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Major article

Catheter-associated urinary tract infection: Role of the setting of catheter insertion

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Key Words:
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Background: This study aimed to describe the epidemiology of catheter-associated urinary tract infections (CAUTIs) in patients admitted to a surgical ward in Central Italy and to analyze the associated risk factors.
Methods: An active surveillance program for CAUTI was carried out in patients catheterized for at least 48 hours. Place of catheter insertion (operating room, hospital ward, cystoscopy room, emergency care unit), indication for catheterization and its duration, among other risk factors were monitored until discharge. Antibiotic resistance profiles of isolates were analyzed.
Results: There were 641 catheterized patients monitored for CAUTI onset. Of these, 40 (6.2%) developed a CAUTI (rates were 15.1/1,000 catheter days, 95% confidence interval [CI], 11.9-22.6; 8.7/1,000 patient days, 95% CI, 6.9-13.1). Patients with CAUTI were older ($P < .05$) and their durations of hospitalization and catheterization were both longer compared with those who were not affected ($P < .05$). Catheterization >4 days (odds ratio [OR] = 8.21; 95% CI, 3.79-17.73; $P < .05$) and place of catheter insertion different from the operating room (OR = 7.9; 95% CI, 2.83-22.08; $P < .05$, for catheters placed in the ward) were associated with CAUTI. Among the micro-organisms isolated in CAUTIs, the most common were *Pseudomonas aeruginosa* (41.5%), *Klebsiella pneumoniae* (19.5%), and *Escherichia coli* (12.2%); 82.5% of them were resistant to different classes of antibiotics.
Conclusion: These results highlight the role played by the setting of catheter insertion in CAUTIs onset, therefore reflecting the importance of hand hygiene and proper aseptic insertion techniques as crucial determinants in CAUTIs prevention.

Catheter-associated urinary tract infections (CAUTIs) are among the most common hospital-acquired infections worldwide, accounting for >1 million cases in the United States and Europe annually[1,2]; 70%-80% of hospital-acquired infections are attributable to an indwelling urethral catheter,[3,4] which is often misused, in the absence of an appropriate indication.[5-7] The main factors contributing to the increased risk of developing CAUTIs have been studied and addressed in continuously updated guidelines.[8-10] Among the well-established risk factors, the duration of catheterization is one of the most important[11]; additional risk factors include female sex, older age, and not maintaining a closed-drainage system.[9,12] Among the other categories, patients undergoing surgical procedures of the urinary tract have several risk factors for developing urinary tract infections.

The purpose of this study was to describe the epidemiology of CAUTIs in patients admitted to a surgical ward in an acute care hospital in Central Italy and to analyze the associated risk factors.

METHODS

Setting

The study was conducted in a surgical ward of the Azienda Ospedaliero-Universitaria "Ospedali Riuniti of Ancona," a 950-bed teaching hospital located in Central Italy.

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Conflicts of interest: None to report.

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Data collection

From January 2013-December 2013, an active surveillance program was carried out. The surveillance was carried out by 2 trained physicians of the hospital hygiene service, by reviewing medical records and discussion with physicians and nurses belonging to the surgical ward, 2 times a week. All patients admitted to the surgical ward and requiring urethral catheterization for at least 48 hours were included in the surveillance program, whereas those admitted for day surgery or day hospital and those catheterized for <48 hours were excluded. The following data were collected for each patient: sex, date of birth, date of admission, date of catheter insertion, place of catheter insertion (operating room, hospital ward, cystoscopy room, emergency care unit), indication for catheterization (acute urinary retention or bladder outlet obstruction, measurement of urinary output in critically ill patients, urological surgery, miscellaneous indications), date of catheter removal, date of discharge, presence of clinical signs and symptoms of urinary infection, and microbiologic findings (antibiotic sensitivity-resistance profiles of all organisms were analyzed). All patients were monitored until they were discharged or transferred to another ward; CAUTI onset was not considered a reason for follow-up dropout. Therefore, all patients were followed until the catheter was removed, except those discharged with the catheter left in place. The CAUTI definition was in agreement with that of the Centers for Disease Control and Prevention and National Healthcare Safety Network.[13] Patients were considered CAUTI negative if not meeting the defined criteria during their hospitalization. All indications to catheterization were evaluated for appropriateness based on the Centers for Disease Control and Prevention's 2009 guidelines.[9]

A catheterization duration of 4 days was selected as a threshold of significant increased risk in CAUTI, as reported by previous studies,[1,14] because it has been found that the removal of unnecessary urinary catheters 4 days after insertion reduces the frequency of late CAUTI.[15] Moreover, this theoretical threshold was confirmed in our sample by performing an analysis by receiver operating characteristic curve of correctly classified cases (area under receiver operating characteristic curve = 0.71; 95% confidence interval [CI], 68.3-75.4).

