A THREE YEAR REVIEW OF CATHETER-ASSOCIATED URINARY TRACT INFECTIONS REPORTED TO THE NATIONAL HEALTHCARE SAFETY NETWORK AT A TERTIARY CARE HOSPITAL

by

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ABSTRACT

Background: Catheter-associated urinary tract infections (CAUTI) are one of the most common hospital-associated infections. Recent efforts to characterize the etiology and reduce incidence of CAUTIs have been spurred by the Centers for Medicare and Medicaid Services (CMS) decision to cease reimbursement for CAUTI. To have a national standardized definition for CAUTI for national improvement efforts and public reporting, many agencies including CMS, have opted to use the National Healthcare Safety Network (NHSN) CAUTI definition. The NHSN CAUTI definition was developed for surveillance efforts and therefore does not necessarily reflect clinical practice.

Objectives: The objective of this study is to determine the extent to which NHSN reported CAUTI events correspond with clinician diagnosis of CAUTI at a University-Affiliated Tertiary Care Hospital.

Methods: This study is a retrospective chart review analysis of all CAUTI events reported to NHSN from July 1, 2010 through June 30, 2013. Patient medical records were reviewed to determine clinician and Infectious Disease (ID) consultant CAUTI diagnosis.

Results: A total of 102 NHSN CAUTI events were reported over the 3-year period. Of these, 66.67% meet the clinician CAUTI diagnosis and 41.67% meet the ID consult CAUTI diagnosis.

Conclusions: These results suggest a poor correlation between NHSN reported CAUTI events and actual clinical practice, with only two thirds of the NHSN reported CAUTI events being diagnosed by a clinician and only 42% being diagnosed by an Infectious Disease consultant. As long as the NSHN-CAUTI definition is used for public reporting, it is important to realize that the reported rates are not necessarily reflective of infectious complications of urinary catheters or clinical diagnosis. Instead, these rates should be evaluated to identify areas for improvement within the reporting facilities and when addressing national improvement efforts.

Public Health Significance: The NHSN CAUTI definition was developed for surveillance purposes and is therefore very broad to capture all possible CAUTI events. Since the NHSN surveillance definition is being used for public reporting, the reported CAUTI rates may be artificially inflated and thus may not truly reflect patient care at any given hospital. This makes it difficult for a consumer to legitimately compare hospitals when determining where to receive care, as the rate may be more reflective of the frequency of obtaining urine cultures than of actual CAUTI events.

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1.0 INTRODUCTION

Urinary tract infections (UTIs) are one of the most commonly reported hospital-acquired infections (HAI), accounting for 15% to 30% of all HAI reported by hospitals [1, 2]. The National Healthcare Safety Network (NHSN) reports that nearly 75% of UTIs acquired in hospitals are associated with urinary catheters [3]. Indwelling urinary catheters are often essential in critically ill patients and are used in 65% of patients in Critical Care Units (CCU) and in approximately 20% patients on the general wards [3]. The use of urinary catheters is warranted in many cases, but many catheters are used unnecessarily and for prolonged periods of time [4, 5]. Inappropriate use of urinary catheters puts patients at an increased risk for both infectious and noninfectious complications [6, 7], leads to overuse of antimicrobials and contributes to the rise of antimicrobial resistance, and increases healthcare costs [8, 9].

Recent efforts to characterize the etiology and reduce the incidence of CAUTI have been spurred by the Centers for Medicare and Medicaid Services (CMS) decision to no longer reimburse hospitals for CAUTI as it was determined to be a preventable HAI [10]. CMS has also recently establish rules for public reporting of CAUTI events in critical care units, inpatient rehabilitation facilities and long term care hospitals as of 2012 as well as all medical/ surgical wards by January 2015 [11]. To have a national

standardized definition for CAUTI for national improvement efforts and public reporting, many agencies including CMS, have opted to use the NHSN CAUTI definition.

The NHSN definition of CAUTI was developed for use in surveillance and, for this reason, is very broad to ensure that it captures all hospital acquired CAUTI events and therefore does not necessarily take clinical definitions into account. Because the NHSN definition is so sensitive, it has the potential gather false CAUTI events, which may result in a poor predictive value (PPV) for identifying true CAUTI. In fact, a recent study found that the NHSN CAUTI definition has a PPV of 35% when using the Infectious Disease physician diagnosis of CAUTI as the gold standard and PPV of 62.2% when compared to clinician diagnosis of CAUTI [12].

The purpose of this study is to determine the extent to which NHSN reported CAUTI events correspond with clinician diagnosis of CAUTI over a three-year period within a University-Affiliated Tertiary Care Hospital in the state of Pennsylvania. Secondary aims of the study are to describe the incidence and etiology of CAUTI and to characterize the patient population that experience said CAUTI events.

2.0 BACKGROUND

2.1 NHSN AND INFECTION CONTROL

The National Healthcare and Safety Network (NHSN) is an internet-based surveillance system to track healthcare associated infections that is managed by the Division of Healthcare Quality Promotion at the Centers for Disease Control and Prevention [13]. Healthcare facilities that participate in reporting programs operated by the Centers for Medicare and Medicaid Services (CMS) can do so through use of NHSN. In addition, some U.S. states, such as Pennsylvania, utilize NHSN as a means for healthcare facilities to submit data on healthcare associated infections mandated through state legislation.

2.1.1 Surveillance

Enrollment in NHSN is optional and healthcare facilities can choose which modules they participate in (ex. urinary tract infections and catheter-associated urinary tract infections, pneumonia and ventilator-associated pneumonia, *Clostridium difficile* infections, surgical site infections, blood stream infections and catheter-associated blood stream infections, etc). Most modules require active, patient-based, prospective surveillance of events and their corresponding denominator data (ex. catheter days) by a trained Infection Preventionist (IP). IPs are highly trained experts working in healthcare facilities that conduct active surveillance of HAIs using standardized surveillance definitions created

by NHSN. In addition, most IPs provide patient and staff education and participate in process improvement projects. During a patient's stay, IPs actively seek out infections by screening a variety of data sources, such as laboratory, pharmacy, admission/discharge/transfer, radiology/imaging, and pathology databases, as well as patient charts, including history and physical exam notes, nurses/physicians notes, temperature charts, etc. to identify any healthcare-associated infections.

2.2 CATHETER-ASSOCIATED URINARY TRACT INFECTIONS

2.2.1 Definitions

NHSN defines a healthcare-associated infection (HAI) as a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) that was not present on admission to the acute care facility and occurs on or after the third calendar day of admission [14].

Catheter-associated UTI (CAUTI) is defined by NHSN as a 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, a*nd* at least 1 of the following signs or symptoms: fever (>38°C); urgency; frequency; dysuria; suprapubic tenderness; costovertebral angle pain or tenderness *and* a positive urine culture of $\geq 10^3$ colony-forming units (CFU)/ml with no more than 2 species of microorganisms. 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 [14] (for a complete definition, see Appendix A).

An indwelling catheter is defined by NHSN as a drainage tube that is inserted into the urinary bladder through the urethra that is left in place, and is connected to a drainage bag (including leg bags), also called a Foley catheter. This does not include condom or straight in-and-out catheters or nephrostomy tubes or suprapubic catheters.

