logistic regression where appropriate. An interrupted time series model was used to analyze the impact of the intervention on urine culture rates during the study period. Data were analyzed using SAS version 9.3 (SAS Institute, Cary, NC). This study was approved by the Washington University Human Research Protection Office.

Results

Patient characteristics

During the study period, 18,954 patients had ≥ 1 urine culture ordered during their hospital stay (11,780 during the pre- vs. 7,174 during the post-intervention period) (Table 2). Median age of the patients was 62 years. Approximately 69% of patients were white and 52.3% were female. About 66% of these patients were routinely discharged home and 25.5% were discharged/ transferred to other facilities. Patients in the pre-intervention period were slightly younger (61 years pre- vs. 62 years post-intervention; p=0.015), male predominant (48.4% vs. 46.5%; p=0.012) and were routinely discharged home (66.6% vs. 63.9%; p<0.001) compared to post-intervention period.

Urine culture characteristics

A total of 24,569 urine cultures were ordered (during 18,954 admissions at the rate of 29.4 cultures per 1000 patient days, median: 1 urine culture per admission) during the study period. Of these, 70.7% had an associated urinalysis and 70.4% had an associated microscopy (25.4% of urine cultures were deemed to be isolated). Twenty-seven percent (n=6642) of the urine cultures performed were positive. Proportion of the positive urine cultures increased in the post-intervention period (25.5% pre- vs. 29.7% post-intervention; p<0.001), whereas the proportion of isolated urine cultures decreased (26.0% pre- vs. 24.2% post-intervention; p=0.002) (Table 3).

Urine culture rates by specimen type

Urine culture decreased by 45.1% in the post-intervention period (38.1 pre-vs. 20.9 per 1000 patient days post-intervention, p<0.001) (Table 3). This decrease was observed for clean catch (30.0 pre- vs. 18.7 per 1000 patient days post-intervention, p<0.001) and catheterized urine cultures (7.8 pre- vs. 1.9 per 1000 patient days post-intervention, p<0.001), whereas procedure-related urine cultures remained stable at 0.3 per 1000 patient days (Figure 1).

When adjusted for impact of the intervention using an interrupted time series model, urine culture rates decreased significantly for overall (p<0.001), catheterized (p<0.001) and isolated cultures (p=0.027) respectively (Figure 2).

Catheter associated urinary tract infections (CAUTI)

Two hundred and fifty CAUTIs were identified during the study period (0.30 per 1000 patient days); however, post-intervention there was no significant change in the CAUTI rates (0.30 pre- vs. 0.30 per 1000 patient days post-intervention, p=0.871; 1.25 pre- vs. 1.27 per 1000 catheter days post-intervention, p=0.899) (Table 3).

Effect of intervention on laboratory costs

Our intervention resulted in a $6,490 reduction in the mean monthly laboratory cost during the post-intervention period, with an estimated total cost savings of $103,345 for inpatient urine culture laboratory costs in the post-intervention period ($236,190 in the pre- vs. $132,345 in the post-intervention).

Discussion

In this retrospective study, we observed a 45.1% unadjusted decrease in the rate of inpatient urine cultures performed, because of changes to electronic orders in the computer physician order entry system. The reduction in the urine culture rate was most marked for the catheterized (75.6%) compared to a clean catch specimens (37.8%). We also noticed a 16.4% increase in the proportion of positive urine cultures and a 6.9% decrease in the proportion of isolated urine cultures obtained. Overall, our intervention resulted in an estimated reduction of $103,845 in laboratory charges to patients.

