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A PROSPECTIVE ANALYSIS OF URINARY TRACT INFECTIONS AMONG ELDERLY TRAUMA PATIENTS

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Abstract

Introduction—Catheter-associated urinary tract infections (CAUTI) have been deemed “reasonably preventable” by the Centers for Medicare and Medicaid (CMS) thereby eliminating reimbursement. Elderly trauma patients, however, are at high risk for developing urinary tract infections (UTI) given their extensive comorbidities, immobilization, and environmental changes in the urine which provide the ideal environment for bacterial overgrowth. Whether these patients develop CAUTI as a complication of their hospitalization or have asymptomatic bacteriuria (ASB) or UTI upon admission must be determined in order to justify the “reasonably preventable” classification. We hypothesize that a significant proportion of elderly patients will present with ASB or UTI on admission.

Methods—IRB permission was obtained to perform a prospective, observational clinical trial of all elderly (≥ 65 years) patients admitted to our Level I Trauma Center as a result of injury. Urinalysis (UA) and culture (UCx) were obtained at admission, 72 hours, and, if diagnosed with UTI, at 2 weeks after injury. Mean cost of UTI was calculated based Center for Disease Control and Prevention estimates of \$862 – \$1,007 per UTI.

Results—Of 201 eligible patients, 129 agreed to participate (64%). Mean age was 81±8.6 years. All patients had a blunt mechanism of injury (76% falls) with a mean Injury Severity Score of 13.8±7.6. Of the 18 (14%) patients diagnosed with CAUTI, 14 (78%) were present at admission.

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Author Contributions:

All authors contributed to the design of this study, for which M.D.Z. managed grant applications. S.F.P. coordinated the study and M.M.K. performed patient recruitment/enrollment. M.M.K., S.F.P., and R.P. contributed to data collection. S.H., K.V.B., and R.P. performed data analyses. All authors contributed to data interpretation and writing. M.D.Z., S.F.P., A.B., H.N., D.H.J., K.V.B., and R.P. participated in critical revision.

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Additionally, there were 18 (14%) patients with ASB on admission. The most common bacterial species present on admission urine culture were *E. coli* (24%) and *Enterococcus* (16%). Clinical features associated with bacteriuria on admission included a history of UTI, positive gram stain, abnormal microscopy, and pyuria. The estimated loss of reimbursement for 18 UTIs on admission was \$15,516 – \$18,126; however, given an estimated cost of \$1981 to screen all patients with UA and UCx at admission, up to \$16,144 savings was realized.

Conclusion—Many elderly trauma patients present with UTI. Screening UA and UCx on admission for elderly trauma patients identifies these UTIs and is cost-effective.

INTRODUCTION

The Centers for Medicare and Medicaid (CMS) identified several “reasonably preventable” in-hospital complications and stopped reimbursement of these events in 2008. Among these complications was catheter associated urinary tract infection (CAUTI). To limit financial implications, medical institutions responded to this policy change by limiting exposure to urinary catheters, the main risk factor to CAUTI development, as well as implementing guidelines for early catheter removal.¹ A reduction in CAUTI was seen following these changes, however, it continues to be diagnosed at a concerning rate.²

Elderly trauma patients are a unique population with multiple inherent risk factors for CAUTI not present in other populations.^{3,4} For instance, urinary catheterization is often necessary given the mobility restrictions of these patients from their comorbidities and injuries, whether real or potential (i.e. spine immobilization). These risk factors, including female sex, head injury, impaired sensorium, congestive heart failure, and prolonged hospital stays, are generally unmodifiable despite the “reasonably preventable” nomenclature placed on CAUTI by CMS. As a result, the accuracy of the CAUTI diagnosis must be questioned as urinary tract infection (UTI) or asymptomatic bacteriuria (ASB) may actually be present prior to admission but not diagnosed until after catheter placement days into the patient’s hospitalization. Whether these patients develop CAUTI as a complication of their hospitalization or have comorbid UTI upon admission must be determined in order to justify the “reasonably preventable” classification. Therefore, we aimed to identify those injured, elderly patients who have a UTI present on admission and hypothesized that the majority of patients who would have been diagnosed with CAUTI actually had UTI prior to hospitalization.

METHODS

A prospective, observational trial of consecutive elderly patients (≥ 65 years old) admitted to the hospital as a result of injury was performed between April and September, 2013. Patients with genitourinary trauma were excluded. Urine samples were collected at admission and at 72 hours after admission. Urinalyses, gram stain, microscopy, and cultures were performed with each specimen. An additional urine culture was performed at 2 weeks in patients with a positive admission or 72 hour culture. All therapy, including antibiotic treatment, was based on the discretion of the treating clinicians who were blinded to the results of the urine cultures. Delayed consent was obtained after specimen collection; specimens were destroyed for those patients who refused consent.

