Prevention of catheter-associated UTI

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Abstract

We surveyed existing guidelines and literature on the prevention of catheter-associated urinary tract infection (CAUTI). Key principles include avoiding unnecessary urinary catheterization, maintaining a closed aseptic drainage system and minimizing duration of catheterization. Institutional guidelines on appropriate indications for catheterization, reminder and stop-order systems, and policies on restricted urinary catheterization and nurse-directed catheter removal are effective and recommended. Urinary catheter care bundles and infection control interventions described in various guidelines are summarized and should be considered. While routine use of anti-infective coated catheters are not recommended, anti-infective-impregnated catheters may reduce risks of CAUTI for short term catheterization, and may be considered if shown to be cost effective. Evidence for the use of routine systemic antibiotic prophylaxis for the prevention of CAUTI is inconsistent and insufficient. Treatment of symptomatic CAUTI should be guided by local uropathogens, susceptibility patterns and urine culture results, and antibiotic should be deescalated to the narrowest spectrum choice where possible. Routine treatment of catheter-associated asymptomatic bacteriuria in not recommended.

Summary of recommendations

Recommendation		LE/GR
Avoiding unnecessary catheterization and prompt removal		
1.	Establishing institutional guidelines to prevent inappropriate urinary catheterization has been shown to reduce catheter use and CAUTI rates [1], [2], [3], [4].	2b/B
2.	Early removal of IUCs reduces the risks of subsequent CAUTI [1], [3], [5], [6] and other complications [5], [7].	2b/B
3.	Health care workers are often unaware about the presence of IUCs in patients [8], [9]. This should be addressed, in order to minimize inappropriate use of IUCs and reduce duration of catheterization.	3/B
4.	Nurse generated or electronic-based reminder and stop-order systems for the removal of urinary catheters reduce utilization of IUCs and rates of CAUTIs [1], [3], [4], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24].	1a/B
5.	A restricted urinary catheterization policy with daily chart review of appropriateness of catheter insertion reduces urinary catheterization rates [25].	2b/B

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6.	Nurse-directed urinary catheter removal reduces urinary catheter utilization and rates of CAUTI [16], [20], [22], [26], [27].	2a/B
7.	Alternative methods of bladder drainage such as SPCs and intermittent catheterization may be considered, but evidence of efficacy in preventing symptomatic UTI remains limited [28], [29], [30], [31].	1b/C
8.	Educational interventions may reduce IUC utilization [2], [4], [32].	2a/B
Care and maintenance of urinary catheter system		
9.	Maintaining sterility of closed urinary catheter systems is recommended to prevent the development of CAUTIs [33], [34], [35], [36], [37], [38], [39], [40].	3/B
Urinary catheter types		
10.	Evidence for various urinary catheter types are as follows:	
	• No recommendations on the use of hydrophilic-coated catheters for intermittent catheterization can be made [41], [42], [43].	1a
	• Anti-infective-impregnated catheters reduce risks of CAUTI slightly in short-term catheterization of 14 days or less, and may be cost effective [44], [45], [46].	1b/B
	• Silver alloy catheters reduce risks of bacteriuria, but not CAUTI, and are unlikely to be cost effective [44], [45], [46].	1a/A
	• There are insufficient data to recommend the use of antibiotic-impregnated or silver alloy catheters for long-term catheterization [47].	1b
CAUTI prophylaxis		
11.	No recommendation can be made for the routine use of antibiotic prophylaxis for the prevention of CAUTI due to inconsistent and insufficient evidence, and potential risks of increased antimicrobial resistance. It may be considered where benefits are deemed to outweigh risks.	1a
	• Use of antibiotic prophylaxis during short-term urinary catheterization of up to 14 days in adult patients is associated with significant reduction in asymptomatic bacteriuria, but there is no strong evidence showing reduction in symptomatic UTIs [48], [49].	
	• Antibiotic prophylaxis at time of short-term IUC removal is associated with significant reduction in symptomatic UTI, but cannot be recommended routinely due to high numbers needed to treat, and the potential to increase antimicrobial resistance rates [50], [51].	

	• There is insufficient evidence to recommend antimicrobial prophylaxis for long-term catheterization of more than 14 days [30].	
Treatment of CAUTI		
12.	Empiric antimicrobial therapy may be guided by recent prior urine culture results, where possible [52]. Catheter removal and if necessary reinsertion remains the key to treatment.	2b/C
13.	Early de-escalation of antibiotic therapy, as guided by urine culture results, to the narrowest spectrum antibiotic available.	4/C
14.	Shorter 5 day course of antibiotics with catheter exchange may be considered in the treatment of CAUTI in patients with spinal cord injury [53].	1b/B
15.	Catheter-associated asymptomatic bacteriuria should not be routinely treated with antibiotics [35], [54].	1b/A

1 Introduction

Urinary tract infections (UTIs) are the commonest cause of nosocomial infections worldwide, and have been estimated to cause approximately 30% of healthcare-associated infections in the acute care setting in the United States [55]. Approximately 75% of healthcare-associated UTIs are associated with an indwelling urinary catheter (IUC), and 12 to 16 percent of hospitalized patients will undergo urinary catheterization [56]. The high frequency of IUC utilization in healthcare highlights the impact and challenge of catheter-associated UTI (CAUTI) in the healthcare system globally [57], [58], [59], [60], [61], [62], [63] (LE: 3).