Unnecessary ordering of urine cultures and inappropriate antimicrobial use for asymptomatic bacteriuria remain common among clinicians (13, 15–17, 25–27). Lack of familiarity with the recommendations, excessive testing in patients with comorbidities and certain practice patterns among physicians are some of the common factors driving this clinical practice (9, 28). Moreover, a urine culture result is often difficult for clinicians to ignore and drives antimicrobial therapy regardless of symptoms (29)

Several prior efforts to prevent treatment of asymptomatic bacteriuria included educational sessions (6, 30), pocket cards with diagnostic algorithms with audit and feedback for training clinicians (13) and antimicrobial stewardship efforts. Recently, Hartley *et al* (4) replicated these interventions in hospitalist-based service in three different hospitals and observed a 24% reduction in ASB treatment rates, resulting in fewer days of antimicrobial therapy. Other recent interventions have included focus groups interviews for identifying factors that affect nurse initiated urine culture ordering and collection practices (31), reflex urine culture cancellation (21) and two-step urine culture ordering in the emergency department (22). Although there are several of these upstream interventions in eliminating unnecessary ordering and downstream interventions in reducing treatment of asymptomatic bacteriuria, there is limited knowledge on the role of CPOE in reducing the burden of unnecessary ordering in inpatient setting.

Because of our intervention, we also noticed a significant increase in the proportion of urine cultures that were positive during the post-intervention period. This may indicate increased clarity of reflex algorithm test names and a change in the behavior of ordering clinicians (e.g., urine cultures are more likely to be ordered in patients with a higher pre-test probability). The post-intervention period had significantly higher proportion of positive urine cultures with an associated abnormal/positive urinalysis (1896/2621 72.3% vs. 2442/4021 60.7%, $p<0.001$) and significantly lower proportion of positive urine culture results with an associated negative urinalyses (122/2621 4.7% vs. 479/4021 11.9%, $p<0.001$). These findings suggests that a chance of an important urinary tract infection been missed due to decreased rate of urine culture following the intervention is less unlikely. Although we noticed a significant, but small (6.9%), decrease in the isolated urine culture and substantial decrease (75.6%) in the rate of catheterized urine cultures per 1000 patient-days, there was no significant change in the CAUTI rate post-intervention. Given that we had previously reported that isolated urine cultures were more likely to be ordered on catheterized patients and patients with prolonged hospital stays (32), we evaluated the proportion of CAUTIs associated with isolated urine cultures. We found no significant difference between study periods in the proportion of CAUTIs that were identified based on isolated urine cultures (39/125 (31.2%) pre-intervention vs. 26/125 (20.8%) post-intervention, $p=0.06$). These findings suggest that for patient in whom a clinical suspicion of CAUTI existed, clinicians were ordering diagnostic tests and detecting it in both intervention periods; therefore, additional infection prevention efforts may be required in this study cohort to prevent CAUTIs.

Our intervention resulted in an estimated cost savings of approximately $104,000 for inpatient laboratory costs after implementation. This represents a fraction of the total costs and does not reflect the costs saved based on the medical decisions (e.g., delayed hospital discharge) and antimicrobial therapy (27). In an era of reducing reimbursement for clinical laboratory testing (33), the prudent use of common diagnostic tests in patient care is increasingly important.

Limitations of our study include a retrospective design, the absence of chart review for test indication and lack of data on antibiotic use for assessment of antimicrobial therapy. We were unable to assess asymptomatic bacteriuria, as data on clinical symptoms or signs were not collected. In addition, this is a single academic medical center and may not be generalizable to other settings. Our medical informatics database does not include orders; therefore, we were unable to directly evaluate the frequency of urinalysis reflex to microscopy with culture and types of urine culture orders. We attempted to address this limitation by examining urine cultures that were performed along with urinalysis and/or microscopy, but we would not be able to identify how much our intervention reduced the proportion of urinalysis that reflexed to culture. The median number of urine cultures for the pre-intervention and post-intervention periods were the same (including demographic characteristics patients who had more than one urine culture), therefore, we did not make any adjustments for the repeat observations. We were unable to directly assess if antibiotic use changed in patients with urinary testing because of the intervention, and its subsequent effect on antimicrobial resistance among urinary pathogens. Strengths of our study include using data from a large academic medical center and electronic order sets for intervention. Use of CPOE for such intervention requires relatively little ongoing intervention effort compared with other diagnostic stewardship efforts, which require constant monitoring. Our study results complement a similar CPOE intervention conducted in the emergency department of the same hospital, where we observed a 47% decrease in the urine cultures ordered when only “urinalysis with reflex to microscopy” retained in the frequently ordered list of laboratory tests (34). A similar study of urine diagnostics reported that the elimination of reflexed microscopy examination for inpatient locations resulted in a 95% reduction in the urine microscopy performed (35).

