ORIGINAL ARTICLE

Improving Value of Care: Cessation of Screening Urine Culture Prior to Orthopedic and Spinal Surgery

Walter C. Hellinger, MD; Daniela A. Haehn, MD; Michael G. Heckman, MS; Joan M. Irizarry Alvarado, MD; Wendelyn Bosch, MD; and Sher-Lu Pai, MD

Abstract

Objective: To assess the impact of cessation of screening urine cultures on surgical site infection (SSI) incidence in clinical practice.

Patients and Methods: Our study included patients undergoing hip replacement, knee replacement, spinal fusion, and laminectomy 12 months before (preintervention) and after (postintervention) cessation of preoperative screening urine cultures on June 1, 2017, at our institution. Urine cultures and urinalyses performed within 30 days before surgery during the 12 months before and after cessation were reviewed. SSI surveillance was performed in accordance with the methods of the National Healthcare Safety Network.

Results: A total of 2754 patients were included (1286 preintervention and 1468 postintervention). In the preintervention period, 1141 urine cultures were performed, compared to 153 in the postintervention period; 35 and 6 episodes of asymptomatic bacteriuria were treated, respectively. The occurrence of SSI did not differ noticeably between time periods (1.2% vs 0.7%, P=.24), and quarterly incidences of SSI were unchanged. The rate of SSI was significantly lower in the postintervention period for laminectomy (3.0% vs 0.3%, P=.02).

Conclusion: An 86.6% (153 vs 1141) reduction in screening urine cultures over a 12-month period was associated with a reduction of 988 unnecessary urine cultures, an 82.8% (6 vs 35) decline in inappropriate antibiotic treatment of asymptomatic bacteriuria, and no increase in SSI incidence after hip replacement, knee replacement, spinal fusion, or laminectomy procedures. No value of screening urine cultures before clean surgery was identified.

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From the Division of Infectious Diseases (W.C.H., W.B.); the Department of Urology (D.A.H.); the Division of Biomedical Statistics and Informatics (M.G.H.); the Division of General Internal Medicine (J.M.I.A.); and the Department of Anesthesiology and Perioperative Medicine (J.M.I.A., S.-L.P.), Mayo Clinic, Jacksonville, FL.

Preoperative screening urine culture and urinalysis are not recommended before non-urologic surgery in guidelines supported by the Infectious Disease Society of America[1,2] and the American Society of Anesthesiologists.[3] Although no surgical society in the United States has advised against this guidance, it has not been universally integrated into practice. Specific concerns for surgical site infection (SSI) are often raised with respect to clean surgical procedures during which implants are placed, but attempts to identify the value of screening for bacteriuria before vascular surgery,[4] orthopedic surgery,[5] and neurosurgery[6] have not been successful.

In the spring of 2016, a recommendation was brought to our surgical practice committee to cease collection of screening urine cultures before non-urologic surgery. This recommendation was accepted on the understanding that the impact on practice, specifically the impact on SSI incidence after clean implant surgery, would be assessed. A comprehensive SSI surveillance program was in place well before this practice change. Based on surgical volumes and the magnitude of concerns voiced by different surgical groups, SSI incidences after hip replacement (HPRO), knee replacement (KPRO), spinal fusion (FUSN), and laminectomy (LAM) were

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selected for monitoring, recognizing that LAM procedures without fusion did not involve implantation of foreign material.

The primary aim of our study was to assess SSI incidence following HPRO, KPRO, FUSN, and LAM before and after cessation of screening preoperative urine culture. A secondary objective was to describe the impact of this practice change on management of preoperative asymptomatic bacteriuria (ASB).

PATIENTS AND METHODS

The preoperative evaluation clinic ceased collection of screening urine cultures before non-urologic surgery on June 1, 2017. The 12-month periods before (June 1, 2016, through May 31, 2017) and after (June 1, 2017, through May 31, 2018) were designated the pre- and postintervention periods, respectively.