According to the recently published European Centre for Disease Prevention and Control and Centers for Disease Control and Prevention joint recommendations for epidemiologic studies,[16] pathogens identified were defined as multidrug resistant (MDR) if nonsusceptible to ≥3 antimicrobial categories, extensively drug resistant (XDR) if nonsusceptible to all but 2 or 1 categories, or pandrug resistant (PDR) if nonsusceptible to all antimicrobial agents tested.

Statistical analysis

The incidence of CAUTIs was calculated as the number of first episodes per 1,000 catheter days and as the number of first episodes per 1,000 patient days. The device utilization ratio was obtained by dividing the total number of catheter days by the total number of hospitalization days and multiplying by 100.

A case-control approach was used to study factors potentially associated with infection (eg, sex, age, catheterization days before CAUTI onset, hospitalization days). Bivariate analyses were performed to analyze the association between risk factors and cumulative incidence of CAUTIs in the sample using a χ^2 test. Multiple logistic regression models were developed to evaluate which factors were independently associated with the outcome (CAUTI onset). The significance level for variables to enter the multiple logistic regression model was set at ≤0.2, and for removing them from the model it was set at ≤0.4. The level of significance was set at $P < .05$. Data were analyzed using Stata 9.0 software package (StataCorp, College Station, TX).

Table 1
Distribution of baseline characteristics among catheterized patients with or without CAUTI (*P* values <.05 are reported in the text)

Variables	Patients with CAUTI	Patients without CAUTI	OR	*P* value
Sex				
Men	30 (75.0)	470 (78.2)	1	
Women	10 (25.0)	131 (21.8)	1.20	.636
Age (y)				
<65;	16 (40.0)	275 (45.8)	1	
65-84	19 (47.5)	267 (44.4)	1.22	.565
≥85	5 (12.5)	59 (9.8)	1.45	.480
Duration of catheterization (d)				
<4	11 (27.5)	429 (71.4)	1	
≥4	29 (72.5)	172 (28.5)	6.58	<.05
Indication				
Acute urinary retention	NA	3 (0.5)	NA	NA
Measurement of urinary output	1 (2.5)	4 (0.5)	NA	NA
Urological surgery	28 (70.0)	532 (88.5)	0.30	<.05
Hematuria	8 (20.0)	42 (7.0)	3.28	<.05
Miscellaneous indications	3 (7.5)	20 (3.3)	1.51	.587
Place of catheter insertion				
Operating room	10 (25.0)	274 (45.6)	1	
Hospital ward	18 (45.0)	268 (44.6)	7.68	<.05
Emergency department	5 (12.5)	32 (5.3)	3.41	.08
Cystoscopy room	7 (17.5)	27 (4.5)	1.83	.13

NOTE. Values are n (%) or as otherwise indicated.
CAUTI, catheter-associated urinary tract infection; *NA*, not applicable; *OR*, odds ratio.

RESULTS

During the study, 641 catheterized patients were monitored for CAUTI incidence; patients included 500 men (83.2%) and 141 women (16.8%) (Table 1), with a mean age of 63.3 ± 16.0 years (95% CI, 62.1-64.5). The catheterization rate was 57.8 per 100 patient days. The main indication for catheterization was the perioperative use in patients undergoing surgery (84.4%, n = 540), followed by hematuria (7.8%, n = 50).

During the surveillance period, 40 out of 641 (6.2%) patients developed a CAUTI, with a CAUTI rate of 15.1 per 1,000 catheter days (95% CI, 11.9-22.6) and 8.7 per 1,000 patient days (95% CI, 6.9-13.1). The mean duration of catheterization was 4.11 days (range, 2-40), with 9.4 ± 7.95 days (range, 2-40) for patients with CAUTI versus 3.8 ± 2.76 days (range, 2-24) for patients who did not develop any urinary infection ($P < .05$). The mean duration of hospitalization was 7.1 ± 6.0 days, with variations between infected and noninfected patients: length of stay was 16.3 ± 12.38 days (range, 3-70) in patients with CAUTI versus 6.5 ± 4.71 days (range, 2-37) in those without CAUTI ($P < .05$).

Multinomial logistic regression (Table 2) has highlighted the role of duration of catheterization of >4 days as an important risk factor for CAUTI (odds ratio = 8.21; 95% CI, 3.79-17.73); moreover, the place of catheter insertion was revealed as a risk factor, in particular, catheters inserted in places different from the operating room showed various grade of risk, up to an odds ratio of 7.9 (95% CI, 2.83-22.08) for catheters put in place in the ward.

In regard to microbiologic findings, the most common microorganism isolated in CAUTIs was *Pseudomonas aeruginosa* (41.5% of isolates, n = 16), followed by *Klebsiella pneumoniae* (19.5% of the total, n = 8), *Enterococcus* spp (15%, n = 6), *Escherichia coli* (12.2%, n = 5), and *Candida albicans* (5%, n = 2). Moreover, 33 (82.5%) isolated bacteria were resistant to different classes of antibiotics: specifically, 9 micro-organisms (22.5% of all isolates) were MDR, 23 (57.5% of the total) were defined as XDR, and 1 (2.5%) was nonsusceptible to all the antimicrobial agents tested (PDR).