To conclude, we found that a staged intervention to clarify test names and inclusion of new reflex tests resulted in a 45% reduction in the urine cultures ordered with an estimated cost savings of $104,000. Further studies are needed in evaluating the role of CPOE in combination with education sessions for ordering physicians and antimicrobial stewardship efforts in reducing the incidence of unnecessary urine cultures. Future research should also focus on reducing isolated urine cultures and catheter-associated urinary tract infections.

Acknowledgements:

Financial support:

This study was funded in part by Centers for Disease Control and Prevention Epicenters Program (grant no. 1U54CK000482-01).

References

1. Trautner BW. Asymptomatic bacteriuria: when the treatment is worse than the disease. Nat Rev Urol. 2011;9(2):85–93. [PubMed: 22143416]
2. McMaster-Baxter NL, Musher DM. Clostridium difficile: recent epidemiologic findings and advances in therapy. Pharmacotherapy. 2007;27(7):1029–1039. [PubMed: 17594209]
3. Saint S Clinical and economic consequences of nosocomial catheter-related bacteriuria. Am J Infect Control. 2000;28(1):68–75. [PubMed: 10679141]
4. Hartley SE, Kuhn L, Valley S, et al. Evaluating a Hospitalist-Based Intervention to Decrease Unnecessary Antimicrobial Use in Patients With Asymptomatic Bacteriuria. Infect Control Hosp Epidemiol. 2016;37(9):1044–1051. [PubMed: 27263795]
5. Cope M, Cevallos ME, Cadle RM, Darouiche RO, Musher DM, Trautner BW. Inappropriate treatment of catheter-associated asymptomatic bacteriuria in a tertiary care hospital. Clin Infect Dis. 2009;48(9):1182–1188. [PubMed: 19292664]
6. Pavese P, Saurel N, Labarere J, et al. Does an educational session with an infectious diseases physician reduce the use of inappropriate antibiotic therapy for inpatients with positive urine culture results? A controlled before-and-after study. Infect Control Hosp Epidemiol. 2009;30(6):596–599. [PubMed: 19419329]
7. Kelley D, Aaronson P, Poon E, McCarter YS, Bato B, Jankowski CA. Evaluation of an antimicrobial stewardship approach to minimize overuse of antibiotics in patients with asymptomatic bacteriuria. Infect Control Hosp Epidemiol. 2014;35(2):193–195. [PubMed: 24442085]
8. Yin P, Kiss A, Leis JA. Urinalysis Orders Among Patients Admitted to the General Medicine Service. JAMA Intern Med. 2015;175(10):1711–1713. [PubMed: 26280990]
9. Hartley S, Valley S, Kuhn L, et al. Overtreatment of asymptomatic bacteriuria: identifying targets for improvement. Infect Control Hosp Epidemiol. 2015;36(4):470–473. [PubMed: 25782904]
10. Grein JD, Kahn KL, Eells SJ, et al. Treatment for Positive Urine Cultures in Hospitalized Adults: A Survey of Prevalence and Risk Factors in 3 Medical Centers. Infect Control Hosp Epidemiol. 2016;37(3):319–326. [PubMed: 26607408]
11. Trautner BW, Bhimani RD, Amspoker AB, et al. Development and validation of an algorithm to recalibrate mental models and reduce diagnostic errors associated with catheter-associated bacteriuria. BMC Med Inform Decis Mak. 2013;13:48. [PubMed: 23587259]