Although this study focuses on CAUTI events reported to NHSN using NHSN definitions for identifying a CAUTI event, it is important to note a few other definitions. In particular, bacteriuria and asymptomatic bacteriuria (ASB). According to the Infectious Diseases Society of America (IDSA), bacteriuria is a significant amount of bacteria in urine, which is usually considered to be $\geq 10^3$ cfu/ml for a catheterized specimen and $\geq 10^5$ cfu/ml for non-catheterized specimens. IDSA defines a UTI as significant bacteriuria in a patient with symptoms or signs attributable to the urinary tract and no alternate source. Asymptomatic bacteriuria (ASB) is defined as significant bacteriuria in a patient without symptoms or signs attributable to the urinary tract [15].

Several studies have found that asymptomatic bacteriuria (ASB) will be present in virtually every long-term catheter user once the catheter has been in place > 30 days [16, 17] and approximately 75% to 90% of patients with ASB will not develop a systemic inflammatory response or other signs or symptoms attributable to a UTI [18, 19]

2.2.2 Signs and Symptoms

NHSN lists signs and symptoms of a UTI or CAUTI as the one or more of the following: fever (>38°C); urgency*; frequency*; dysuria*; suprapubic tenderness*; costovertebral angle pain or tenderness*[14]. The starred symptoms can only be used to define a CAUTI event if those symptoms cannot be attributable to any other cause. Note: if fever is

present, it is always used to define a CAUTI event, even if it can be attributed to another cause.

According to the Infectious Diseases Society of America (IDSA) 2009 Guidelines for the Diagnosis, Prevention, and Treatment of Catheter-Associated Urinary Tract Infection in Adults; CAUTI is defined by the presence of symptoms or signs compatible with UTI with no other identified source of infection along with $\geq 10^3$ colony-forming units (cfu)/mL of ≥1 bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral catheter has been removed within the previous 48 hours [15] (for complete IDSA definition, see Appendix B).

IDSA lists signs and symptoms compatible with UTI or CAUTI as one or more of the following: new onset or worsening of fever, rigors, altered mental status, malaise, or lethargy with no other identified cause, flank pain, costovertebral angle tenderness, acute hematuria, pelvic discomfort, and in those whose catheters have been removed; dysuria, urgent or frequent urination, or suprapubic pain or tenderness. In patients with spinal cord injury, increased spasticity, autonomic dysreflexia, or sense of unease are also compatible with CAUTI [15].

In addition, the IDSA CAUTI guidelines state that pyuria (≥ 10 WBC/mm^3 in unspun urine or >5 WBC/ hpf (high power field) in spun urine found in a urine specimen is not considered to be diagnostic of CA-bacteriuria or CAUTI and the presence or absence of pyuria should not be used to differentiate CA-ASB from CAUTI nor should pyuria be considered as an indicator for antimicrobial treatment of CA-ASB. Also, in catheterized patients, the presence or absence of odorous or cloudy urine alone should not

be used to differentiate CA-ASB from CAUTI or as an indication for urine culture or antimicrobial therapy [15].

Many studies have found that symptoms are not reliable for the diagnosis of CAUTI. In a large prospective study by Tambyah et al, the authors were unable to demonstrate a difference between symptomatic CAUTI and asymptomatic bacteriuria in the presence of fever or symptoms related to the urinary tract in catheterized patients with or without CA-asymptomatic bacteriuria [20]. Tambyah et al. states that the urinary catheter itself can often be the source of symptoms, as the proportion of catheterized patients without CAUTI that experienced symptoms was similar to those with CAUTI.

It has been found that many patients with a urinary catheter do not experience any of the typical symptoms associated with a UTI such as dysuria or supra-pubic pain because the catheter itself prevents contact of inflammatory cells in urine and large numbers of microorganisms with the urethral mucosa [21]. The presence of the urinary catheter also allows for decompression of the bladder and therefore prevents symptoms related to bladder distension or reflux [21]. Interestingly, it has also been shown that febrile episodes rarely occur in patients with long-term indwelling catheters even though they experience significant amounts of bacteriuria [22, 23]. Likewise, in a retrospective cohort study of patients who had experienced trauma, neither fever nor leukocytosis was associated with CAUTI [24]. The authors concluded that there was an unnecessary emphasis on UTI as a source of fever and leukocytosis in patients hospitalized in the intensive care unit (ICU).

In March of 2012, the CDC/NHSN sent out a newsletter stating that fever can be attributed to many different HAIs, such as CAUTI and pneumonia, and it is often

impossible to distinguish which infection is the root cause so the fever must be attributed to all possible causes [25]. This change in definition was an attempt to prevent healthcare facilities from selectively choosing which type of HAI to attribute the fever to, however, this may cause more physicians to diagnose and treat patients for a CAUTI even though the patient may have CA-bacteriuria and the fever is due to another reason. This also has the potential to lead to an increased number of CAUTI events being falsely reported to NHSN and CMS and subsequently hospitals performance scores.

2.2.3 Treatment

IDSA suggests a urine specimen for culture should be obtained prior to initiating antimicrobial therapy for a presumed CAUTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance [15]. The IDSA guidelines also specifically state "catheterized patients should be thoroughly evaluated for the source of signs and symptoms before attributing them to the urinary tract and initiating antimicrobial therapy"[15]. IDSA recommends the following treatment guidelines for patients found to have CAUTI [15]:

Seven days is the recommended duration of antimicrobial treatment for patients with CAUTI who have prompt resolution of symptoms, and 10–14 days of treatment is recommended for those with a delayed response, regardless of whether the patient remains catheterized or not.

i. A 5-day regimen of levofloxacin may be considered in patients with CAUTI who are not severely ill. Data are insufficient to make such a recommendation about other fluoroquinolones.

ii. A 3-day antimicrobial regimen may be considered for women aged ≥65 years who develop CAUTI without upper urinary tract symptoms after an indwelling catheter has been removed.

2.3 EPIDEMIOLOGY AND PATHOGENESIS

The incidence of bacteriuria associated with indwelling catheterization is 3%–8% per catheter day [23, 26-28], with almost universal bacteriuria with long-term catheterization of > 30 days [16, 17]. It has also been found that the duration of catheterization is the most important risk factor for the development of CA-bacteriuria [16, 29]. Other risk factors that have been found to be associated with CA-bacteriuria include not receiving systemic antimicrobial therapy, female sex, microbial colonization of the drainage bag, catheter insertion outside the operating room, catheter care violations, fatal underlying illness, older age, diabetes mellitus and other sites of infection at the time of catheterization [16, 26, 29, 30].

