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State of the Science Review

Promoting appropriate urine culture management to improve health care outcomes and the accuracy of catheter-associated urinary tract infections

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Published literature indicates that the unjustified ordering or improper collection of urine for urinalysis or culture from either catheterized patients or those without indwelling devices, or misinterpretation of positive results, often leads to adverse health care events, including increased financial burdens, overreporting of mandated catheter-associated urinary tract infection events, overtreatment of patients with antimicrobial agents, selection of multidrug-resistant organisms, and *Clostridium difficile* infection. Moreover, national guidelines that provide evidence-based direction on core processes that form the basis for subsequent clinical therapy decisions or surveillance interpretations; that is, the appropriate ordering and collection of urine for laboratory testing and the treatment of patients with symptomatic urinary tract infection, are not widely known or lack adherence. This article provides published evidence on the influence of inappropriate ordering of urine specimens and subsequent treatment of asymptomatic bacteriuria and associated adverse effects; reviews research on bacterial contamination and preservation; and delineates best practices in the collection, handling, and testing of urine specimens for culture or for biochemical analysis in both catheterized and noncatheterized patients. The goal is to provide infection preventionists (IPs) with a cohesive evidence-based framework that will assist them in facilitating the implementation of a urine culture management program that reduces patient harms, enhances the accuracy of catheter-associated urinary tract infection surveillance, improves antibiotic stewardship, and reduces costs.

Since the Institute of Medicine report "To Err is Human" 19 years ago,[1] hospitals across the United States have modified practices and conducted extensive educational programs aimed at enhancing patient safety. In response to the occurrence of harms, hospital executives have become aware of the importance of not only creating a culture of safety, but also creation of a culture of systems; that is, a culture in which systems of care are carefully assessed, standardized across organizations, and change effectively over time.[2,3] The competency model for infection preventionists (IPs) contains domains needed for instituting successful practices, such as performance improvement and implementation science. The competency model is an essential tool for ". . .translating evidence into practice, addressing gaps between theory and practice, and serves as a useful clinical model to accomplish improvement in safety, quality, and effectiveness of patient care."[4]

Urinary tract infections (UTIs) are among the most common infections in adults,[5] accounting for nearly 10 million health care visits[6] and 100,000 hospitalizations annually.[7] A subset of UTIs, catheter-associated UTIs (CAUTIs), account for up to 25% of health care-associated infections,[8] with more than 35,600 events reported by acute care hospitals to the National Healthcare Safety Network (NHSN) in 2013.[9] In addition, unjustified ordering or improper collection of urine for urinalysis (UA) or culture from either catheterized patients or those without indwelling devices, or misinterpretation of positive results, often leads to adverse health care events, including increased financial burdens,[10] overreporting of mandated CAUTI events,[11] overtreatment of patients with antimicrobial agents,[12] selection of multidrug-resistant organisms (MDROs),[13] and *Clostridium difficile* infection (CDI).[14] Moreover, national guidelines that provide evidence-based direction on core processes that form the basis for subsequent clinical therapy decisions or surveillance interpretations; that is, the appropriate ordering and collection

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of urine for laboratory testing and the treatment of patients with symptomatic UTI, are not widely known or lack adherence.[15-18]

The purpose of this article is to provide published evidence on the influence of inappropriate ordering of urine specimens and subsequent treatment of asymptomatic bacteriuria (ASB) and associated adverse effects; review research on bacterial contamination and preservation; and delineate best practices in the collection, handling, and testing of urine specimens for culture or for biochemical analysis in both catheterized and noncatheterized patients. The review focuses on adult patients and does not address issues related to neonatal, pediatric, or specialized populations such as transplant patients or those receiving chemotherapy. The goal is to provide IPs with a cohesive evidence-based framework that will assist them in facilitating the implementation of an innovative health care program that reduces patient harms, enhances the accuracy of CAUTI surveillance, improves antibiotic stewardship, and reduces costs.

DEFINITIONS

The existence of varied definitions for symptomatic and asymptomatic UTI can cause disagreements between clinicians and IPs when they attempt to diagnose and/or categorize individual cases. For example, a nonpregnant catheterized female patient presenting with symptomology of a UTI, an abnormal UA, and a urine culture (UC) of $\geq 10^3$ CFU/mL gram-negative bacteria might be diagnosed as having a clinically significant CAUTI based on Infectious Diseases Society of America (IDSA) guidelines.[15] Prior NHSN CAUTI definitions would also have categorized this patient with a reportable CAUTI. However, according to the revised NHSN 2015 CAUTI definition, an IP would not classify this event as a reportable health care-associated infection because the criterion now requires the bacterial colony count to be a minimum of $\geq 10^5$ CFU/mL. This 2-log (100-fold) increase in the threshold for the colony count is among several changes that were introduced in this revision to simplify and increase the specificity of CAUTI surveillance definitions.[19] Conversely, a patient with an indwelling urinary catheter exhibiting fever and identified with $\geq 10^5$ CFU/mL *Escherichia coli* in a UC fulfills NHSN CAUTI surveillance criteria but may not be considered to be a clinical UTI if the patient has a secondary condition causing the fever. Table 1 illustrates the variety of clinical and epidemiologic definitions currently used in health care institutions to assist in diagnosing patients and to determine reportable conditions. Regardless of which definition is being used, a UC comprises the core element of each definition and it must be ordered judiciously, and collected and handled in a manner that increases the accuracy of the outcome.