12. Linares LA, Thornton DJ, Strymish J, Baker E, Gupta K. Electronic memorandum decreases unnecessary antimicrobial use for asymptomatic bacteriuria and culture-negative pyuria. Infect Control Hosp Epidemiol. 2011;32(7):644–648. [PubMed: 21666393]
13. Trautner BW, Grigoryan L, Petersen NJ, et al. Effectiveness of an Antimicrobial Stewardship Approach for Urinary Catheter-Associated Asymptomatic Bacteriuria. JAMA Intern Med. 2015;175(7):1120–1127. [PubMed: 26010222]
14. Gupta K, Hooton TM, Naber KG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis. 2011;52(5):e103–120. [PubMed: 21292654]
15. Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. Clin Infect Dis. 2005;40(5):643–654. [PubMed: 15714408]
16. Nicolle LE. Asymptomatic bacteriuria: review and discussion of the IDSA guidelines. Int J Antimicrob Agents. 2006;28(Suppl 1):S42–48. [PubMed: 16829049]
17. Choosing Wisely: an initiative of the ABIM Foundation. 2015 http://www.choosingwisely.org/doctor-patient-lists/infectious-diseases-society-of-america/. Accessed March 3, 2018.
18. Bonnal C, Baune B, Mion M, et al. Bacteriuria in a geriatric hospital: impact of an antibiotic improvement program. J Am Med Dir Assoc. 2008;9(8):605–609. [PubMed: 19083296]
19. Chowdhury F, Sarkar K, Branche A, et al. Preventing the inappropriate treatment of asymptomatic bacteriuria at a community teaching hospital. J Community Hosp Intern Med Perspect. 2012;2(2).
20. Leis JA, Palmay L, Elligsen M, Walker SA, Lee C, Daneman N. Lessons from audit and feedback of hospitalized patients with bacteriuria. Am J Infect Control. 2014;42(10):1136–1137. doi: 10.016/j.ajic.2014.06.020. [PubMed: 25278413]
21. Jones CW, Culbreath KD, Mehrotra A, Gilligan PH. Reflect urine culture cancellation in the emergency department. J Emerg Med. 2014;46(1):71–76. [PubMed: 24140018]
22. Stagg A, Lutz H, Kirpalaney S, et al. Impact of two-step urine culture ordering in the emergency department: a time series analysis. BMJ Qual Saf. 2018;27:140–147.
23. Catheter-associated urinary tract infection (CAUTI) event NHSN Patient Safety Manual 2018 Centers for Disease Control and Prevention website https://www.cdc.gov/nhsn/pdfs/validation/2018/pcsmanual_2018-508.pdf.
24. Clinical Laboratory Fee Schedule, 2017 Centers for Medicare and Medicaid Services 2017 [updated January 2017]. Available from: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched/Clinical-Laboratory-Fee-Schedule-Files-Items/17CLAB.html?DLPage=1&DLEntries=100&DLSort=2&DLSortDir=descending.
25. Tomford JW, Hershey CO. The i.v. therapy team: impact on patient care and costs of hospitalization. NITA. 1985;8(5):387–389. [PubMed: 3850385]
26. Gupta K, Hooton TM, Naber KG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis. 2011;52(5):e103–20. [PubMed: 21292654]
27. Forsman RW. Why is the laboratory an afterthought for managed care organizations? Clin Chem. 1996;42(5):813–816. [PubMed: 8653920]
28. Trautner BW, Petersen NJ, Hysong SJ, Horwitz D, Kelly PA, Naik AD. Overtreatment of asymptomatic bacteriuria: identifying provider barriers to evidence-based care. Am J Infect Control. 2014;42(6):653–658. [PubMed: 24713596]
29. Leis JA, Rebick GW, Daneman N, et al. Reducing Antimicrobial Therapy for Asymptomatic Bacteriuria Among Noncatheterized Inpatients: A Proof-of-Concept Study. Clinical Infectious Diseases. 2014;58(7):980–983. [PubMed: 24577290]
30. Irfan N, Brooks A, Mithoowani S, Celetti SJ, Main C, Mertz D. A Controlled Quasi-Experimental Study of an Educational Intervention to Reduce the Unnecessary Use of Antimicrobials For Asymptomatic Bacteriuria. PLoS One. 2015;10(7):e0132071. [PubMed: 26182348]
31. Redwood R, Knobloch MJ, Pellegrini DC, Ziegler MJ, Pulia M, Safdar N. Reducing unnecessary culturing: a systems approach to evaluating urine culture ordering and collection practices among