The urinary catheter disrupts host defense mechanisms and allows for easy access of uropathogens to enter the bladder [31, 32]. There are two main modes for microbes to gain entry into the urinary tract during catheterization, that is either extraluminal or intraluminal. Microbes utilize the extraluminal route either at the time of catheter insertion or when perineal bacteria move up along the outer surface of the catheter into the bladder [33]. Microbial entry occurs intraluminally when contaminated urine enters the bladder from the collection bag or when there is a break in the closed drainage system [34]. A prospective study by Tambyah, et al [34] found that 66% of the identified

CAUTIs were extraluminally acquired, 18% occurred early (detected within 24 h) while 48% occurred later (around 6 days after catheterization), and 34% were acquired intraluminally. Infections caused by gram-positive cocci (staphylococci and enterococci) and yeast were mostly extraluminal, whereas gram-negative infections occurred approximately equally through either route. Additionally, patients appear to remain at an increased risk of bacteriuria for at least 24 h even after removal of the catheter [27], which seems to suggest that colonization of the urethra persists even after the catheter is removed.

A urinary catheter also allows for the formation of a biofilm, which is central to the development of CAUTI. Formation of biofilms by microbes on the surface of a urinary catheter and in the drainage system will inevitably occur with long-term catheterization [35]. Initially, biofilms are comprised of one bacterial species, but eventually become polymicrobial with long-term catheterization [15]. The organisms that form these biofilms are often extremely antimicrobial resistant due to the high rate of genetic material exchanged between the organisms comprising the biofilm [36]. In addition to being extremely antimicrobial resistant, microbes within a biofilm are also resistant to host defenses, making them virtually impossible to eradicate without removing the catheter [37].

The majority of organisms that cause CAUTI are commensal perineal, rectal or vaginal flora. However, bacteria acquired from the hands of health-care personnel have also been implicated [38]. The most commonly implicated bacteria associated with CAUTI reported to NHSN (combining both ASB and SUTI) is *Escherichia coli* (21.4%) and Candida *spp.* (21.0%), followed by *Enterococcus spp* (14.9%), *Pseudomonas*

aeruginosa (10.0%), *Klebsiella pneumoniae* (7.7%), and Enterobacter *spp* (4.1%) with a smaller proportion caused by other gram-negative bacteria and *Staphylococcus spp*. [37, 39].

2.4 IMPACT OF CAUTI

2.4.1 Length of Stay

Studies conducted in the early eighties found that the additional length of stay attributable to CAUTI was 2–4 days [40-42]. However, a 2011 meta-analysis of 11 observational studies analyzing outcome of catheter-associated urinary tract infections found that CAUTI was significantly associated with an increased length of stay of 12 days in the intensive care unit (95% CI, 9-15 days) and an increased hospital length of stay of 21 days (95% CI, 11-32 days) [43].

2.4.2 Morbidity and Mortality

There seems to be little consensus on the effect of CA-bacteriuria on mortality. A prospective study by Platt et al [44] reported an adjusted odds ratio of 2.8 for mortality in patients with an indwelling catheter who acquired CA-bacteriuria compared to those who did not. A meta-analysis and review of 11 observational studies found that CAUTI was associated with increased crude mortality, with an odds ratio of 1.99 [43]. This increase in mortality among catheterized patients is thought to be associated with secondary

bacteremia and septicemia [38]. On the other hand, several studies have suggested that the association with mortality is most likely explained by confounding, as most catheterized patients tend to be more sick and functionally impaired [22, 45].

CAUTI can also lead to complications such complications as cystitis, pyelonephritis, periurethral abscess, gram-negative bacteremia, prostatitis, epididymitis, and orchitis in males and, less commonly, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis in all patients [14, 17]

2.4.3 Contribution to the Rise of Antimicrobial Resistance

In general, physicians typically view CAUTI as low risk to patients, with low rates of progression from CAUTI to bactermia or fungemia [19, 46]. However, despite this perception of minimal risk, CAUTI is frequently treated with antimicrobials even in asymptomatic patients, with over one-third of antimicrobial use inappropriately aimed at treatment of asymptomatic bacteriuria [47, 48]. This inappropriate use of antimicrobials may be a contributing factor to the rise in antimicrobial resistant microbes and subsequent increases in healthcare costs.

When a patient is exposed to antimicrobials, it applies selective pressures on bacteria inhabiting the patient and the bacteria will try to develop ways to resist the drug's effects, therefore reducing their susceptibility [49]. Since resistance arises with antibiotic use, it is important to use antibiotics sparingly and only when clinically indicated. Antibiotic use is especially common in healthcare facilities with around 25% of all hospitalized patients receiving antibiotics at least once during their hospitalization [49]. Inappropriate use of antibiotics, including inappropriate dosages and durations, or

treating a patient with antimicrobials when it is not clinically indicated is contributing to the problem of antimicrobial resistance. Studies have shown that "antibiotic use is unnecessary or inappropriate in as many as 50% of cases in the United States." [49]

For this reason, IDSA suggests a urine specimen for culture should be obtained prior to initiating antimicrobial therapy for presumed CAUTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance [15]. As mentioned before, IDSA states that, in the catheterized patient, the presence or absence pyuria or of odorous or cloudy urine alone should not be used as an indication for urine culture or antimicrobial therapy [15]. Although some physicians will treat a patient with antimicrobials based solely on these signs [50].

Because so many episodes of bacteriuria are inappropriately treated with antimicrobials and because of the high rate of biofilm formation and subsequent antimicrobial resistance, CAUTIs are a major reservoir of resistant pathogens [7, 51]. Approximately one quarter of *E. coli* isolates and one third of *P. aeruginosa* isolates from CAUTI cases reported to NHSN were fluoroquinolone-resistant [37]. Resistance of gram-negative pathogens to other antimicrobials, including third-generation cephalosporins and carbapenems, from CAUTI events was also substantial high [39]. The proportion of organisms that were multidrug-resistant, defined by non-susceptibility to all agents in 4 classes, was 4% of P. aeruginosa, 9% of *K. pneumoniae*, and 21% of *Acinetobacter baumannii.* [52].

2.4.4 Costs

According to the US Deficit Reduction Act that went into effect in October 2008, hospitals will no longer receive reimbursement for managing 'reasonably preventable' healthcare-associated infections. The Centers for Medicare and Medicaid Services (CMS) identified hospital acquired CAUTI as one of these eight conditions for which hospitals will not receive additional reimbursement. In a review by Umscheid et al, the authors found that the number of avoidable CAUTIs in the United States ranges from 95,483 to 387,550 infections per year, the potential lives that could be saved ranged from 2,225 to 9,031 annually, and the estimated annual costs of preventable CAUTIs are from $115 million to $1.8 billion [5].

A 27 year literature review and meta-analysis found that each CAUTI event costs the US Health Care System $896 per person for a total of $27,884,193 per year [8]. CAUTIs caused by E. coli cost considerably less ($363.3/ CAUTI event) than infections caused by other gram-negative bacilli ($690.4/ CAUTI event) or yeasts ($821.2/ CAUTI). Similar to CAUTI caused by E. coli, CAUTI caused by staphylococci or enterococci has been shown to cost approximately $387.1/CAUTI event [18, 20]. Another study found that bacteremia associated with CA-bacteriuria is estimated to cost at least $2836 per event [20].

3.0 METHODS

3.1 STUDY OBJECTIVES

The purpose of this study is compare clinician diagnosis of CAUTI to NHSN reported CAUTI events over a three-year period within a University-affiliated Tertiary Care Hospital. Secondary aims of the study are to describe the incidence and etiology of CAUTI and to characterize the patient population that experience said CAUTI events.