We reviewed results of culture and urinalysis of urine specimens collected 30 d before HPRO, KPRO, FUSN, and LAM procedures performed from June 1, 2016, through May 31, 2018. Medical charts of patients whose urine cultures yielded growth of 10,000 colony-forming units (CFUs)/mL or more were reviewed (by D.A.H. or W.C.H.) for documentation of urinary frequency, urinary urgency, dysuria, or suprapubic pain at time of collection of the urine specimen. Those with one or more of these symptoms were assessed as having urinary tract infection and those without were assessed as having ASB. The same review and assessment was made for patients whose urinalyses showed moderate or heavy leukocyte esterase with growth of less than 10,000 CFUs/mL in the accompanying urine culture. Surveillance for SSI following HPRO, KPRO, FUSN, and LAM procedures was performed in accordance with the methods of the National Healthcare Safety Network.[7] Information on SSI outcome was collected through August 30, 2018. Patient and operative characteristics of the HPRO, KPRO, FUSN, and LAM procedures performed during the pre- and postintervention periods were collected and compared, including the National Nosocomial Infection Surveillance risk score, in which single points (maximum 3) were added for contaminated or infected surgical wounds; an American Society of Anesthesiology score of 3 or greater; or operative time exceeding the 75th percentile by procedure.[8] Strategies to reduce the risk of SSI through avoidance of hair removal at the operative site with razors, selection and application of surgical skin antisepsis, selection and administration of perioperative antibiotic prophylaxis, intraoperative body temperature control, and perioperative glucose control were unchanged from 2014 through 2018. Preoperative *Staphylococcus aureus* decolonization before HPRO and KPRO was introduced in January 2016 and remained in place through the pre- and postintervention periods.

Statistical Analysis

Continuous variables were summarized with sample median and interquartile range. Categorical variables were summarized with number and percentage of patients. Comparisons of patient and operative characteristics between the pre- and postintervention periods were made using the Fisher exact test (categorical characteristics) or Wilcoxon rank sum test (continuous or ordinal characteristics). Both in the overall sample and separately by surgery type, the proportions of patients who developed an SSI were compared between the pre- and postintervention time periods using the Fisher exact test. For patients who had more than one procedure during the study time, only the first procedure was included to satisfy the statistical assumption of independent measurements. *P* values less than .05 were considered statistically significant, and all statistical tests were two-sided. Statistical analyses were performed using SAS, version 9.4 (SAS Institute, Inc, Cary, NC).

Institutional Review

The methods of our investigation were assessed in accordance with the Code of Federal Regulations, 45 CFR 46.102, and determined not to require review by the Mayo Clinic Institutional Review Board.

RESULTS

During the study period, 3089 FUSN, HPRO, KPRO, and LAM procedures were performed on 2771 patients: 1377 procedures on 1294 patients preintervention and 1712 procedures on 1477 patients postintervention. Eighty-four patients underwent emergency surgery (44 preintervention, 40 postintervention); these patients were not included as they may not have had the opportunity to undergo screening urine studies before surgery. A small number of patients (17, including 8 preintervention and 9 postintervention) did not survive the surveillance period for SSI postoperatively. Patient and operative characteristics of 2754 patients (1286 preintervention, 1468 postintervention) undergoing their first HPRO, KPRO, FUSN, or LAM procedure during the pre- or postintervention periods and who were alive at the end of postoperative surveillance for SSI are provided in Table 1. There were no notable differences in age, sex, distribution of procedures, or National Nosocomial Infection Surveillance risk scores between the two periods.

Results of the preoperative urine cultures and urinalyses performed during the pre- and postintervention periods are provided in Table 2. More than 90% of specimens were midstream collections from ambulatory patients. A total of 1141 specimens were submitted for culture during the preintervention period, whereas only 153 were submitted during the postintervention period. Incomplete adherence to the expected clinical practice during both periods was often due to preoperative assessments being performed by providers outside of the preoperative evaluation clinic. A total of 35 patients were treated for ASB during the preintervention period compared with 6 postintervention. Eleven patients had urinary tract infections identified by urine culture during the preintervention period versus none during the postintervention period. Reviews of medical records found that the results of the urine cultures were present at the time of preoperative assessment during both periods and appeared to influence identification and characterization of voiding symptomatology. When urine cultures yielding 10,000 CFUs/mL or more were acknowledged in provider notes, comments indicating the presence of urinary tract infection symptomatology were often found during the preintervention period, whereas comments indicating the absence of those symptoms were often found during the postintervention period. Similar differences were observed between the pre- and postintervention periods when moderate or high leukocyte esterase in urinalysis without growth of 10,000 CFUs/mL or more in the accompanying urine culture was acknowledged in provider notes. No patients required rescheduling of their surgery due to the results of preoperative urine studies during either period, and no patients developed *Clostridioides difficile* infection.