Definitions

Asymptomatic bacteriuria was defined as 10^3 colony forming units (CFU) per milliliter of no more than two species of microorganisms in a urinary catheter specimen or 10^5 CFUs per milliliter in a midstream voided specimen in the absence of UTI symptoms.^{5,6,7} Catheter associated UTI (CAUTI) was defined as a symptomatic patient with 10^3 CFUs per milliliter of no more than two species of microorganisms and the presence of a urinary catheter within 48 hours prior to sample collection. Symptoms included: fever ($\geq 38.5^\circ\text{C}$), rigors, altered mental status, malaise, lethargy, flank pain, costovertebral angle tenderness, hematuria, suprapubic discomfort, dysuria, and urgent/frequent urination. In spinal cord injury patients, increased spasticity, autonomic dysreflexia, and unease were also included. Abnormal urine microscopy was defined as the presence of leukocytes, erythrocytes, epithelial cells, microorganisms, casts, or crystals. Patients diagnosed with UTI on admission and had a urinary catheter placed during the first 48 hours of their hospital stay were termed “early diagnosed CAUTI.” The reason for this term is that, without the urine sample on admission, these UTIs would have likely gone undiagnosed until admission to the hospital. As a result, despite these UTIs being present on admission, the patient would have met CMS criteria for CAUTI. For this reason, CAUTI and “early diagnosed CAUTI” were combined for the analysis. Non-catheter associated UTIs were defined similarly to CAUTI but without the need for urinary catheterization. The CAUTI group was compared to the group of patients who did not develop CAUTI (including those patients with ASB).

Statistics

Data was presented as rates or medians plus interquartile ranges (IQR) where appropriate. Univariate analyses were performed between those patients who did and did not develop CAUTI. Chi square or Fisher’s exact analyses were performed for categorical variables while the Wilcoxon rank sum test was used for continuous variables. All tests were two-sided and statistical significance was defined as p value ≤ 0.05 .

RESULTS

A total of 201 patients met inclusion criteria of whom 129 (64%) consented to participate. All patients had a blunt mechanism of injury (76% falls) with a mean Injury Severity Score (ISS) of 11 (IQR 9-17). Fifty-nine patients met criteria to be level 1 or 2 trauma activations (45.7%; the highest levels of activation); the remaining 70 patients did not require trauma team activation and were cared for and triaged by emergency department staff. Of the 14 patients with UTI on admission, 13 fell from standing height. The remaining patient was struck by a falling tree branch.

Catheterized admission urine samples were obtained in 101 patients and the remaining 28 were clean catch specimens. In total, 32 patients (25%) had bacteriuria (i.e. positive urine cultures) on admission urine studies (25 catheterized and 7 clean catch samples; Figure 1). Of these, 14 patients (11%) met study criteria for “early diagnosed CAUTI.” The remaining 18 patients had ASB and were placed in the non-CAUTI group. Another 12 patients (9%) had bacteriuria on the 72 hour urine culture, 4 of which met criteria for CAUTI. The most common CAUTI symptoms were mental status changes ($n=6$) and malaise ($n=6$), followed

by hematuria (n=3), suprapubic discomfort (n=2), fever (n=2), rigors (n=1), and dysuria (n=1).

The 18 patients in the CAUTI group were compared to the remaining 111 patients in the non-CAUTI group. Of note, none of the patients with ASB on admission developed a CAUTI; however, two patients continued to have ASB on the 72 hour urine culture. There were no differences in age, sex, concomitant injuries, or catheterization rates between the patients who did and did not develop CAUTI (Table 1). In addition, there were no differences in outcomes including intensive care unit (ICU) or hospital durations of stay (LOS). There were no deaths in either group.

There were several significant differences on admission urinalysis between subjects who did and did not develop CAUTI (Table 2). The pH was significantly lower while white blood cells per high power field were significantly elevated for CAUTI patients. Additionally, microscopy was more commonly abnormal and the gram stain was more commonly positive in patients with CAUTI.

The most common pathogen was *Escherichia coli* (28%) followed by *Enterococcus* (22%) and *Klebsiella oxytoca* (17%). Two patients had multi-organismal CAUTI, both on the admission urine culture. These organisms included *Escherichia coli* with *Proteus mirabilis* and *Pseudomonas aeruginosa* with *Staphylococcus aureus*.