Author Manuscript
Author Manuscript
Author Manuscript

nurses in two acute care settings. Antimicrob Resist Infect Control. 2018;7:4. [PubMed: 29340148]

32. Carlson AL, Munigala S, Russo AJ, et al. Inpatient Urine Cultures Are Frequently Performed Without Urinalysis or Microscopy: Findings From a Large Academic Medical Center. Infect Control Hosp Epidemiol. 2017;38(4):455–460. [PubMed: 28052781]
33. Information regarding the final CY 2018 private payor rate-based clinical laboratory fee schedule (CLFS) payment rates. Centers for Medicare and Medicaid website https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched/Downloads/CY2018-CLFS-HCPCS-Median-Calculations.pdf.
34. Munigala S, Jackups RR, Jr., Poirier RF, et al. Impact of order set design on urine culturing practices at an academic medical centre emergency department. BMJ Qual Saf. 2018;27:587–592.
35. Chen M, Eintracht S, MacNamara E. Successful protocol for eliminating excessive urine microscopies: Quality improvement and cost savings with physician support. Clin Biochem. 2017;50(1–2):88–93. [PubMed: 27836623]

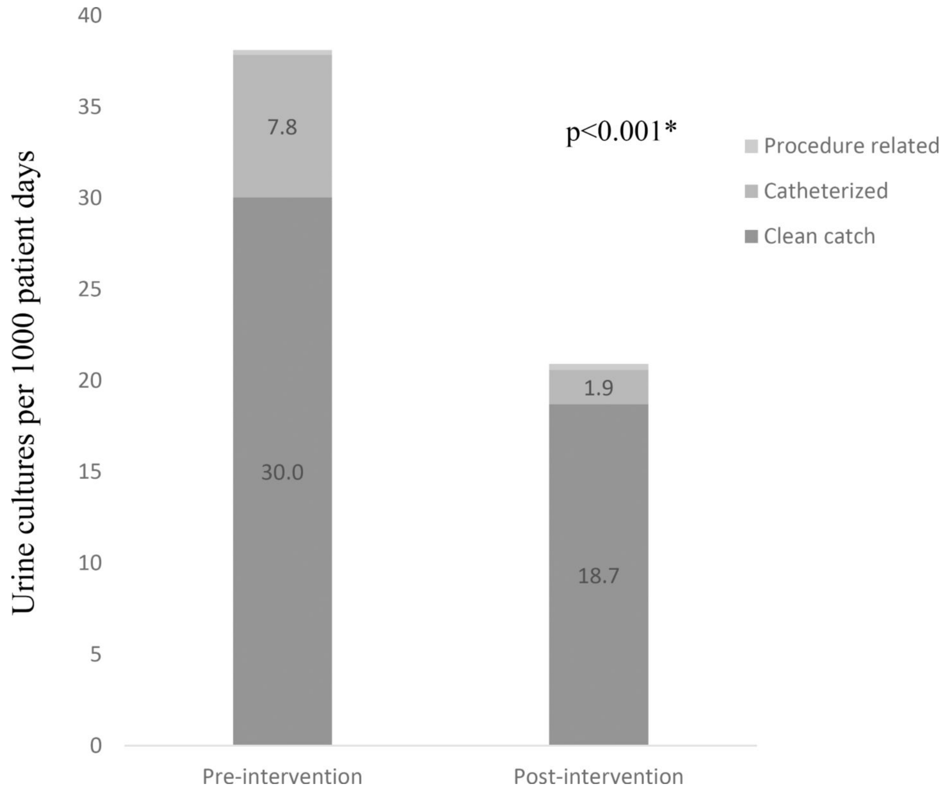
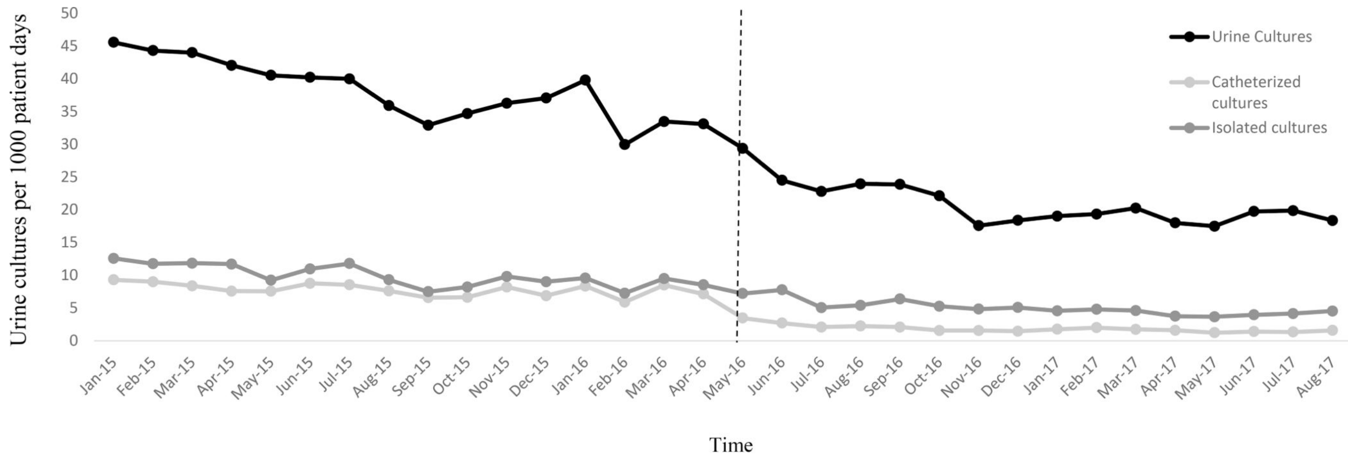


Figure 1.

Urine culture rate by specimen type. *p value for clean-catch and catheterized cultures. Note. The pre-intervention period was January 2015 to April 2016 and the post-intervention period was May 2016 to August 2017.



Intervention - - -

Figure 2.
Inpatient urine culturing practices from January 1, 2015 to August 31, 2017. The intervention time point is noted by a dashed line. $p < .001$ for urine cultures and catheterized cultures; $p = 0.027$ for isolated cultures, using interrupted time series analysis.

