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Review Article

## Catheter-associated urinary tract infections – A review

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### ABSTRACT

Catheter-associated urinary tract infections (CAUTIs) are one of the most common hospital-acquired infections and contribute to significant morbidity and mortality in patients. They can cause symptoms such as fever, hematuria, pain, and acute confusion. The most common causative organism is *Escherichia coli*. The treatment of CAUTIs is often dependent on the urine cultures and sensitivities. CAUTIs account for a significantly large number of hospital-acquired infections. They are often preventable with the right education and management. In obstetrics and gynecology, it is important to have a policy of taking catheters out as soon as feasible to reduce the risk of UTIs as well as health-care costs. In this review we discuss the pathophysiology, treatment, and prevention strategies of CAUTIs and current evidence based perspective.

**Keywords:** Catheter, Urinary tract infections, Hospital acquired infection

### INTRODUCTION

Urinary catheters (either urethral or suprapubic) are usually indicated in situations such as urinary retention and bladder outlet obstruction to monitor urine output during surgical procedures or urology investigations, for immobile patients, or for some patients on end-of-life care.

Urinary tract infections (UTIs) are one of the most common hospital-acquired infections (HCAIs). The HCAI is an important cause of prolonged hospital stays around the globe. UTIs are one of the most common HCAIs with an estimated prevalence of 1–10%, accounting for 40% or more of all HCAIs reported in hospital settings.<sup>[1]</sup> Majority of infections of urinary tract are directly linked to the widespread use of indwelling catheters. Between 12% and 16% of hospitalized patients may receive a short-term indwelling urinary catheter.<sup>[2]</sup> In a hospital-based observational study from a medical intensive care unit (ICU) of a tertiary center in northern India, the CAUTI rate was reported to be 9.4/1000 urinary catheter days, while the overall magnitude was 14.67%. It was predominantly reported in 51–70-year age group (34%), in those with diabetes (17.24%) and females (63.63%) with *Escherichia coli* being the most common pathogen.<sup>[3]</sup> Besides, female gender and those with diabetes mellitus, malnutrition, chronic kidney disease, and immune deficiency are risk factors for catheter-associated urinary tract infections (CAUTIs).<sup>[4]</sup>

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In long-term catheterization (that is, by the end of 30 days), CAUTI develops in 100% patients usually with two or more symptoms or clinical signs of hematuria, fever, suprapubic or loin pain, visible biofilm in character or catheter tube, and acute confusion.<sup>[5]</sup>

CAUTI contributes to significant morbidity and mortality in hospitalized populations.<sup>[6]</sup> The Centers for Disease Control and Prevention provides a definition for CAUTI, which pertains to patients who have a catheter inserted and left in place for 48 h or longer.<sup>[7]</sup> CAUTIs can lead to such complications as cystitis, pyelonephritis, Gram-negative bacteremia, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis in patients.<sup>[8]</sup>

Indwelling catheters facilitate colonization with bacteria by providing a surface for the attachment of host cell binding receptors. This is recognized by bacterial adhesins, thus causing more bacterial adhesion. Furthermore, the uroepithelial mucosa is damaged which allows new binding sites for bacterial adhesins. Most organisms that cause CAUTI enter the bladder through the intraluminal or extraluminal surfaces of the catheter. The catheter lumen can be contaminated by bacteria from failure of the closed drainage system or contaminated urine in the catheter drainage bag. Extraluminal bacterial colonization can occur from non-sterile insertion technique.<sup>[9]</sup> Extraluminal route may be of greater importance in women because of the short urethra and its close proximity to the anus.

The most common cause of UTIs in both inpatient and outpatient settings is *E. coli*, accounting for the majority of cases. In addition, coagulase-negative Staphylococci, *Klebsiella* species, *Proteus* species, *Enterobacter* species, and yeasts such as *Candida* species account for most of the other causes of CAUTIs.<sup>[10]</sup>

## DIAGNOSIS

The symptoms of CAUTIs are generally non-specific and often asymptomatic. Some symptoms that can occur are listed above.<sup>[5]</sup>

Dipstick testing is not an effective method for detecting UTIs in adults with indwelling urinary catheters. Catheters quickly become colonized with bacteria and can irritate the bladder wall, resulting in pyuria; however, this does not always indicate infection.<sup>[11]</sup>

The presence, absence, or degree of pyuria, as well as the presence or absence of odorous or cloudy urine alone, should not be used to differentiate catheter-associated asymptomatic bacteriuria from CAUTI.

