

Urinary tract infections in the critical care unit: A brief review

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Abstract

The use of indwelling catheters in the Critical Care Units (CCUs) has a major role in determining the incidence and the morbidity as well as mortality from hospital-acquired urinary tract infections (UTIs). Instituting evidence-based protocols can significantly reduce both the prevalence of indwelling catheterization as well as the incidence of hospital-acquired UTIs. The prevalence of catheter-associated urinary tract infections (CAUTIs) in the CCUs is directly linked to the widespread use of indwelling catheters in these settings. CAUTIs result in significant cost escalation for individual hospitals as well as the healthcare system as a whole. A UTI is an inflammatory response to colonization of the urinary tract, most commonly by bacteria or fungi. A UTI should be differentiated from the mere detection of bacteria in the urinary tract. This condition, referred to as asymptomatic bacteriuria, is common and does not require treatment, especially in the patient with an indwelling urinary catheter. A CAUTI occurs when a patient with an indwelling urinary catheter develops 2 or more signs or symptoms of a UTI such as hematuria, fever, suprapubic or flank pain, change in urine character, and altered mental status. CAUTI is classified as a complicated UTI. The current review highlights the important management issues in critical care patients having CAUTI. We performed a MEDLINE search using combinations of keywords such as urinary tract infection, critical care unit and indwelling urinary catheter. We reviewed the relevant publications with regard to CAUTI in patients in CCU.

Keywords: Catheter-associated urinary tract infection, critical care unit, urinary tract infection

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Introduction

Catheter-associated urinary tract infection (CAUTI) is an important cause of morbidity and mortality in Indian subjects, affecting all age groups.^[1] Bacteriuria or candiduria is almost inevitable in nearly half of the patients who require an indwelling urinary catheter for more than 5 days.^[2,3] Asymptomatic bacteriuria constitutes a major pool of the antibiotic-resistant strains of pathogens in any hospital, with critical care units (CCUs) accounting for the majority of them.^[4,5] CAUTI is also a major cause of hospital-acquired bacteremia,^[6] and even asymptomatic bacteriuria may be associated with enhanced in-hospital mortality rates.^[4,7] Patients in critical care units are

often febrile due to causes which may be infectious or non-infectious.^[8-11] These patients by their very nature and the surroundings that they are in, are at a high risk of developing infections. The importance of UTIs in the CCU lies in the fact that distinguishing urosepsis from inconsequential bacteriuria with fever from other causes can be difficult. Therefore, it is always tempting to initiate antibiotic therapy on the basis of a positive urine culture. The current review highlights the important issues in the management of patients with UTI in the CCU.

We performed a MEDLINE search using combinations of keywords such as urinary tract infection, critical care unit and indwelling urinary catheter. Between 1966 to March 2013, the search yielded over 100 papers. In an attempt to provide a review of comprehensive management of patients with UTI in the CCU, we selected 76 relevant publications with some important cross-references from the list of publications.

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Pathogenesis

Barring hematogenous seeding, almost exclusively, of *Staphylococcus aureus*, causing pyelonephritis, almost all micro-organisms implicated in endemic CAUTI are either part of the patient's colonic or perineal flora, or derived from the hands of medical and paramedical personnel during insertion of indwelling catheters or improper handling of the collection system. Organisms may cause CAUTI in one of two ways [Figure 1]. Extraluminal ascending infection may be caused either during the time of indwelling catheter insertion, or later on by organisms from the perineal areas moving upward by capillary action in the thin mucous film that coats the external surface of the catheter. Intraluminal infection is caused by organisms gaining access to the lumen of the catheter either from failure of closed drainage or the urine in the collecting bag getting contaminated. While extraluminal ascension of micro-organisms may be the more common means of causation of CAUTIs, both routes are important.^[12]

