Journal of Infection and Chemotherapy 27 (2021) 1400–1406

Contents lists available at ScienceDirect

Journal of Infection and Chemotherapy

journal homepage: www.elsevier.com/locate/jic

Guideline

Catheter-associated urinary tract infection

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ARTICLE INFO

Keywords:
CAUTI
UTI
Catheter-associated urinary tract infection
Urinary tract infection

ABSTRACT

This guideline contains updated recommendations on the management and prevention of CAUTIs by the Urological Association of Asia and the Asian Association of Urinary Tract Infection and Sexually Transmitted Infection.

1. Summary of recommendations

1. CAUTIs are a leading cause of nosocomial infections. Definitions remain controversial, but the US NHSN definitions [1] have been widely accepted.
2. Higher rates of CAUTIs and antibiotic resistant organisms have been reported in parts of Asia. Hence, antimicrobial treatment choice should be guided by local antibiograms and culture results (LE: 4).
3. CAASB should not be routinely treated with antibiotics (LE: 1b). Routine surveillance cultures in catheterized patients are not warranted and should not be done.
4. Reducing the duration of urethral catheterization remains key to the prevention of CAUTIs (LE: 2b), for which various reminder systems have been shown to be effective (LE: 1a).
5. Urinary catheter care bundles have also been shown to reduce CAUTI rates (LE: 2a).

2. Introduction

This guideline is an update of published guidelines from Asia [2] and beyond [3–5] on the management and prevention of CAUTIs.

3. Methods

A systematic literature search was performed in PubMed using the following search terms: urinary tract infection OR bacteriuria OR CAUTI OR UTI, AND catheter. Search was limited to studies published over the past ten years in English with abstract available. Sixty-two papers were shortlisted for further review, together with other major clinical trials cited in the earlier guideline.

4. Definition

CAUTI refers to UTIs associated with indwelling urinary catheters, which are defined as drainage tubes inserted into the urinary bladder through the urethra, left in place, and connected to a collection system [4].

The definition of CAUTI remains controversial, with all guidelines agreeing that symptoms alone are not reliable for the diagnosis of CAUTI [2] [–] [4,6] [–] [10]. For surveillance purposes, the US CDC's NHSN definitions [1] have commonly been accepted and used in most published reports [11], despite these definitions being difficult to apply in practice [12]. The NHSN definitions are described below in the diagnosis section.

Alternative urinary drainage methods are available, such as clean intermittent ("in-and-out") urinary catheterization, external catheters that fit over or adhere to the genitalia ("condom" catheters), suprapubic catheters and nephrostomy tubes. Although UTIs associated with these methods may be considered device-associated, NHSN CAUTI definitions typically refer only to UTIs associated with indwelling urethral catheters. Hence, CAUTI will be taken to refer only to indwelling urethral catheters throughout this guideline.

5. Epidemiology

UTIs are a leading cause of nosocomial infections worldwide, and have been estimated to cause approximately 30 % of HCAIs in the acute

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https://doi.org/10.1016/j.jiac.2021.07.022
Received 12 June 2021; Accepted 27 July 2021
Available online 4 August 2021

Abbreviations

CAASB	catheter-associated asymptomatic bacteriuria
CAUTI	catheter-associated urinary tract infection
CDC	Centers for Disease Control and Prevention
CFU	colony-forming unit
HAI/HCAI	healthcare-associated infections
ICU	intensive care unit
NHSN	National Healthcare Safety Network
US	United States
UTI	urinary tract infection
WBC	white blood cell

surveillance study was conducted over 6 years by the International Nosocomial Infection Control Consortium in 422 ICUs of 36 countries in Latin America, Asia, Africa, and Europe, of which 57 % were in Asia. The study found developing countries to have a rate of 6.3 CAUTIs per 1000 urinary catheter-days, compared to 3.3 per 1000 catheter-days in comparable US ICUs [15]. CAUTIs in developing countries were also associated with higher rates of antibiotic resistance on microbiological surveillance.

