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Not all nosocomial *Escherichia coli* bacteriurias are catheter-associated

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Abstract

We prospectively determined what proportion of nosocomial *E. coli* bacteriurias are associated with urinary catheters. Only 46% (95% CI 37–56%) of nosocomial *E. coli* bacteriurias were catheter-associated. Compared to bacteriuric patients with catheters, non-catheterized patients were less likely to be male and have renal insufficiency or a recent urogenital procedure.

Keywords

Escherichia coli; Bacteriuria; Urinary Tract; Catheter; Nosocomial

Urinary tract infections (UTIs) are the most common hospital-acquired infections and are thought to be primarily a consequence of urinary catheterization.[1] Strategies to prevent hospital-acquired UTIs focus almost exclusively on urinary catheter management. However, data to support the assumption that hospital-acquired UTIs can be equated with catheter-associated UTIs are very limited. In a recent editorial for a nationwide survey of practices to prevent hospital-acquired UTIs the author stated that 80% of these infections were catheter-associated but did not provide a reference.[2]

METHODS

We performed a 12-month prospective cohort study of inpatients with *E. coli* bacteriuria (defined as $\geq 5\times10^4$ colony-forming units/ml in a clean-voided urine culture, or $\geq 5\times10^3$ in urine culture from a catheterized patient) starting August 1st, 2009, at Barnes-Jewish Hospital, a 1250-bed teaching hospital in Missouri. Adult patients with a first positive urine culture ≥48 hours after admission were included. Urine cultures were performed at the treating physician's discretion. We excluded patients with polymicrobial bacteriuria and/or concurrent, non-*E. coli* bacteremia. Using medical records, the patients' clinical presentation, vital signs, laboratory, radiological, and pharmacy data were recorded prospectively.

A bacteriuria episode was considered to be catheter-associated if a catheter had been in place within 48 hours before urine cultures were obtained. Asymptomatic bacteriuria (ASB) was defined as absence of urinary symptoms;[3] cystitis as presence of dysuria, frequency, or urinary retention; pyelonephritis as flank pain or tenderness and/or fever (± cystitis

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symptoms). Sepsis was defined using established criteria. We reviewed blood cultures that were drawn within ±1 day of the bacteriuria.

We used SPSS 18 (SPSS Inc., Chicago, IL) for data analysis. Univariate comparisons of categorical variables were performed with χ^2 test or Fisher's exact test as appropriate. Continuous independent variables were analyzed using Student's t test or Mann-Whitney U test. A two-sided p value of <0.05 was considered significant. We entered variables with a p<0.1 in univariate testing into a multivariate logistic regression model. The study was approved by the Washington University Human Research Protection Office.

RESULTS

One hundred eighty-three patients had hospital-acquired *E. coli* bacteriuria during the study period and met study criteria. Patients were diagnosed with ASB (77; 42%), cystitis (28; 15%), pyelonephritis (55; 30%), or unclassifiable bacteriuria (e.g., intubated patients) (23; 13%). Among asymptomatic patients, 65 (84%) were female.

Eighty-five [46% (95% confidence interval, 37–56%)] of 183 episodes were catheter-associated. Patients with catheter-associated bacteriuria were more likely to be male (p=0.003), have renal insufficiency (p=0.02) and a recent urological procedure (p=0.03) (Table 1). There was no difference in frequency of ASB (p=0.6).

One hundred fifty-one bacteriuric patients (83%) received antibiotic treatment, including 64 (83%) of patients with ASB. The presence of a catheter did not determine whether antibiotics were given [70/71 (99%) with vs. 77/80 (96%) without catheter; p=0.6]. Among patients tested for it there was no difference in frequency of bacteremia (p=0.5). In-hospital mortality was similar in catheter-associated vs. non-catheter-associated bacteriuria (p=1.0) as was length of hospital stay after bacteriuria (p=0.08). Independent factors predisposing to catheter-association in bacteriuric patients are shown in Table 1.

DISCUSSION

It is widely assumed that the terms "hospital-acquired bacteriuria" and "catheter-associated bacteriuria" are synonymous. However, few data actually quantify urinary catheterization as a precursor of bacteriuria. The 1983 CDC guideline for prevention of catheter-associated UTIs states that 66–86% episodes of hospital-acquired bacteriuria are secondary to urinary instrumentation.[4] The corresponding reference does not explicitly provide this information.[5] Also, to our knowledge, this statement has not been reevaluated over the past three decades. We found that only 46% of hospital-acquired bacteriurias in a tertiary-care hospital were catheter-associated, lower than previously suspected. Why there was such a high proportion of non-catheterized bacteriuric patients is unclear. Changes in genitourinary hygiene during hospitalization may play a role as could medications that alter the bladder function. Possibly, hospital policies to reduce unnecessary device use resulted in a lower proportion of catheter-associated bacteriuria. The development of targeted preventive measures clearly depends on a better understanding of the pathogenesis of non-catheter-associated nosocomial bacteriuria.