As shown in Table 3, the incidence of SSI was not significantly different between the pre- and postintervention periods (1.2% vs 0.7%, P=.24). Three SSIs in the preintervention period (1 KPRO, 2 LAM) and two in the postintervention period (1 FUSN, 1 KPRO) were superficial. The rest were deep or organ-space. When examining each surgery type separately, there was a significant decrease in the occurrence of SSI in the postintervention period for LAM (3.0% vs 0.3%, P=.02). Factors that may have contributed to this difference include unassessed differences in patient characteristics, responses of surgeons to feedback of SSI incidence (a component of the SSI surveillance program during both periods), and differences in detection of superficial SSIs between the 2 periods. The incidences of deep or organ-space SSI after LAM procedures in the pre- and postintervention periods were 2.3% vs 0.3% (P=.06). There

TABLE 1. Patient and Operative Characteristics[a]

Characteristic	Preintervention (n=1286)	Postintervention (n=1468)	P value[b]
Age, y, median (IQR)	66 (58-74)	66 (57-73)	.14
Sex, male, n (%)	597 (46.4)	698 (47.5)	.57
Surgery type, n (%)			.10
FUSN	195 (15.2)	272 (18.5)	
HPRO	377 (29.3)	393 (26.8)	
KPRO	450 (35.0)	508 (34.6)	
LAM	264 (20.5)	295 (20.1)	
NNIS risk score, n (%)			.13
0	496 (38.6)	524 (35.7)	
1	599 (46.6)	688 (46.9)	
2	185 (14.4)	252 (17.2)	
3	6 (0.5)	4 (0.3)	
Surgery duration, median (IQR)	101 (85-141)	110 (90-153)	.37

[a]FUSN = spinal fusion; HPRO = hip replacement; IQR = interquartile range; KPRO = knee replacement; LAM = laminectomy; NNIS = National Nosocomial Infection Surveillance System.
[b]P values result from Fisher exact test (categorical variables) or a Wilcoxon rank sum test (continuous or ordinal variables).

TABLE 2. Preoperative Urine Cultures and Urinalyses[a]

Urine study	Preintervention	Postintervention
Urine cultures	1141	153
>100,000 CFUs/mL growth	84	21
Asymptomatic bacteriuria	77	21
Treated with antibiotics	27	6
Urinary tract infection	6	0
Treated with antibiotics	6	0
10,000-100,000 CFUs/mL growth	20	5
Asymptomatic bacteriuria	15	5
Treated with antibiotics	8	0
Urinary tract infection	5	0
Treated with antibiotics	4	0
Urinalysis with moderate to large esterase with <10,000 CFUs/mL growth in urine culture	101	18
Asymptomatic pyuria	94	18
Treated with antibiotics	3	2
Urinary tract infection	7	1
Treated with antibiotics	1	0

[a]CFU = colony-forming unit.

were no changes in surgeons or surgical methods between the pre- and postintervention periods.

Two patients who sustained SSIs during the preintervention period (1 HPRO organ-space SSI, and 1 FUSN deep SSI) and 1 who sustained an SSI during the postintervention period (KPRO organ-space SSI) had preoperative urine cultures yielding 10,000 CFUs/mL or more of growth. For all three

TABLE 3. Comparison of the Incidence of SSI Between Pre- and Postintervention Periods[a]

	Preintervention period		Postintervention period		
Patient Group	N	n (%) of patients with an SSI	N	n (%) of patients with an SSI	*P* value[b]
All patients	1286	16 (1.2)	1468	11 (0.7)	.24
FUSN	195	1 (0.5)	272	1 (0.4)	1.00
HPRO	377	3 (0.8)	393	0 (0.0)	.12
KPRO	450	4 (0.9)	508	9 (1.8)	.28
LAM	264	8 (3.0)	295	1 (0.3)	.02
Quarter 1[c]	333	4 (1.2)	340	3 (0.9)	.72
Quarter 2[c]	276	2 (0.7)	311	2 (0.6)	1.00
Quarter 3[c]	326	8 (2.5)	380	4 (1.0)	.24
Quarter 4[c]	351	2 (0.6)	434	2 (0.5)	1.00