The sheer frequency of urinary catheter usage in most healthcare settings highlights the impact and significance of CAUTI in the healthcare system globally and in Asia [4,14,16] [–] [20]. However, a recent point-prevalence survey in the US have shown that implementation of evidence-based interventions in programs such as the Comprehensive Unit-based Safety Program, which aims to reduce urinary catheter use, may be effective in reducing the prevalence of CAUTI [21].

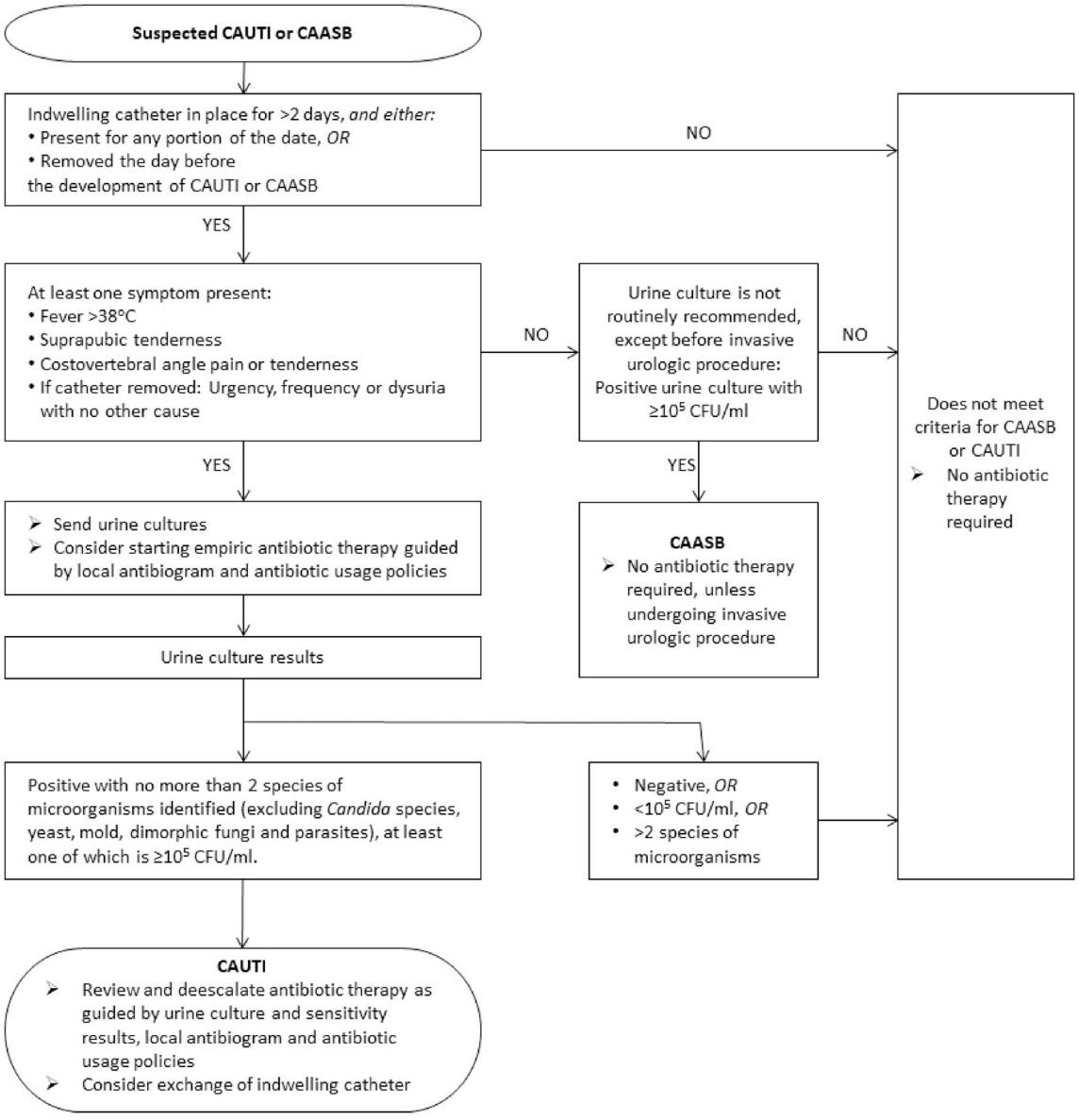

Fig. 1. Algorithm for diagnosis, classification and management of CAUTI and CAASB.

care setting in the United States [13]. Of these, approximately 75 % are associated with an indwelling urinary catheter.

The impact of CAUTI is likely to be even greater in Asia [14]. A

6. Pathogenesis and risk factors

The presence of a urethral catheter will bypass or inhibit natural host

Table 1
Criteria and classification of CAUTI and CAASB.

	Indwelling urinary catheter criteria	Symptoms criteria	Microbiological criteria
CAUTI	In place for >2 consecutive days, and catheter present for any portion of the date of development of CAUTI	At least 1 of the following: • Fever >38 °C • Suprapubic tenderness • Costovertebral angle pain or tenderness	Positive urine culture with no more than 2 species of microorganisms identified (excluding *Candida* species, yeast, mold, dimorphic fungi and parasites), at least one of which is $\geq 10^5$ CFU/ml.
	In place for >2 consecutive days, but removed the day before the development of CAUTI	At least 1 of the following: • Urgency, frequency or dysuria with no other cause • Fever >38 °C • Suprapubic tenderness • Costovertebral angle pain or tenderness	Positive urine culture with no more than 2 species of microorganisms identified (excluding *Candida* species, yeast, mold, dimorphic fungi and parasites), at least one of which is $\geq 10^5$ CFU/ml.