Table 1.

Urine order set definitions during the study period

Pre-intervention (January 2015 - April 2016)		Post-intervention (May 2016 - August 2017)	
Test name(s)	**Definition**	**Test name(s)**	**Definition**
		UA Reflex to Microscopy WITH Culture	If urinalysis is positive for nitrites OR leukocyte esterase, then microscopy and urine culture will automatically be performed
Urine Flex (Urine Macroscopic UA Flex) UA Flex C/S (Urine Macroscopic UA Flex)	Perform urine dipstick, if positive for any protein >trace, blood, nitrite or leukocyte esterase, then proceed to microscopy and culture	UA Reflex for Neutropenic Patients	If urinalysis is positive for protein (>trace), blood, nitrites, OR leukocyte esterase, then microscopy and urine culture will automatically be performed
UA Reflex UA W/Reflexed Microscopic (UA Reflex)	Perform urine dipstick, if positive for any protein >trace, blood, nitrite or leukocyte esterase, then proceed to microscopy	UA Reflex to Microscopy WITHOUT Culture	If urinalysis is positive for protein (>trace), blood, nitrites, OR leukocyte esterase, then microscopy will automatically be performed
Urine Macro Urinalysis UA Macro UA Dip Macroscopic	Macroscopic Dipstick Urinalysis only	Urine Macro Urinalysis UA Macro UA Dip Macroscopic	Macroscopic Dipstick Urinalysis only
UA Microscopy UA Micro	Urine Sediment Examination only	UA Microscopy UA Micro	Urine Sediment Examination only
Urine culture, X (X= aerobic, fungal, mycobacterial)		Urine culture, X (X= aerobic, fungal, mycobacterial)	