Definition of CAUTI

CAUTI needs to be defined with some caution. Urine sampling for microbiological workup needs to be done carefully avoiding contamination, either routinely once a week, or at the beginning of a new episode of sepsis. CAUTI is usually deemed present if there are at least 10^3 colony-forming units (cfu)/mL of 1 or 2 micro-organisms identified by urine culture.^[13,14] While 'significant' bacteriuria is defined as $>10^5$ cfu/mL, once micro-organisms are detected in the urine, in the absence of anti-microbials, it is almost inevitable to reach the 10^5 cfu/mL level quite rapidly, which is why the level of 10^3 cfu/mL is believed to be indicative of true CAUTI. An ICU-acquired UTI refers to those patients who develop a

positive urine culture first identified on ICU Day 3 (48 h) or later.^[9,15] Patients developing positive urine cultures within 48 h of being discharged from an ICU, could also be defined as having ICU-acquired UTI. The Centers for Disease Control and Prevention (CDC) defines CAUTI for those patients who have an indwelling catheter in place for 48 h or more.^[16] For diagnosing UTI, the CDC requires that the patient should be manifesting symptoms such as fever or chills, new onset of burning pain, urgency or frequency if not catheterized at that point of time, change in urine character, flank or suprapubic pain or tenderness or change or decrease in mental or functional status in patients older than 65 years. In patients who do not have compelling laboratory evidence such as positive urine culture, the CDC gives credence to a positive dipstick test for leucocyte esterase and/or nitrate, pyuria and visualization of organisms on Gram stain of unspun urine, if these are associated with two or more clinical symptoms of UTI. The CDC guidelines therefore, help distinguish asymptomatic catheter-associated bacteriuria or candiduria, which are rarely associated with adverse outcomes and generally do not require treatment with antimicrobials,^[17] from true CAUTI.

Risk factors for CAUTI

Multiple factors have been identified as potential risk factors for CAUTI [Table 1]. Many of them are relevant for patients managed in CCUs including prolonged catheterization,^[18] use of systemic antibiotics,^[19] other active sites of infection,^[13] diabetes mellitus,^[20] and elevated creatinine.^[13] Females have much higher risk compared to males,^[20] and pre-existing conditions such as malnutrition^[18] also put the patient at increased risk. Insertion of the indwelling catheter outside the protected environs of the operating room,^[18] ureteric stenting^[13] and assiduous monitoring of urine output using the catheter^[21] are all independent risk factors for CAUTI. A most important and potentially modifiable risk factor

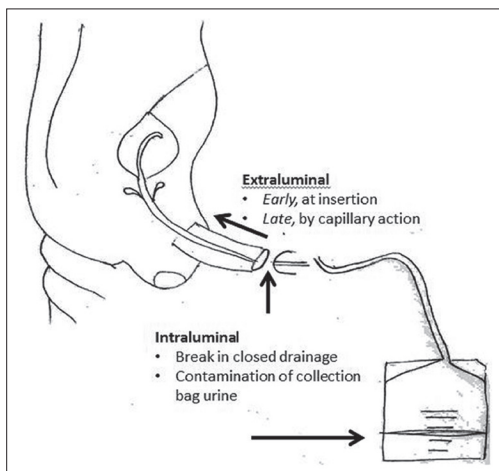


Figure 1: Routes of entry of micro-organisms into a catheterized urinary tract

Table 1: Risk factors for catheter-associated urinary tract infection

Prolonged catheterization
Female gender
Catheter insertion outside operating theatre
Urology service
Other active sites of infection
Diabetes
Malnutrition
Creatinine >2 mg/dL
Ureteric stents
Rigorous monitoring of urine output
Improper positioning of drainage tube
Antimicrobial drug therapy

Modified and used from: Guide to the elimination of catheter-associated urinary tract infections (CAUTIs): Developing and applying facility-based prevention interventions in acute and long-term care settings. <http://www.apic.org>

is the duration of catheterization,^[13] and hence indwelling urinary catheters need to be used for the shortest periods of time feasible. By the 30th day of catheterization, infection rates are about 100%.^[13] Closed drainage,^[22] dependent drainage including proper positioning of the drainage tubing and collection bag and protection of the drainage port could go a long way in reducing the burden of CAUTI.^[23] Antimicrobial drug therapy, while protective for short-duration catheterizations, carries the risk of selective colonization with multi-drug-resistant organisms such as *Pseudomonas aeruginosa*, other resistant Gram-negative bacilli, enterococci and yeasts.^[24] CCU-acquired CAUTI was not found to be an independent risk factor of in-hospital death,^[25] although it contributes to significant morbidity.^[26]