CAASB	In place for >2 days, and either in place on the date of assessment, **OR** removed on the day of or the day before assessment	No symptoms of UTI, including: • Urgency, frequency or dysuria • Fever • Suprapubic tenderness • Costovertebral angle pain or tenderness	Positive urine culture of $\geq 10^5$ CFU/ml.

Routine urine cultures in asymptomatic catheterized patients are not recommended.

defenses, predisposing patients to CAUTIs [22]. This is further exacerbated by the development of biofilm on the urinary catheters, which provides a favorable environment for bacterial proliferation & invasion [2,23].

Bacteria may be introduced into the urinary tract via several routes, such as:

i. Inoculation at the time of catheter insertion, especially in patients who have had inadequate disinfection of the perineum prior to catheterization.
ii. Via intraluminal ascent in the urinary catheter lumen after contamination of the closed urinary catheter system (such as via breaks in aseptic practice during the emptying of the urinary drainage bag, or temporary disconnection of catheters from urinary bags).
iii. Via extraluminal route of ascent along the external surface of the urinary catheter into the urethra.

The most common uropathogen isolated from the catheterized urinary tract is *Escherichia coli*. Other common organisms isolated in patients with short-term catheterization include *Pseudomonas, Klebsiella, Proteus,* Enterococcus and Candida species. *Proteus mirabilis* bacteriuria is often associated with catheter obstruction, and polymicrobial bacteriuria is commonly found in patients with long-term catheters [21,24].

Risk factors for CAUTI which have been identified in prospective observational studies include [22,25] [–] [27]:

- Duration of catheterization
- Female gender
- Anatomical or functional abnormalities of the urinary tract
- Insertion of the catheter outside the operating room

Table 2
Principles to guide selection of antibiotics.