REASONS FOR INAPPROPRIATE UC AND UA ORDERING

Understanding the underlying reasons why clinicians and nurses order and collect urine specimens is fundamental to formulating an improvement strategy. A recent survey of resident physicians (100 out of 280 responded) used clinical management vignettes to gauge knowledge deficits in urine testing and management.[21] Questions were posed based on commonly encountered scenarios, including elderly patients with confusion, preoperative screening, ASB in a patient undergoing transurethral resection of the prostate, and patients with cloudy urine in the drainage bag. The authors reported a poor overall mean percentage of correct answers of 48%. Questions directed at treatment of ASB were answered correctly only 23% of the time. Further evidence examining potential underlying causes for inappropriate ordering of UCs is found in the exploration of the perceptions of focused groups consisting of physicians and nurses caring for institutionalized elderly patients.[22] A primary finding of the study was that treatment for nonspecific indicators of UTI was common, often considered due to a patient's inability to articulate his or her symptoms; however, there is no evidence in guidelines to support the ordering of UCs and treating positive cultures for patients other than those who are symptomatic. Another survey of medicine and surgery resident physicians reiterated the finding that UCs are often ordered for inappropriate indications, including foul-smelling urine, cloudy or dark urine, or hematuria.[23]

Nurses' knowledge, training, and practices regarding the appropriate reasons for the collection of UCs in catheterized patients was assessed in a 2016 published survey conducted in 5 hospitals of a health care system.[24] Of the 19 questions directed at determining which conditions trigger the collection of a UC on a catheterized patient, a total of 12 (63.2%) were answered incorrectly; that is, did not conform to published clinical guidelines.[15] Among the incorrect selections were collection of urine when foul-smelling or cloudy, during routine catheter insertion, and chronic catheterization on admission. Of interest, the authors found that although 83% of all nurses indicated that they never obtain a urine sample from a drainage bag, only 58.4% reported observing others being compliant with this collection standard.

Identifying complex behaviors contributing to unnecessary urine collection in an emergency department study by using frontline ownership methodology uncovered several issues that may reflect typical practice in many hospitals.[25] Poor compliance with published UC guidelines,[15] staff practice based on outdated policies, the inclusion of urine collection containers in catheterization kits encouraging inappropriate collection, and manual point-of-care urine testing all were contributors to inappropriate UC collection.

EVIDENCE OF INAPPROPRIATE ORDERING OF UC AND UA TESTING

Examples of hospital-based studies documenting the ordering of urine for testing without appropriate clinical reasons are found in the literature. Medical records of a randomly selected group of newly admitted patients over a period of 1 year at the University of Michigan Health System were examined for adherence to guideline recommendations when ordering UCs.[26] Results of the study indicated several glaring findings: of 208 patients in the study, 120 (57.7%) did not meet guideline-based criteria for a UC; 62.5% of those had a reason for culturing that was inappropriate; no documented reason for ordering the UC was found in 37.5% of patients; specific clinical indications were documented in only 23.9% of patients; and for patients meeting criteria, fever was the sole indication for obtaining a UC in nearly three-quarters. In another study conducted at 2 hospitals, it was reported that 68% of UCs were ordered without clinical indication, including 21% from catheterized patients.[27]

A significant number of urine screening tests originate in hospital emergency departments. One group of researchers at a large, tertiary care center retrospectively studied the appropriateness of UA orders on admission to a general medicine service of an emergency department.[28] Assessment of these cases included whether the patient exhibited symptoms of UTI. The study found that the majority of the 198 patients who had UA orders did not have symptoms of a UTI. More importantly, 21.8% of asymptomatic patients who had a positive UA received empirical antibiotic therapy. Likewise, in another emergency department-based examination of UA and UC in elderly patients, results indicated that positive UC rates were only slightly higher in patients exhibiting vague symptoms of UTI than they were in asymptomatic patients treated for nonurologic problems. This suggests that many positive UCs in elderly patients without UTI symptomology were false-positive tests in that they represented ASB and not UTI.[29] These results are not unique. In a third study of 195 emergency department patients who had UAs ordered, the authors reported that 43% had nonspecific signs or symptoms and 19% had no symptoms at all. Physicians ordered