3.2 STUDY DESIGN

This study is a retrospective chart review analysis of all patients admitted to a Tertiary Care Hospital (TCH) with a hospital stay of greater than 2 calendar days for which a CAUTI event was reported to the Centers for Disease Control (CDC) through the National Healthcare Safety Network (NHSN) from July 1, 2010 through June 30, 2013.

3.3 STUDY AREA

This study was developed as a quality improvement measure and was approved by the hospital's Quality Improvement Committee. Data collection and analysis was overseen

by the department of Infection Control. The data was collected and analyzed at the TCH and at the University of Pittsburgh.

The TCH is part of a large network of hospitals in Western Pennsylvania. The hospital is a 495-bed facility with many inpatient and outpatient services including, but not limited to: orthopedic surgery, cardiology, neurology, and inpatient rehabilitation. The hospital also serves a Level I Burn and Trauma Center, is equipped with a fully functioning Emergency Department is and is affiliated with a local University.

3.4 STUDY POPULATION

3.4.1 Inclusion Criteria

All patients included in the study are those that were reported to the Centers for Disease Control (CDC) through the National Healthcare Safety Network (NHSN), following NHSN CAUTI definition, by the hospital's Department of Infection Control from July 1, 2010 through June 30, 2013. Trained Infection Preventionists used standardized surveillance definitions to identify all CAUTI events (for a complete definition, please see Appendix A). This includes patients age >18 with a positive urine culture collected more than 48 hours after admission to the hospital with an indwelling urinary catheter or within 48 hours of catheter removal.

3.4.2 Exclusion Criteria

Patients excluded from this study are those that were initially excluded by Infection Preventionists when the CAUTI events were originally reported to NHSN following NHSN CAUTI guidelines. Patients with a positive urine culture within 48 hours of admission were excluded to avoid including patients that were admitted with a UTI. Patients with condom or suprapubic catheters and patients that were intermittently catheterized were also excluded form the study.

3.5 DATA COLLECTION

Patient information was accessed via e Record and medical charts were carefully reviewed using Cerner's PowerChart, Epic, and Theradoc. Admission notes, nurses' observation notes, history and physical notes, progress notes, Infectious Disease consultation notes, and discharge summary for each patient encounter were reviewed to extract patient demographics and relevant clinical and laboratory data. Data extracted was recorded in an Excel document.

3.5.1 Demographic and Clinical Data Collection

Demographic data collected includes age, race, gender, comorbidities as determined by the Charlson Comorbidity index, reason for admission, prior hospitalization within the previous year, location before admission, discharge disposition, length of hospital stay, time from admission to identification of CAUTI, location of catheter insertion, catheter

dwell time, catheter necessity, and location of patient when the positive urine culture was collected.

Clinical data collected includes signs and symptoms such as temperature, dysuria frequency of urination, urgency of urination, suprapubic pain or tenderness, flank pain, and altered mental status. Pharmaceutical data collected includes empiric antimicrobials prescribed if a CAUTI was suspected and if a CAUTI was diagnosed, definitive antimicrobial prescribed and duration of definitive antimicrobial.

Laboratory data collected includes peripheral white blood cell count, urinalysis results of nitrates, leukocyte esterase and urine microscopic WBC count/ hpf. If a urinalysis or WBC count were not performed on the day of the positive culture, results from the 24 hours before or 24 hours after urine collection were used, depending on which was more abnormal. Microbiology data collected includes organism identified from the urine culture, colony count of the bacteria isolated (cfu/ul), and antimicrobial sensitivities.

3.5.2 CAUTI Diagnosis

Clinician diagnosis: Patient medical records were reviewed to determine if the patient's clinician had documented the occurrence UTI and if the clinician started antimicrobial treatment for it.

Infectious Disease Consult diagnosis: Consult notes were reviewed to determine if the patient was seen by an Infectious Disease consultant and whether the ID consultant documented occurrence of a UTI and recommended treatment.

NHSN definition diagnosis: All patients were considered to meet the NHSN definition of CAUTI as they were reported to the NHSN as such. See Appendix A for complete NHSN CAUTI definition.

3.6 DATA ANALYSIS

Descriptive statistics were calculated to characterize the study population with respect to demographic and clinical characteristics. Incidence rate of CAUTI for each fiscal year and overall incidence rate of CAUTI was calculated as events per 1,000 catheter days by dividing the total number CAUTI events by the total number of catheter days for each fiscal year at the hospital over the three-year period. Catheter utilization rate (CUR) for the same time period was calculated by dividing the number of catheter-days by patient-days. All data was analyzed using Microsoft Excel and STATA 13.0.

4.0 RESULTS

Over the 3-year period, 102 CAUTI events were reported to NHSN; 42 in fiscal year (FY) 2011, 23 in FY 2012, 37 in FY 2013. Overall, the hospital wide incidence rate for CAUTI over the three-year period was 1.26 events per 1,000 catheter days. Incidence of CAUTI for FY 2011 was 1.63, 0.92 in FY 2012, and 1.23 in FY 2013 (Table 1).

Table 1. Overall Incidence Rate (IR) for CAUTI and Catheter Utilization Ratio (CUR)

	Fiscal year 2011	**Fiscal year 2012**	**Fiscal year 2013**
CAUTI events	42	23	37
CAUTI IR	1.63	0.92	1.23
CUR	0.18	0.18	0.22

Note. CAUTI IRs were calculated as CAUTI events per 1,000 catheter-days (CDs) and CUR was calculated as CDs divided by total patient-days.

4.1.1 Patient characteristics

Out of the 102 CAUTI events, 59 (57.84%) were female. The median age was 60 with minimum age of 18 years and maximum of 94 years. The most common reason for admission was a central nervous system incident (33.33%), which included conditions such as cerebral vascular accident, hemorrhagic stoke, cerebral thrombosis and one case of human herpes virus encephalitis. Other reasons for admission included surgical conditions (19.61%) such as total knee arthroplasty, CABG, and hysterectomy; trauma (15.69%), which included motor vehicle accident, gunshot wound, and burns; and other

reasons for admission (31.37%), which included conditions such as respiratory failure, chronic heart failure, COPD exacerbation, and alcohol withdrawal.

The median length of stay at the hospital was 19 days with a minimum of 3 and a maximum of 128 days. A total of 54% of patients presented for admission to the facility from home. The remaining patients were receiving some sort of care prior to admission the TCH either transferring from another hospital (35.29%), coming from a nursing facility (6.89%), or some other form of care (3.92%) (see table 2). In addition, 63.73% of the patients had been hospitalized within the previous year.

Table 2. Location of Patients Prior to Admission

Location Before Admission	Total (n=102)
Home	55 (53.92%)
Acute care hospital	36 (35.29%)
Nursing home/ extended care facility	7 (6.86%)
Home nursing	2 (1.96%)
Inpatient rehab	1 (0.98%)
Long term hospital	1 (0.98%)

At the time of the CAUTI event, 60.78% of patients were in a Critical Care Unit (CCU), 20.58% were on a medical or surgical ward, and 18.64% were in inpatient rehabilitation. The median duration of urinary catheterization prior to urine culture was 9 days with a minimum of 2 days and maximum of 63 days and 14.71% of patients had been catheterized for greater than 30 days. At the time of urine collection, 81.37% had a urinary catheter in place.