	Recommendation	LE/GR
1.	Monitoring of local antibiotic resistance patterns in uropathogens.	4/C
2.	Urine cultures, preferably before initiation of antibiotic therapy, to guide choice of definitive antibiotic therapy.	4/C
3.	Empiric antimicrobial therapy could be guided by recent prior urine culture results, where possible [37].	2 b/C
4.	Early de-escalation of antibiotic therapy, as guided by urine culture results, to the narrowest spectrum antibiotic available.	4/C
5.	Shorter 5 day course of antibiotics with catheter exchange may be considered in the treatment of CAUTI in patients with spinal cord injury [38].	1 b/B
6.	CAASB should not be routinely treated with antibiotics [3,39].	1 b/B

- Diabetes mellitus
- Poor catheter care including failure of aseptic technique or breaks in closed drainage

7. Diagnosis

7.1. Symptoms (physical examination)

Among patients without catheters with microbiology confirmed bacteriuria, the presence of symptoms attributable to an infection of the urinary tract has classically differentiated patients with asymptomatic bacteriuria from those with symptomatic UTI. These symptoms include fever, urgency, dysuria, hematuria, suprapubic pain and costovertebral angle tenderness [28] [–] [30].

However, this distinction may be difficult in some patients with chronic indwelling catheters, such as in patients with spinal cord injury, and patients who are unable to communicate due to illness, comorbidities or extremes of age [3,25,29,31,32]. In particular, symptoms referable to the urinary tract have been found to be uncommon in patients with CAUTI for whom the catheter alone may be a source of symptoms, and have poor predictive value for differentiating CAUTIs from CAASBs [6]. It is thus recommended for clinicians to evaluate patients carefully for the likelihood of UTI/CAUTI against alternative sources of infection, and only obtain urine cultures when suspicion of UTI/CAUTI is high. This is to avoid inadvertent misdiagnosis of CAUTIs in cases of CAASB, resulting in unnecessary antimicrobial use [33].

7.2. Criteria and classification

The criteria and classifications of CAUTI and CAASB, as adapted from the US NHSN [1], are as detailed below in Table 1. There are other more complex classification criteria which have been developed [10] for research purposes, but the NHSN criteria are most practical in the setting of surveillance and clinical decision making. Criteria for the categories of presence of indwelling urinary catheter, symptoms and positive microbiology must all be met to qualify for the diagnosis of CAUTI (see Fig. 1). Culture of indwelling urinary catheter is not recommended.

8. Treatment

The treatment, management and prevention of CAUTIs are as follows:

8.1. Medication/Drug therapy

Significantly higher rates of antibiotic resistance have been found in Asia as compared to Europe and North America [34]. In addition, clinical prescribing practices and availability of antibiotics differ between countries and healthcare facilities. Hence, no single set of recommendation for empiric antibiotics can be made for the treatment of CAUTIs in Asia. Recommendations with regards to selection of antibiotics are

Table 3
Recommendations on the use of urinary catheters.

	Recommendation	LE/GR
1.	Evidence for antibiotic or antiseptic impregnated or coated urinary catheters are as follows [22,40–43]: • Use of hydrophilic-coated catheters was associated with a lower incidence of CAUTIs [41,42,44]. • Antibiotic-impregnated catheters lowered rates of asymptomatic bacteriuria in the short term (less than 1 week), but this effect was not significant at longer durations [22,40,43,45,46]. • Silver alloy catheters significantly reduced incidence of asymptomatic bacteriuria, and may be considered. However, clinical impact on reduction of symptomatic CAUTI has not been determined, and increased costs of these catheters must be considered. Conversely, silver oxide catheters have not been found to decrease incidence of bacteriuria [40,43,45,46]. • Chlorhexidine coated urinary catheters have shown efficacy in preventing biofilm formation in in vitro and animal studies, but evidence for clinical efficacy are still lacking [47,48].	1 b/C
2.	Alternative methods of bladder drainage with external and suprapubic catheters may be considered, but evidence of efficacy in preventing CAUTI remains limited [49,50].	1 b/C
3.	Consider changing long-term indwelling urinary catheters prior to initiating antimicrobial therapy [51].	1 b/B

Table 4
Recommendations for the prevention of CAUTIs.