UA, urinalysis; Urine Flex & Urine Flex C/S were same orders with different names during the pre-intervention period; UA Reflex & UA W/Reflexed were same orders with different names during the pre-intervention period; Urine Macro, Urinalysis, UA Macro and UA Dip Macroscopic were same orders with different names during the study period; UA Microscopy and UA Micro were same orders with different names during the study period.

Table 2.

Characteristics of patients with ≥1 urine cultures obtained from inpatients

	Study Cohort* N=18954	Pre-Intervention (January 2015 to April 2016) N= 11780	Post-Intervention (May 2016 to August 2017) N= 7174	P-value
Age, median (IQR)	62 (49–72)	61 (48–72)	62 (49–72)	0.015
Race				
White	13043 (68.8)	8098 (68.7)	4945 (68.9)	Reference
Black	4791 (25.3)	2926 (24.8)	1865 (26.0)	0.217
Other	1120 (5.9)	756 (6.4)	364 (5.1)	<0.001
Sex				
Male	9040 (47.7)	5702 (48.4)	3338 (46.5)	0.012
Female	9914 (52.3)	6078 (51.6)	3836 (53.5)	Ref
Median urine culture per admit (range)	1 (1–12)	1 (1–12)	1 (1–12)	
Discharge status^				
Discharged to home	12336 (65.6)	7762 (66.6)	4574 (63.9)	<0.001
Discharged to other facility	4805 (25.5)	2890 (24.8)	1915 (26.7)	Reference
Other	1670 (8.9)	999 (8.6)	671 (9.4)	0.815

* Each admission is treated as an observation for this analysis purpose. Study cohort includes patients admitted to hospital whose urine was tested (≥ 1) for culture at the hospital during the study period (does not include urine cultures performed at emergency department, 24/7 clinic or in any outpatient setting). Overall, 18,954 patient admissions contributed to 24,569 urine culture tests during the study period (median, IQR: 1, 1–1). IQR- interquartile range.

^ Missing 143; Other- Still in hospital 9, Expired 1532, left against advice 106, Unknown 23; Pre-intervention- Missing 129; Still in hospital 5, Admitted to hospital 12, Expired 910, left against advice 72; Post-intervention- Missing 14; Still in hospital 4, Expired 622, left against advice 34, Unknown 11;

Table 3.

Comparison of urine culture testing practices before and after intervention

	Total n=24,569, n (%)	Pre-Intervention (January 2015 to April 2016) n=15746, n (%)	Post-Intervention (May 2016 to August 2017) n=8823, n (%)	P-value
Positive cultures*	6642 (27.0)	4021 (25.5)	2621 (29.7)	<0.001
Isolated cultures*	6240 (25.4)	4101 (26.0)	2139 (24.2)	0.002
Urine cultures per 1000 patient days**	29.4	38.1	20.9	<0.001
Catheterized urine cultures per 1000 patient days	4.8	7.8	1.9	<0.001
Catheter associated UTI	250 (1.0)	125 (0.8)	125 (1.4)	
CAUTI per 1000 patient days	0.30	0.30	0.30	0.871
CAUTI per 1000 catheter days	1.26	1.25	1.27	0.899

*See methods for definitions.

Note: UTI, urinary tract infection; CAUTI, catheter associated urinary tract infection.

**based upon 413,137 patient-days pre-intervention and 421,714 patient-days post-intervention for all patients admitted to the hospital during the study period (See Methods)