One third (33.33%) of patients had a concurrent infection at the time of the urine culture collection. Of the 62 patients that were in critical care, 26 (41.94%) had a concurrent infection. The most common concurrent infection in the CCU was infectious

pneumonia (n=19, 67.86%), followed by sepsis (n=6, 21.43%), and *Clostridium difficile* (n=3, 10.71%). Two of these patients had both pneumonia and *C. difficile*. Of the 21 patients on a Medical/ Surgical unit, 5 (23.81%) had a concurrent infection including 2 with infectious pneumonia, two with *Clostridium difficile,* and one with sepsis. Four of the 19 patients (21.05%) in inpatient rehabilitation also had concurrent infections; two with *Clostridium difficile,* one with sepsis, and one with a surgical site infection. Patient characteristics are summarized in Table 3.

Table 3. Characteristics of Patients with CAUTI

Variable	Total (n=102)
Female sex	59 (57.84%)
Patient age, median years (IQR)	60 (50-69)
Length of stay, median days (IQR)	19 (12-29)
Time from admission to diagnosis, median days (IQR)	7 (5-15)
Hospitalization with previous year	65 (63.73%)
History of urinary tract infections (UTIs)	26 (25.49%)
Patient survived	92 (90.20%)
Patient with another concurrent infection	34 (33.33%)
Catheter present at time of specimen collection	83 (81.37%)
Catheter dwell time, median days (IQR)	9 (5-17)
>30 days	15 (14.71%)
Mean temperature (°C ± SD)	38.45 ± 0.77
Mean peripheral white blood cell count (cells/mm3 ± SD)	12.15 ± 4.74
Reason for admission	
Central Nervous System incident	34 (33.33%)
Other	32 (31.37%)
Surgical	20 (19.61%)
Trauma	16 (15.69%)
Patient location at time of CAUTI	
Critical Care Unit (CCU)	62 (60.78%)
Medical/Surgical ward	21 (20.58%)
Rehabilitation	19 (18.64%)

Note. Data are number (%) patients unless otherwise indicated. IQR, interquartile range. SD, standard deviation.

4.1.2 Laboratory Findings and Microbiology Data

All of the patients had a peripheral white blood cell (WBC) count drawn within 24 hours before or 24 hours after urine culture collection. The mean WBC count was 12.15 ± 4.74 per mm3. Of all the patients that experienced a CAUTI event, 88.24% received a urinalysis (UA). Of those that had a UA, 39.22% were positive for nitrates, 83.33% were positive for leukocyte esterase, and 77.45% were consistent with pyuria (>5 WBC/hpf seen in spun urine).

The majority of the urine cultures were monomicrobial (79.41%) and the remainder had two organisms for a total of 123 organisms isolated. The predominant organisms were gram-negative with most common organism isolated from the urine culture being *Escherichia coli* (39.84%), followed by *Klebsiella pneumonia* (9.76%), *Pseudomonas aeruginiosa* (8.13%), *Proteus mirabilis* (7.32%), *Enterobacter* species (4.07%), and other gram negative (5.69%). The most common gram-positive organisms were *Enterococcous* species (14.63%), followed by other gram-positive organism (n=3, 2.44%), which includes *Staphylococcus aureus* (n=2) and non-hemolytic *Streptococci* (n=1). Ten of the 123 (8.13%) organisms isolated were *Candida* species. These results are consistent with other published data of CAUTI organisms. Microbiology data is summarized in Table 4.

Table 4. Microorganisms Isolated form Urine Cultures of Patients with CAUTI

Pathogen	Percentage (n=123)	Remarks
Escherichia coli	39.84%	
Enterococcous spp.	14.63%	8/18 (44.44%), VRE
Klebsiella pneumoniae	9.76%	1/12 (8.33%), ESBL producer 2/12 (16.67%), KPC producer
Pseudomonas aeruginiosa	8.13%	
Candida spp.	8.13%	
Proteus mirabilis	7.32%	
Other gram negative	9.76%	
Gram positive	2.44%	

VRE, vancomycin-resistant enterococci. ESBL, extended spectrum beta-lactamase.
KPC, *Klebsiella pneumoniae* carbapenemase.

4.1.3 Patient Signs and Symptoms

Mean patient temperature was 38.45°C ± 0.77°C. The most common sign and symptom that was documented in the patient's chart as being associated with the UTI was fever (58.82%). Signs and symptoms commonly associated with a UTI such as dysuria (4.90%), frequency (3.92%), urgency (3.92%), and burning (0.98%) were noted in a few of the patients that did not have catheters at the time of urine collection. Only one patient was noted to have flank pain (0.98%). For some patients, incontinence (n=7, 6.86%), altered mental status (n=3, 2.94%), and leukocytosis (n=3, 2.94%) were documented, none of which are considered to be signs or symptoms attributable to a UTI according to NHSN (see Appendix A). A total of 26 (25.49%) patients had no documented symptoms at all (see table 5).

Table 5. Signs and Symptoms of Patients with CAUTI

Signs and Symptoms	Total (%) (n=102)
Fever	60 (58.82%)
No documented symptoms	26 (25.49%)
Incontinence	7 (6.86%)
Dysuria	5 (4.90%)
Urinary frequency	4 (3.92%)
Urinary urgency	4 (3.92%)
Leukocytosis	3 (2.94%)
Altered mental status	3 (2.94%)
Flank pain	1 (0.98%)
Burning	1 (0.98%)
SIRS	1 (0.98%)

4.1.4 Reason for Ordering Urinalysis and Urine Culture

The most common reason for ordering a UA and urine culture documented in the patient's charts was a pan culture (requesting all possible cultures at once) for fever and/or leukocytosis (37.25%). Twenty-eight (27.45%) of the urine cultures were performed with no documented reason. Other documented reasons for ordering a urine culture consistent with a UTI included; fever (16.67%), dysuria (4.90%), frequency (2.94%), urgency (2.94%), flank pain (0.98%). Documented reasons not consistent with the NHSN UTI definition include; incontinence (5.88%), leukocytosis (3.92%), cloudy urine (3.92%), systemic inflammatory response syndrome (SIRS) (0.98%), condition C (0.98%), and foul smelling urine (0.98%) (see table 6).