[a]FUSN = spinal fusion; HPRO = hip replacement; KPRO = knee replacement; LAM = laminectomy; SSI = surgical site infection.
[b]*P* values result from Fisher exact test.
[c]Quarter 1 = June-August; Quarter 2 = September-November; Quarter 3 = December-February; Quarter 4 = March-May.

patients, the bacteria recovered in the urine cultures (ie, *Klebsiella* species, *Streptococcus agalactiae*, *Escherichia coli*) differed from the bacteria recovered in the SSIs (*Proteus mirabilis*, *Klebsiella oxytoca*, *Staphylococcus aureus*).

DISCUSSION

Clinical guidance at our institution to cease preoperative screening urine culture before nonurologic surgery led to an 86.6% (153 vs 1141) reduction in this practice among patients undergoing HPRO, KPRO, FUSN, and LAM, without an increase in SSI incidence. Nearly 1000 fewer urine specimens were collected for culture before these procedures during the 12-month postintervention period. Assuming a commensurate decline across all 6659 patients (3905 inpatient, 2754 outpatient) undergoing clean surgical procedures at our institution during the postintervention period, more than 5000 fewer preoperative urine specimens (1141/1286×6659 vs 153/1468×6659) were collected for culture, resulting in a substantial reduction in the burden of care for patients and providers alike. Reduction of preoperative screening urine culture led to an 82.8% (6 vs 35) reduction in patients being unnecessarily treated for ASB before HPRO, KPRO, FUSN, or LAM during the postintervention period. Assuming a commensurate decline in collection of preoperative screening urine culture, similar prevalence of ASB, and an unchanged likelihood of antibiotic treatment across the entire clean surgical practice, 154 fewer patients were unnecessarily treated for ASB during the postintervention period (35/1286×6659 vs 6/1468×6659).

Study Limitations

There are several limitations to our report in addition to its single-center setting and retrospective design. Adherence to nonoperative care designed to reduce the risk of SSI was not assessed, and changes in that adherence may have influenced SSI incidence in both periods. As we did not perform a washout period following practice guidance to stop screening urine cultures before nonurologic surgery, some patients undergoing surgery in June 2017 did have preoperative urine cultures performed in May 2017 before a change of practice was requested. Additionally, although the sample size of the study was large, the number of patients who developed an SSI was fairly small. Therefore, the possibility of a type II error (ie, false-negative finding) with respect to our reported lack of association of SSI incidence with cessation of preoperative screening urine culture is to be considered. Finally, a relatively small number of patients who died before completing the period for SSI surveillance after their surgery in the pre- or postintervention period were excluded from analysis of SSI incidence. In our estimation, these limitations do not challenge our conclusions.

CONCLUSION

Our study confirms the safety of deferring preoperative screening urine culture in patients undergoing HPRO, KPRO, FUSN, or LAM. It also shows an important opportunity to reduce unnecessary patient testing and exposure to antibiotics, which can lead to an increased risk of adverse drug reactions, development of antibiotic-resistant pathogen colonization, and *C. difficile* infection. Cessation of screening urine cultures before these surgeries is safe, eliminates waste, and increases the value of care we deliver to our patients. We have no reason to believe that these benefits do not extend to all patients undergoing clean non-urologic surgical procedures.

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Abbreviations and Acronyms: **ASB** = asymptomatic bacteriuria; **CFU** = colony-forming unit; **FUSN** = spinal fusion; **HPRO** = hip replacement; **KPRO** = knee replacement; **LAM** = laminectomy; **SSI** = surgical site infection

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Correspondence: Address to Walter C. Hellinger, MD, Division of Infectious Diseases, Mayo Clinic, 4500 San Pablo Rd, Jacksonville, FL 32224 (hellinger.walter@mayo.edu).

ORCID

Walter C. Hellinger: https://orcid.org/0000-0001-5518-7405; Daniela A. Haehn: https://orcid.org/0000-0001-6819-7493; Sher-Lu Pai: https://orcid.org/0000-0002-4446-3993

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