Of the 46 patients with a positive urine culture on admission or at 72 hours, 11 provided a 2 week follow-up urine sample. Of these 11, 4 continued to have positive cultures. One of these patients grew the same organism on subsequent culture (*Klebsiella pneumoniae*).

Mean cost of UTI was calculated based Center for Disease Control and Prevention (CDC) estimates of \$862 – \$1,007 per UTI.⁸ The estimated loss of reimbursement for 18 CAUTIs was \$15,516 – \$18,126; however, given an estimated cost of \$1981 to screen all patients with urinalysis and urine culture at admission (\$110 per patient), between \$13,535 and \$16,145 savings was realized.⁹

DISCUSSION

Health care associated UTI is a morbid and expensive issue in the United States. It is thought to result in more than 13,000 deaths and to prolong hospitalization by 0.5–6.0 days. To incentivize reduction of CAUTIs, CMS ceased reimbursement. While CAUTI has decreased following this policy change, elimination of all CAUTI is not feasible.^{3,10,11} Due to potential financial implications, it is critical to determine the patient populations in which the policy change is not justified. We believe that elderly trauma patients are one of these populations as they have altered physiology increasing susceptibility to UTI as well as injuries and comorbidities which both require urinary catheter use and preclude identification of symptoms of UTI that may be present on admission. The results of this study support that non-reimbursement of CAUTI is not justified in elderly trauma patients, as close to 80% of UTIs diagnosed during hospitalization of this patient population were present on admission. Without screening urine studies on admission, these UTIs would have been diagnosed as CAUTI later in the hospitalization and, thus, not reimbursed.

The cost burden to those hospitals caring for elderly trauma patients is not limited to lost reimbursement for CAUTI. As noted, CAUTI is highly associated with increased complications and LOS.^{8,9,10,12} We did not include these additional costs in our analysis as we could not determine with any certainty whether CAUTI cause increased LOS. Additionally, while CAUTI had a numerically greater hospital LOS, there was no statistical difference between groups. As a result, we focused on the loss of revenue rather than the institutional costs. In fact, the costs are likely substantially greater than the \$1000 per patient cited.

In addition to the cost burden that CMS policy changes place on hospitals, the policy has the potential to further increase costs and prevalence of antimicrobial resistance.¹² The inability to distinguish between CAUTI developed in the hospital and UTI as a pre-existing comorbidity without laboratory assessment on admission creates a situation where clinicians may increase testing for UTI. This laboratory analysis may or may not be necessary; with increased testing, more cultures will be positive. Whether this increased rate of bacteriuria actually represent UTI or ASB is difficult to ascertain. Strict criteria exist to differentiate between the two entities; however, the actual distinction eludes most clinicians.⁵ As a result, ASB will more likely be treated unnecessarily with antibiotics furthering antimicrobial resistance as well as complications from the antibiotics.

The difficulty in differentiating ASB from CAUTI is compounded in elderly trauma patients. Elderly patients at a baseline have increased rates of impaired sensorium.² This results in an inability to reliably obtain data pertaining to UTI symptoms on admission, the main distinguishing feature between ASB and UTI. A second difficulty distinguishing ASB from CAUTI is the increased need for urinary catheterization as a result of their injuries. Catheters are generally necessary in trauma and emergency surgery patients given their mobility restrictions, prolonged procedures, need for careful urine output monitoring, and urinary retention.¹³ The elimination or reduction in catheterization may not be possible. In addition, these injuries may preclude a review of symptoms to the detail required. Many of the symptoms experienced by patients in this study could feasibly be attributed to the injuries sustained rather than UTI. As a result, our study may be biased given the baseline injuries that the patients sustained. We maintain, however, that with the difficulty in truly distinguishing ASB from UTI within this population, the clinician should error on the side of treatment.

The assumption that patients with UTI on admission who also underwent urinary catheterization (i.e. “early diagnosed CAUTI”) would subsequently be diagnosed with CAUTI is an assumption that lies at the heart of our study. Of course, this assumption lends potential bias; for a potentially wide variety of reasons, these patients may not have ultimately been diagnosed with CAUTI. For instance, antibiotics received for other injuries may have been enough to effectively treat the patient or the patient may have been dismissed to home/died prior to CAUTI diagnosis.

Nevertheless, the only feature missing from our definition of “early-diagnosed CAUTI” compared to CMS’s definition of CAUTI is the timing of diagnosis; whether it was prior to

admission or as an inpatient. Without our assumption, these infections would likely have been diagnosed as CAUTI with its consequent complications and financial implications.