Table 6. Reason for Ordering Urine Culture

Reason for Ordering Urine Culture	Total (%) (n=102)
Pan culture for Fever or Leukocytosis	38 (37.25%)
No documented reason	28 (27.45%)
Fever	17 (16.67%)
Incontinence	6 (5.88%)
Dysuria	5 (4.90%)
Leukocytosis	4 (3.92%)
Cloudy urine	4 (3.92%)
Frequency	3 (2.94%)
Urgency	3 (2.94%)
SIRS	1 (0.98%)
Flank pain	1 (0.98%)
Condition C	1 (0.98%)
Foul smell	1 (0.98%)

4.1.5 CAUTI Diagnosis and Treatment

Of the 102 CAUTI events reported to NHSN, 68 (66.67%) patients meet the clinician diagnosis definition, where the clinician mentioned of the occurrence of a UTI in the patient's records and the patient was subsequently treated with antimicrobials. An Infectious Disease (ID) Consultant was involved in the care of 24 (23.53%) of the patients. Of these 24 patients, 10 (41.67%) patients meet the ID consult CAUTI diagnosis, where the ID consultant documented in the patient's records the presence of UTI and recommended treatment. All 10 of theses patients were treated with antimicrobials, but 2 did not meet the clinician diagnosis definition, as the clinician never mentioned the presence of a UTI in the patient's records. In addition, ID consultants

documented the presence of colonization or asymptomatic bacteriuria in 5 (20.83%) of the patients seen.

Antimicrobial treatment was initiated in 80 (78.43%) of the patients, meaning that 12 patients were not diagnosed with a UTI by either their clinician or an ID consultant but were treated with antimicrobials. For two of the patients, antimicrobials were stopped after 2 days of treatment from a recommendation of the ID consultant that the patient's Foley was colonized. Four of these patients had urine cultures positive for *Candida* and were treated with fluconazole for "persistent funguria." Medical records reveal that another four of these patients were being treated solely because of a "positive urine culture." Interestingly, for the other two patients, it was specifically noted in the patient's chart that they were asymptomatic and the positive culture was due colonization but they were treated with antimicrobials anyway.

5.0 DISCUSSION

5.1 SUMMARY OF RESULTS

The hospital wide CAUTI incidence rate per 1,000 catheter days was 1.63 for fiscal year 2011, 0.92 for fiscal year 2012, and 1.23 for fiscal year 2013. Overall CAUTI incidence for the three-year period was 1.26 events per 1,000 catheter days. These rates are consistently less than the 2011 Pennsylvania benchmark of 1.71 CAUTI events per 1,000 catheter days.

CAUTI was more common in women, patients of older age, critically ill and in people with other sites of infection. These patient characteristics are consistent with risk factors found in other published data [26, 29, 30]. Additionally, the microbiology results are similar to data reported to NHSN with predominately gram-negative organisms being isolated and *E. coli* being the most common pathogen found [39]. Similar to previous studies, this study also found that administering antimicrobials for catheterized patients with asymptomatic bacteriuria was common practice [48].

Only 66.67% of the NHSN CAUTI events over the three-year period meet the clinician diagnosis definition. Of the 24 cases seen by an ID consultant, only 10 (41.67%) meet the ID diagnosis definition. These numbers are similar to those found in a recent study published by Al-Qas Hanna *et. al*., where the authors found that the NHSN CAUTI

definition had a positive predictive value (PPV) of 35% when using an Infectious Disease physician diagnosis of CAUTI as the gold standard and a PPV of 62.2% when compared to clinician diagnosis of CAUTI [12]. These results suggest that at least one third of CAUTI events reported NHSN are not true CAUTI.

5.2 SIGNS AND SYMPTOMS

Catheter-associated urinary tract infections are traditionally difficult to diagnosis. In this study only 11 out of 102 patients had signs or symptoms classically associated with a UTI, such as dysuria, urgency, and flank pain, similar to a previously study [19]. This lack of focal signs and symptoms makes the diagnosis of CAUTI challenging and based on excluding other infections. Furthermore, almost two thirds of the patients were in critical care where patients are traditionally more ill, may not be able to convey urinary tract symptoms, and have a greater tendency to be febrile when compared to other units in a hospital.

Many of the documented signs and symptoms such as incontinence, leukocytosis, cloudy urine, and foul smelling urine are not considered be signs or symptoms of a urinary tract infection by either IDSA or NHSN. According to IDSA, no studies have demonstrated that odorous or cloudy urine in a catheterized individual, even if these findings are new, has clinical significance [15]. Also, studies have found that for a hospitalized patient with an indwelling urinary catheter, peripheral leukocytosis has little predictive value for the diagnosis of CAUTI [19]. Therefore, if physicians were better educated on what signs and symptoms warrant obtaining a urine culture, the number of

non-clinical CAUTI events needlessly reported to NHSN would be decreased (see Appendix B for IDSA guidelines).

Fever was documented in the medical records of 60 (58.82%) patients as being attributable to a urinary tract infection. For 57 (55.90%) of these patients, fever was the only documented symptom. In fact, according to NSHN data, fever is the only sign or symptom in greater than 85% of CAUTIs reported to NHSN [53]. Of the 57 patients with fever only, 18 (31.58%) were not diagnosed as having a UTI nor were they treated with antibiotics. By eliminating the reporting of UTIs that are diagnosed by fever alone and are not treated with antimicrobials, NHSN could increase the specificity of the CAUTI definition to more truly reflect clinical practice and patient outcome. At this hospital, this simple definition change would reduce the CAUTI rate by 17.65% over the three-year period.

Out of the 38 patients with CAUTI that were found as a result of panculture for fever or leukocytosis, 18 had a concurrent infection and two had a maintained fever of greater than 38°C. Infectious Diseases Society of America (IDSA) guidelines for diagnosis of a CAUTI specifically state that fever is a compatible sign or symptom of CAUTI only if it is new onset or worsening and cannot be attributed to another cause. None of the patients with concurrent infections or maintained fever had signs or symptoms attributable to a UTI except for the fever. Cohorts of highly skilled infectious disease specialists come together to create the IDSA clinical practice guidelines to assist healthcare providers in properly diagnosing infectious diseases and infectious complications. By taking these clinical guidelines (see Appendix B) into consideration, and excluding fever as a sign or symptom of CAUTI if it can be attributed to another

source, the NSHN definition would again more truly reflect clinical practice and patient outcome. By making this definition change, CAUTI rates would be decreased by as much 19.61% at this hospital.

5.3 AREAS FOR HOPSITAL IMPROVEMENT

The burden of change does not fall solely on the National Healthcare and Safety Network. There are many changes in hospital policy and regulation that can be put into action to reduce the number of false CAUTI events needlessly reported to NHSN as well as the incidence of true CAUTI.

5.3.1 Elimination of Panculture

Fever is relatively common in critically ill and trauma patients and because a fever can be a symptom of infection as well as other noninfectious inflammatory responses, it is important to thoroughly analyze febrile patients to identify the source of fever. Unfortunately, a common practice among clinicians used to identify the source of fever is panculture. Panculture typically refers to the practice of obtaining sputum, urine, and blood cultures on a febrile patient without considering clinical symptoms, or abnormal results form a urinalysis or chest x-ray [54]. This practice results in a large number of negative cultures and unnecessary healthcare costs. It has been found that these unnecessary cultures do not alter the outcome of most of the patients and the cause of fever can typically be identified with a careful review of the patient's history, medical

record, and physical examination [55]. It is also important to consider other noninfectious causes of fever, such as underlying comorbid disease (ex. autoimmune disease or gout), recent procedures (ex. blood transfusion or operation), trauma, current medications, deep vein thrombosis or pulmonary embolism, and alcohol/ drug withdrawal [56, 57].