The gold standard of diagnosing a CAUTI should be based on signs and symptoms of the patient combined with their

urine culture and sensitivities. Urine collected for culture can be obtained from the catheter sample or from a mid-stream urine sample in patients whose catheter has been removed within the past 48 h. The cultures must have  $\geq 1000$  colony-forming unit/mL with more than one bacterial species in a single catheter urine specimen or in a mid-stream void sample from a patient whose catheter has been removed in the past 48 h. The specimen may be contaminated if 3 or more organisms are identified.<sup>[11]</sup> In these cases, it may be worth repeating the sample.

## TREATMENT

Women with asymptomatic bacteriuria do not routinely require treatment unless they are pregnant. The treatment for CAUTIs in patients who are symptomatic should be empirical antibiotic treatment based on culture sensitivities and local guidelines. Before antibiotics are given, a catheter that has been in place for 7 days or more should be removed or changed<sup>[12]</sup> if not already done so. The choice of antibiotic and the dose may differ for pregnant versus non-pregnant women and children under 16 years old. It may also depend on whether the patient has renal or hepatic impairment.

## PREVENTION

CAUTIs are often preventable. Catheters should be placed with an aseptic technique with sterile equipment by a trained professional. A closed drainage system should be used for all patients with an indwelling catheter and the drainage bag should be placed below the pelvis to avoid contamination to the drainage tap.<sup>[13]</sup>

There is no routine antibiotic prophylaxis needed for patients with short or long-term urinary catheters<sup>[14]</sup> and the majority of best practice guidelines do not recommend antibiotics before inserting or removing them. In high-risk groups, however (such as significantly immunocompromised patients or patients with bacteriuria susceptible to endocarditis), it may be appropriate to administer a single dose of antibiotic for prophylaxis.

There have been studies regarding the use of chlorhexidine baths to help prevent CAUTIs which is still debatable. One systematic review involving ICU patients only reported that daily chlorhexidine bathing was associated with a significant reduction in CAUTI (RR 0.68).<sup>[15]</sup>

Hydrophilic-coated catheters have been found to be beneficial for reducing CAUTI rates by reducing the growth of several uropathogens. This is by providing a hydration layer which can resist non-specific adherence.<sup>[16]</sup>

Silver alloy-coated catheters were not effective for reducing the incidence of symptomatic CAUTI. The reduction

noted in CAUTI associated with nitrofurantoin-impregnated catheters was less than that regarded as clinically important. Routine use of antimicrobial-impregnated catheters is not supported.<sup>[17]</sup>

The duration of catheterization is the most important factor in the development of bacteriuria, as its daily usage increases the risk of infection by 3–7%. A systematic review of 7 randomized controlled trials concluded that, among women who have had pelvic organ prolapse surgery, early catheter removal is preferred. Moreover, the timing for removal is preferably within 2 days postoperatively.<sup>[18]</sup>

Early removal of urinary catheters after elective cesarean section is associated with significantly less urinary frequency, dysuria, bacteriuria, hospital stay and mobilization time.<sup>[19]</sup>

Urinary catheter reminders and stop orders appear to reduce the rate of CAUTI and should be strongly considered to enhance the safety of hospitalized patients. The rate of CAUTI (episodes/1000 catheter days) was reduced by 52% ( $P < 0.001$ ) with the use of a reminder or stop order. The mean duration of catheterization decreased by 37%, resulting in 2.61 fewer days of catheterization per patient in the intervention versus control groups.<sup>[20]</sup>

## CONCLUSION

CAUTIs are an extremely prevalent condition. Adequate knowledge of the pathogenesis, investigations, treatment, and prevention methods is useful in reducing the number of patients and morbidity associated with CAUTIs.

### Ethical approval

Institutional Review Board approval is not required.

### Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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### Conflicts of interest

There are no conflicts of interest.

### Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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