Lastly, the 11% rate of UTI on admission found in this study was higher than expected and is concerning for UTI as a risk factor contributing to their injury. This is corroborated by the fact that all but one of the CAUTI patients fell from standing height. Certainly, UTIs can cause lightheadedness and dizziness making patients more prone to fall.^{5,6,7} Despite the prospective nature of this study, it was not designed to show a causative role of UTI in injuries; however, we remain highly suspicious.

Elderly trauma patients present with multiple coexisting comorbidities including UTI. In fact, UTIs may directly contribute to same level falls which results in injury and the need for admission. Given these findings, we recommend early screening in the form of an accurate review of systems as well as urinalysis and urine culture. We believe that this will dramatically reduce the rate of CAUTI diagnosis while in the hospital, increase compensation, and potentially improve outcomes in this challenging patient population.

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Figure 1.

Table 1

Demographics and outcomes of CAUTI compared to non-CAUTI patients. Data are presented as percentages or medians plus interquartile range (IQR), as appropriate.

CAUTI – catheter associated urinary tract infection; UTI - urinary tract infection; Hx – history; UA - urinalysis

	CAUTI (n = 18)	Non-CAUTI (n = 111)	p-value
Age in years, median (range)	81.0 (75.0, 89.0)	81.0 (74.0, 87.0)	0.66 ^A
Sex, n (%)			
Male	8 (44.4)	54 (48.6)	0.74 ^B
Female	10 (55.6)	57 (51.4)	
History of UTI, n (%)			
Yes	9 (56.3)	49 (48.5)	0.56 ^B
No	7 (43.8)	52 (51.5)	
Not available	2	10	
Hx of nephrolithiasis, n (%)			
Yes	0 (0)	11 (10.9)	0.35 ^C
No	15 (100.0)	90 (89.1)	
Not available	3	10	
Antibiotics within 2 weeks, n (%)			
Yes	4 (26.7)	24 (24.7)	1.0 ^C
No	11 (73.3)	73 (75.3)	
Not available	3	14	
Fall from standing mechanism; n (%)	15 (83)	83 (75)	.53
Emergency Department temp; n (%)	36.5 (36.2–36.7)	36.6 (36.4–36.8)	.25 ^A
Injury Severity Score (n=59)	17 (11–21)	11 (9–17)	.26
Glasgow Coma Scale (n=59)	15 (14–15)	15 (14–15)	.13
Days of Catheterization [†] , median (range)	4.0 (3.0–5.0)	3.0 (2.0–5.0)	0.66 ^A
Catheter re-insertion, n (%)			
Yes	2 (14.3)	6 (7.1)	0.37 ^C
No	12 (85.7)	78 (92.9)	
Not available	4	27	
ICU LOS	0 (0–1)	0 (0–1)	.41 ^A
Hospital LOS	8 (5–10)	5 (3–8)	.28 ^A

[†] In patients catheterized, 14 CAUTI and 82 Non-CAUTI patients

^AWilcoxon rank sum test

^BChi square test

^CFisher's exact test

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Table 2

Admission Urinalysis results. Normal urine pH is considered to be 4.5 – 8.0. Normal urine glucose levels can range up to 15 mg/dL.

CAUTI – catheter associated urinary tract infection; UTI - urinary tract infection; Hx – history; UA – urinalysis; RBC – red blood cell; WBC – white blood cell; HPF – high powered field

	CAUTI (n = 18)	Non-CAUTI (n = 111)	p-value
Urine sample, n (%)			
Non-clear	1 (6.7)	1 (1.3)	0.30
Clear	14 (93.3)	76 (98.7)	
Not available	3	34	
Admit pH, median (range)	5.5 (5.2–6.0)	6.3 (5.3–6.7)	0.04 ^A
Admit Glucose(mg/dL), median (range)	14.0 (5.0–23.0)	7.0 (4.0–17.0)	0.25 ^A
Gram Stain, n (%)			
Borderline/Positive	9 (64.3)	13 (17.8)	<0.001 ^C
Negative	5 (35.7%)	60 (82.2%)	
Not available	3	36	
Microscopy Result, n (%)			
Abnormal	13 (86.7)	38 (50.7)	0.01 ^B
Normal	2 (13.3)	37 (49.3)	
RBC per HPF, n (%)			
>10	6 (46.2)	10 (23.3)	0.16 ^C
10	7 (53.8)	33 (76.7)	
Not Available	5	68	
WBC per HPF, n (%)			
4	11 (78.6)	11 (27.5)	<0.04 ^B
<4	3 (21.4)	29 (72.5)	
Not available	4	71	

^A Wilcoxon rank sum test

^B Chi square test

^C Fisher's exact test