The fact that over one third (37.25%) of the NHSN reported CAUTI events over the three-year period were identified via panculture for fever, the practice of "pan-culturing" at this hospital appears to be a common course of action for febrile patients. The practice of panculture should not be condoned and clinicians should instead be encouraged to critically evaluate febrile patients for the source of fever (infectious or noninfectious) before ordering cultures. By implementing policies to regulate the use of urine cultures and developing clinical algorithms for obtaining cultures and initiating antimicrobial treatment in febrile patients, the use of indiscriminant cultures could be greatly reduced.

In an attempt to decrease the random use of urine cultures, blood cultures, and chest x-ray films, one study found a 5-fold decrease in the number of cultures ordered on postoperatively febrile patients and an 8-fold increase in positive test results, resulting thousands of dollars saved all with the implementation of a fever algorithm based on symptoms and physical examination [58]. According to guidelines for the evaluation of fever in critically ill patients, developed by a task force of specialist from the American College of Critical Care Medicine and the Infectious Diseases Society of America, "a new fever in a patient in the intensive care unit should trigger a careful clinical assessment rather than automatic orders for laboratory and radiologic tests. A cost-

conscious approach for obtaining cultures and imaging studies should be undertaken if indicated only after a clinical evaluation."[57]

5.3.2 Reduction of Inappropriate Urinary Catheter Insertion and Duration

The median duration of urinary catheterization prior to urine culture was 9 days with a minimum of 2 days and maximum of 63 days. Furthermore, 14.71% of patients had been catheterized for greater than 30 days. It has been demonstrated that the risk for CAUTI increases by approximately 5% each additional day the urinary catheter remains in the patient [23, 26-28] with almost universal bacteriuria with long-term catheterization of greater than 30 days [16, 17, 19]. By simply reducing the number of urinary catheters that are inserted and decreasing duration of catheterization, we can decrease the number of CAUTI events.

Urinary catheters should only be inserted if appropriately indicated and removed as soon as they are no longer needed. In particular, the use of catheters should be limited in those with higher risk for CAUTI or mortality from catheterization such as women, older patients, and patients with impaired immunity [37]. Catheters should never be used for management of incontinence and should only be used in operative patients if absolutely necessary. The most common documented reason for Foley necessity in this study was the accurate measure of urine output in critically ill patients (66.67%) of which 20.59% were not on a critical care unit. This implies that documentation of Foley necessity is cursory and superficial. Implementation of a system to requires critical reassessment for the need for continued catheterization could be beneficial in the identification and removal of catheters that are no longer needed.

5.4 LIMITATIONS

This study has some limitations. It is a retrospective chart review analysis and is therefore reliant on the quality, completeness, and accuracy of documentation on the part of the all caregivers involved in that particular patient's care. However, excluding clinical signs and symptoms, many of the variables collected were objective measures such vital signs and laboratory data and should be subject to bias. Additionally, the study was conducted at one tertiary care facility in one city in the United States so results may not be generalizable to other facilities in different geographic regions or other types of facilities.

Being as this a retrospective chart review analysis, we do not have information on all of the patients that may have experienced a clinician or ID diagnosed CAUTI that was not captured under the NHSN definition. This could be valuable information in determining the true sensitivity and specificity of the NHSN definition and would a worthwhile study to pursue in the future.

6.0 CONCLUSION

The NHSN CAUTI definition does not truly reflect clinician practice. Of all the NHSN CAUTI events reported over the three-year period, only two thirds of clinicians and only 42% of ID consultants diagnosed the NSHN reported CAUTI events as actual UTIs. While the NHSN CAUTI definition is important for surveillance purposes, it may be overly broad, and not specific enough to measure true clinical CAUTI. The NHSN reported CAUTI rate within each hospital is susceptible to the prevalence of fever and frequency of obtaining urine cultures in patients with urinary catheters. Therefore, I question whether it should be used for national improvement efforts and public reporting of hospitals to CMS. That being said, the NHSN CAUTI definition provides the most reproducible measure currently available for assessing national rates of CAUTI and comparing healthcare facilities.

In conclusion, as long as the NSHN-CAUTI definition is used for public reporting, it is important to realize that the reported rates are not necessarily reflective of infectious complications of urinary catheters or clinical diagnosis. Instead, we should look at these rates to identify areas for improvement within the reporting facilities and when addressing national improvement efforts.

APPENDIX A

CDC AND NHSN UTI EVENT PROTOCOL AND DEFINITIONS

Appendix A: Urinary Tract Infection Criteria as published by the CDC and NHSN [14]

Criterion	Urinary Tract Infection (UTI)
	Symptomatic UTI (SUTI) Must meet at least 1 of the following criteria:
1a	Patient had an indwelling urinary catheter in place for >2 calendar days, with day of device placement being Day 1, and catheter was in place on the date of event *and* at least 1 of the following signs or symptoms: fever (>38°C); suprapubic tenderness*****; costovertebral angle pain or tenderness***** *and* a positive urine culture of $\geq 10^5$ colony-forming units (CFU)/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. ----------OR---------- Patient had an indwelling urinary catheter in place for >2 calendar days and had it removed the day of or the day before the date of event *and* at least 1 of the following signs or symptoms: fever (>38°C); urgency*****; frequency*****; dysuria*****; suprapubic tenderness*****; costovertebral angle pain or tenderness***** *and* a positive urine culture of $\geq 10^5$ colony-forming units (CFU)/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *****With no other recognized cause
1b	Patient did <u>not</u> have an indwelling urinary catheter that had been in place for >2 calendar days and in place at the time of or the day before the date of event *and* has at least 1 of the following signs or symptoms: fever (>38°C) in a patient that is ≤65 years of age; urgency*****; frequency*****; dysuria*****; suprapubic tenderness*****; costovertebral angle pain or tenderness***** *and* a positive urine culture of $\geq 10^5$ CFU/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *****With no other recognized cause

Appendix A: Urinary Tract Infection Criteria as published by the CDC and NHSN

Criterion	Urinary Tract Infection (UTI)
2a	Patient had an indwelling urinary catheter in place for >2 calendar days, with day of device placement being Day 1, and catheter was in place on the date of event. *and* at least 1 of the following signs or symptoms: fever (>38°C); suprapubic tenderness*****; costovertebral angle pain or tenderness***** *and* at least 1 of the following findings: a. positive dipstick for leukocyte esterase and/or nitrite b. pyuria (urine specimen with ≥10 white blood cells [WBC]/mm^3 of unspun urine or >5 WBC/high power field of spun urine) c. microorganisms seen on Gram's stain of unspun urine *and* a positive urine culture of ≥10^3 and <10^5 CFU/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. ----------OR---------- Patient with an indwelling urinary catheter in place for > 2 calendar days and had it removed the day of or the day before the date of event *and* at least 1 of the following signs or symptoms: fever (>38°C); urgency*****; frequency*****; dysuria*****; suprapubic tenderness*****; costovertebral angle pain or tenderness***** *and* at least 1 of the following findings: a. positive dipstick for leukocyte esterase and/or nitrite b. pyuria (urine specimen with ≥10 WBC/mm^3 of unspun urine or >5 WBC/high power field of spun urine c. microorganisms seen on Gram's stain of unspun urine *and* a positive urine culture of ≥10^3 and <10^5 CFU/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *****With no other recognized cause