Guidelines for preventing CAUTI

The single most important manoeuvre which can reduce the incidence of CAUTI is to use indwelling urinary catheters only when justified.^[27] It should never be used for management of urinary incontinence, and alternatives to urethral catheterization should be explored for such situations.^[28] Sterile techniques should be strictly followed for insertion of indwelling urinary catheters.^[27] Pre-connected closed drainage systems might reduce the risk of disconnection of the closed system,^[29] although there is no conclusive data that these can reduce the incidence of CAUTI.^[30] The collection system should always be placed below the level of the bladder and not be allowed to touch the floor.^[31] Aseptic techniques should be employed for emptying the drainage system,^[27] and the same collection system should never be used for more than one patient. Other preventive practices include removal of the catheter as soon as possible,^[32] avoiding opening the system, encouraging fluid intake and avoiding irrigation of the bladder. Anti-infective catheters can be employed if indicated, in patients who are judged to be at a high risk for development of CAUTI.^[33]

Recent studies have shown the effectiveness of the implementation of multidimensional urinary tract infection prevention strategies and bundles in critical care units.^[34-37] Such approaches include a specific bundle of interventions for CAUTI prevention, education, outcome surveillance, process surveillance, feedback of CAUTI rates and performance indices of infection control practices. These strategies have been successfully employed in both adult and pediatric critical care areas. These multidimensional infection control programs for CAUTI prevention have shown reduction in the CAUTI rates of CCUs, which were associated with improvement in hand hygiene, as an

integral component of a multi-faceted strategy, and as a result of providing education and training on CAUTI prevention measures by means of introducing bundles of interventions. Thus, improvements in processes of care can lead to a reduction in the risk of CAUTI, and their adverse consequences, especially in CCUs of resource-limited countries like India. There is also a continuous need to foster sustained improvements in practices.

Anti-infective urinary catheters

The choice of anti-infective catheters is between antiseptic- and antimicrobial-coated urinary catheters, both of which have been widely studied for prevention of catheter-associated bacteriuria. Presently marketed antiseptic-coated catheters are coated with silver alloy, as silver oxide-coated catheters which were tried a few years back, did not demonstrate significant efficacy in preventing CAUTI.^[38] Antimicrobial-coated catheters include those coated with nitrofurazone, rifampicin or minocycline. A meta-analysis in which the benefits of using silver alloy coated catheters was investigated, demonstrated a decreased incidence of catheter-associated asymptomatic bacteriuria with the use of these catheters, compared to standard latex catheters, in patients who had indwelling catheters for less than 7 days duration.^[39] Antimicrobial-coated catheters also reduced the occurrence of asymptomatic bacteriuria in patients catheterized for less than 7 days. However, for duration of catheterization exceeding 7 days, the results from use of antiseptic-impregnated catheters were not as impressive, while antimicrobial-coated catheters failed to demonstrate any benefit in this group. Johnson *et al.*, in their systematic review also reported similar results.^[40] Further, although several studies report reduced incidence of asymptomatic bacteriuria, use of anti-infective catheters has not been demonstrably associated with prevention of CAUTI, reduced incidence of bacteremia resulting out of urosepsis or decreased mortality rates therefrom, and hence their routine use in CCUs cannot at present be recommended.^[41] However, use of anti-infective urinary catheters could be considered in patients deemed to be at high risk for development of CAUTI or if all other preventive measures fail to bring down CAUTI rates in a CCU. Similarly, use of systemic antimicrobials for prophylaxis of CAUTI is also not recommended, based on available evidence.^[42] Thus, the prevention of CAUTI remains an area of active and ongoing research, and updated guidelines should always be referred to when establishing protocols for Critical Care Units with regard to the same.

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