	Recommendation	LE/GR
1.	Early removal of indwelling urinary catheters reduces the risks of subsequent CAUTI [53,54] and other complications [55].	2 b/B
2.	Heath care workers are often unaware about the presence of an indwelling catheter in patients [56]. This should be addressed, so as to minimize inappropriate use of indwelling catheters and reduce duration of catheterization.	3/B
3.	Nurse generated or electronic-based reminder and stop-order systems for the removal of urinary catheters reduce utilization of indwelling catheters and rates of CAUTIs [57–75]	1a/B
4.	Urinary catheter care bundles and infection control programs reduce rates of CAUTI [3,11,84] [–] [76,88] [–] [83]. These bundles and programs may include the following components: • Educational and training interventions on catheter indications [89,90], insertion techniques, care and management. • Avoidance of indwelling catheter use, and the use of alternatives to indwelling urinary catheters where appropriate. • Aseptic catheter insertion technique by trained personnel, with all necessary supplies needed being made conveniently available. Records and indications for catheter insertion should be maintained. • Attention to hand hygiene practices • Surveillance and performance feedback systems.	2a/B
5.	Secure and maintain integrity of closed urinary catheter systems, and prevent flow obstruction [3].	3/B
6.	No recommendation can be made for the routine use of antibiotic prophylaxis for the prevention of CAUTI: • The use of antibiotic prophylaxis during short-term urinary catheterization of up to 14 days in adult patients was reviewed in several randomized controlled trials. Meta-analysis showed only limited evidence in reduction of rates of bacteriuria, pyuria and febrile morbidity in surgical patients post-operatively, and reduction of symptomatic UTIs with antibiotic prophylaxis at the time of catheter removal [36,91,92]. • Meta-analysis on the use of antibiotic prophylaxis in patients requiring long-term intermittent or indwelling urinary catheterization showed inconsistent and limited evidence of efficacy [93]. • The decision to use antibiotic prophylaxis must consider local microbial prevalence and antibiotic resistance patterns, as well as risk-benefit ratio and cost considerations of the antibiotic. In Asia, it is unlikely that prophylaxis will be effective in view of high rates of antimicrobial resistance, and it might have the unintended consequence of selecting for even more resistant pathogens.	1a/D

detailed in Table 2. There is considerable controversy regarding the duration of treatment, the need to treat bacteriuria once catheters are removed [35], and the role of periodic treatment in spinal cord injured patients [36]. No general recommendation can be made for these situations.

8.2. Procedures and interventions

Asepsis of the urinary catheter system is vital for the prevention of CAUTI. Interventions towards this end have been recently been focused on the use of modified catheters, as well as aseptic insertion and maintenance of urinary catheters. Recommendations regarding the use of catheters are detailed in Table 3.

8.3. Prophylaxis, prevention and monitoring

Principles for prevention of CAUTI may be broadly classified under the following categories:

- Avoiding unnecessary urinary catheterization [52] and minimizing duration of catheterization via close surveillance and reminder systems.
- Preserving closed drainage of urinary catheter system and strict aseptic technique during insertion and maintenance.
- Implementation of urinary catheter care bundles and infection control programs.

Specific recommendations are detailed in Table 4.

9. Further research

Studies on the impact of hydrophilic catheters [44], chlorhexidine baths [94–97] and nurse-driven catheter management protocols [98] remain small and not strong enough for generalized recommendations. Further studies into the utility, efficacy and cost-effectiveness of these preventive strategies, as well as other novel diagnostic stewardship [99] [–] [101] and surveillance measures are needed [102–104].

Declaration of competing interest

PAT has received research support from GlaxoSmithKline, Sanofi, Roche, Johnson and Johnson and Arcturus. LC declares no conflict of interest.

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