Appendix A: Urinary Tract Infection Criteria as published by the CDC and NHSN

Criterion	Urinary Tract Infection (UTI)
2b	Patient did <u>not</u> have an indwelling urinary catheter that had been in place for >2 calendar days and in place at the time of, or the day before the date of event *and* has at least 1 of the following signs or symptoms: fever (>38°C) in a patient that is ≤65 years of age; urgency*; frequency*; dysuria*; suprapubic tenderness*; costovertebral angle pain or tenderness* *and* at least 1 of the following findings: a. positive dipstick for leukocyte esterase and/or nitrite b. pyuria (urine specimen with ≥10 WBC/mm^3 of unspun urine or >5 WBC/high power field of spun urine c. microorganisms seen on Gram's stain of unspun urine *and* a positive urine culture of ≥10^3 and <10^5 CFU/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *With no other recognized cause
3	Patient ≤1 year of age with** or without an indwelling urinary catheter has at least 1 of the following signs or symptoms: fever (>38°C core); hypothermia (<36°C core); apnea*; bradycardia*; dysuria*; lethargy*; vomiting* *and* a positive urine culture of ≥10^5 CFU/ml and with no more than 2 species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *With no other recognized cause ** Patient had an indwelling urinary catheter in place for >2 calendar days, with day of device placement being Day 1 and catheter was in place on the date of event.
4	Patient ≤1 year of age with** or without an indwelling urinary catheter has at least 1 of the following signs or symptoms: fever (>38°C core); hypothermia (<36°C core); apnea*; bradycardia*; dysuria*; lethargy*; vomiting* *and* at least 1 of the following findings: a. positive dipstick for leukocyte esterase and/or nitrite b. pyuria (urine specimen with ≥10 WBC/mm^3 of unspun urine or >5 WBC/high power field of spun urine c. microorganisms seen on Gram's stain of unspun urine *and* a positive urine culture of between ≥10^3 and <10^5 CFU/ml and with no more than two species of microorganisms. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent

Appendix A: Urinary Tract Infection Criteria as published by the CDC and NHSN

Criterion	Urinary Tract Infection (UTI)
	elements. *With no other recognized cause ** Patient had an indwelling urinary catheter in place for >2 calendar days, with day of device placement being Day 1 and catheter was in place on the date of event.

Criterion	Asymptomatic Bacteremic Urinary Tract Infection (ABUTI)
	Patient with* or without an indwelling urinary catheter has no signs or symptoms (i.e., for any age patient, no fever (>38°C); urgency; frequency; dysuria; suprapubic tenderness; costovertebral angle pain or tenderness OR for a patient ≤1 year of age; no fever (>38°C core); hypothermia (<36°C core); apnea; bradycardia; dysuria; lethargy; or vomiting) *and* a positive urine culture of $\geq 10^5$ CFU/ml and with no more than 2 species of uropathogen microorganisms** (see Comments section below) *and* a positive blood culture with at least 1 matching uropathogen microorganism to the urine culture, or at least 2 matching blood cultures drawn on separate occasions if the matching pathogen is a common skin commensal. Elements of the criterion must occur within a timeframe that does not exceed a gap of 1 calendar day between two adjacent elements. *Patient had an indwelling urinary catheter in place for >2 calendar days, with day of device placement being Day 1, and catheter was in place on the date of event. **Uropathogen microorganisms are: Gram-negative bacilli, *Staphylococcus spp.*, yeasts, beta-hemolytic *Streptococcus spp*., *Enterococcus spp*., *G. vaginalis*, *Aerococcus urinae*, and *Corynebacterium* (urease positive)[+]. [+]Report *Corynebacterium* (urease positive) as either *Corynebacterium species unspecified (COS*) or as *C. urealyticum* (CORUR) if so speciated. (See complete list of uropathogen microorganisms at http://www.cdc.gov/nhsn/XLS/master-organism-Com-Commensals-Lists.xlsx#uropathogens)
Comments	• Laboratory cultures reported as "mixed flora" represent at least 2 species of organisms. Therefore an additional organism recovered from the same culture, would represent >2 species of microorganisms. Such a specimen cannot be used to meet the UTI criteria. • Urinary catheter tips should not be cultured and are not acceptable for the diagnosis of a urinary tract infection. • Urine cultures must be obtained using appropriate technique, such as clean catch collection or catheterization. Specimens from indwelling catheters

	should be aspirated through the disinfected sampling ports. • In infants, urine cultures should be obtained by bladder catheterization or suprapubic aspiration; positive urine cultures from bag specimens are unreliable and should be confirmed by specimens aseptically obtained by catheterization or suprapubic aspiration. • Urine specimens for culture should be processed as soon as possible, preferably within 1 to 2 hours. If urine specimens cannot be processed within 30 minutes of collection, they should be refrigerated, or inoculated into primary isolation medium before transport, or transported in an appropriate urine preservative. Refrigerated specimens should be cultured within 24 hours. • Urine specimen labels should indicate whether or not the patient is symptomatic. • Report only pathogens in both blood and urine specimens for ABUTI. • Report *Corynebacterium* (urease positive) as either *Corynebacterium species* unspecified (COS) or as *C. urealyticum* (CORUR) if speciated.

APPENDIX B

IDSA GUIDELINES FOR DIAGNOSING CA-ASB AND CAUTI

Appendix B: IDSA 2009 Guidelines [15]

1	CAUTI in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of symptoms or signs compatible with UTI with no other identified source of infection along with ≥10^3 colony- forming units (cfu)/mL of ≥1 bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral, suprapubic, or condom catheter has been removed within the previous 48 hours.
2	CA-ASB should not be screened for except in research studies evaluating interventions designed to reduce the incidence of CA-ASB or CA-UTI and in selected clinical situations, such as in pregnant women. i. CA-ASB in patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization is defined by the presence of ≥10^5 cfu/mL of ≥1 bacterial species in a single catheter urine specimen in a patient without symptoms compatible with UTI
3	Signs and symptoms compatible with CA-UTI include new onset or worsening of fever*, rigors*, altered mental status*, malaise*, or lethargy*; flank pain; costovertebral angle tenderness; acute hematuria; pelvic discomfort; and in those whose catheters have been removed, dysuria, urgent or frequent urination, or suprapubic pain or tenderness. i. In patients with spinal cord injury, increased spasticity, autonomic dysreflexia, or sense of unease are also compatible with CAUTI. *with no other identified cause
4	In the catheterized patient, pyuria is not diagnostic of CA-bacteriuria or CAUTI. i. The presence, absence, or degree of pyuria should not be used to differentiate CA-ASB from CAUTI. ii. Pyuria accompanying CA-ASB should not be interpreted as an indication for antimicrobial treatment. iii. The absence of pyuria in a symptomatic patient suggests a diagnosis other than CAUTI.
5	In the catheterized patient, the presence or absence of odorous or cloudy urine alone should not be used to differentiate CA-ASB from CAUTI or as an indication for urine culture or antimicrobial therapy.

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