In non-catheterized patients ASB may have been present before admission but remained undetected until later in the hospital course, leading to patients being mislabeled as having nosocomial bacteriuria. Testing this hypothesis would require admission urinary cultures to be obtained on patients. Antibiotic treatment of ASB was common (83%), independent of catheter status. Although ASB-related antibiotic overuse in long-term care facilities has stimulated interventions,[6] comparable data for acute-care hospitals are lacking. ASB may be

a major driver of antibiotic use (and antimicrobial resistance) in hospitals and therefore represents a target for antimicrobial stewardship.[7]

We identified a number of plausible independent predictors of catheter-associated bacteriuria. The lower level of catheter-association among bacteriuric women could be in line with their predisposition to ASB.[8] The need for monitoring fluid intake and output may contribute to higher catheterization frequency among bacteriuric patients with renal insufficiency. Lastly, catheters have been shown to result in post-procedure UTIs.[9]

Our data was obtained from medical records, including both physician and nurses' notes. It is possible that some urinary catheterizations were unrecorded, leading us to underestimate the number of catheter-associated bacteriurias. The imperfect correlation between catheterization and its documentation has been addressed in a recent study.[10] Also, the proportion of catheter-associated episodes might be higher for nosocomial pathogens other than *E. coli*.

In summary, we found catheter-associated infection to be less common in nosocomial *E. coli* bacteriuria than previously reported. A better understanding of non-catheter-associated bacteriuria could lead to improved infection prevention strategies among hospitalized patients.

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Table 1

Comparison of patients with hospital-acquired *Escherichia coli* bacteriuria depending on catheter association

Variable	Total n= 183	Catheter-associated n=85	Not catheter-associated n=98	*p value*	Odds Ratio (95% CI)
Gender (male)	46 (25%)	30 (35%)	16 (16%)	0.003	2.8 (1.4–5.7)
Race (white)	124 (68%)	60 (71%)	64 (65%)	0.4	
Age (years, median, range)	70 (20–98)	68 (24–96)	71 (20–98)	0.9	
Body Mass Index (kg/m^2, median, range)	27.1 (12.1–64.2)	27.0 (17.2–64.2)	27.3 (12.1–63.1)	0.7	
Charlson comorbidity score (median, range)	3 (0–13)	3 (0–13)	3 (0–11)	0.4	
Diabetes mellitus	64 (35%)	31 (37%)	33 (34%)	0.7	
Renal insufficiency (Cr>1.5 mg/dl)	42 (23%)	26 (31%)	16 (16%)	0.02	2.2 (1.0–4.6)
Any malignancy	50 (27%)	26 (31%)	24 (25%)	0.4	
Dementia	32 (18%)	10 (12%)	22 (22%)	0.06	0.5 (0.2–1.2)
Benign prostatic hyperplasia	12 (7%)	8 (9%)	4 (4%)	0.1	
Urological procedure this admission	8 (4%)	7 (8%)	1 (1%)	0.03	10.4 (1.2–88.8)
Fever	52 (28%)	23 (27%)	29 (30%)	0.7	
Confusion, altered mental status	47 (26%)	23 (27%)	24 (25%)	0.7	
Sepsis	98 (54%)	47 (55%)	51 (52%)	0.7	
Pyelonephritis	55 (30%)	25 (29%)	30 (31%)	0.9	
Asymptomatic bacteriuria	77 (42%)	34 (40%)	43 (44%)	0.6	
Urinalysis with >10 WBC	121 (66%)	61 (72%)	60 (61%)	0.1	
Outcomes					
Bacteremia (tested n=70)	9/70 (13%)	3/33 (9%)	6/37 (16%)	0.5	
Length of hospital stay after bacteriuria (days, median, range)	4.9 (0.1–66.1)	5.6 (0.2–36.5)	4.2 (0.1–66.1)	0.08	
In-hospital mortality	13 (7%)	6 (7%)	7 (7%)	1.0	

NOTES. All data expressed as n (%) unless otherwise specified.

CI=confidence interval. Cr=Creatinine. WBC=White blood cells. Hosmer-Lemeshow goodness-of-fit p=0.635 (for the multivariate logistic regression model).