The aim of this chapter is to highlight key evidence-based recommendations for the prevention of CAUTIs.

2 Methods

Current published major practice guidelines were reviewed, and their recommendations were summarized. A systematic literature search of studies from the past ten years was also performed in PubMed with the following key words: urinary tract infection, bacteriuria, CAUTI, UTI, catheter. Search criteria were limited by following: availability of abstracts, English language and adults. Publications identified were screened by title and abstracts for relevance, and supplemented by citations and publications known to the authors. A total of 120 publications were included into the review.

The studies were rated according to the level of evidence and the strength of recommendations graded according to the system used in the EAU guidelines (2015) modified from the Oxford Centre for Evidence-based Medicine [37].

3 Pathogenesis and risk factors

The presence of a transurethral catheter predisposes patients to CAUTIs by bypassing or inhibiting natural host defenses [64]. The development of biofilm on the urinary catheters further exacerbates this by providing a favorable environment for bacterial proliferation and invasion [38], [65] (LE: 3).

Bacteria may be introduced into the urinary tract via multiple routes:

i. Inoculation during catheter insertion (e.g. non-compliance to aseptic technique during catheter insertion).
ii. Intraluminal ascent after contamination of the closed urinary catheter system. This may be related to lapses in aseptic practices while emptying the urinary drainage bag, or after disconnection of catheters from urinary bags.
iii. Extraluminal route of ascent along the external catheter surface into the urethra.

Risk factors for CAUTIs which have been identified in prospective observational studies include [64], [66], [67], [68] (LE: 2b):

- Duration of catheterization
- Poor catheter care or breaks in aseptic technique
- Female gender
- Diabetes mellitus
- Anatomical or functional abnormalities of the urinary tract
- Insertion of the catheter outside the operating room

In particular, longer duration of catheterization was highlighted as a risk factor for CAUTI by Barbadoro et al., who found catheterization of greater than 4 days to be associated with CAUTI (odds ratio 8.21; 95% confidence interval, 3.79–17.73; $p<0.05$) [68].

4 Summary of current guidelines on CAUTI prevention

Various guidelines on prevention of CAUTI have been published. Current guidelines include those from the Healthcare Infection Control Practices Advisory Committee (HICPAC) [33], the Infectious Diseases Society of America (IDSA) [34], the Society for Healthcare Epidemiology of America (SHEA) [35], the Department of Health of England (epic3 guidelines) [36], the European Association of Urology (EAU) [37], and also the joint European and Asian guidelines [38]. Their recommendations are summarized in table 1.

Table 1: Summary of recommendations from published guidelines

	European & Asian guidelines 2008 [38]	**IDSA 2009 [34]**	**CDC/HICPAC 2009 [33]**	**epic3 2014 [36]**	**SHEA/IDSA 2014 [35]**	**EAU 2015 [37]**
General						
Provide guidelines on catheter use, insertion and maintenance	Y	Y	Y	Y	Y	Y
Documentation of urinary catheterization: may include details of catheter insertion and removal, indication for insertion, and daily maintenance care tasks	ND	Y	Y	Y	Y	ND
Educate and train healthcare personnel	ND	Y	Y	Y	Y	ND

	European & Asian guidelines 2008 [38]	IDSA 2009 [34]	CDC/HICPAC 2009 [33]	epic3 2014 [36]	SHEA/IDSA 2014 [35]	EAU 2015 [37]
Hand hygiene compliance during patient care	Y	ND	Y	Y	Y	Y
Catheter insertion						
Evaluate need for catheterization						
Consider necessity of catheterization, ensure catheterization only for appropriate indications	ND	Y	Y	Y	Y	ND
Consider alternatives (e.g. condom catheters, intermittent straight catheterization and suprapubic catheters)	Y	Y	Y	Y	Y	Y
Protocol for post-operative urinary retention (e.g. intermittent catheterization, use of bladder scanners)	ND	Y	Y	ND	Y	ND
Choice of catheter						
Use smallest gauge urinary catheter possible	Y	ND	Y	Y	Y	Y
Choice of standard catheter material type	U	ND	Y	U	ND	ND
Routine use of antimicrobial/antiseptic-impregnated catheters is not recommended	Y	Y	U	ND	Y	Y
Routine use of silver alloy catheters is not recommended	Y	Y	U	ND	ND	U
Use of hydrophilic catheters for intermittent catheterization recommended	ND	ND	Y	ND	ND	ND
Use of pre-connected urinary system	ND	Y	Y	ND	ND	ND
Catheter insertion						
Use aseptic technique and sterile equipment	Y	Y	Y	Y	Y	Y

	European & Asian guidelines 2008 [38]	IDSA 2009 [34]	CDC/HICPAC 2009 [33]	epic3 2014 [36]	SHEA/IDSA 2014 [35]	EAU 2015 [37]
Use adequate lubricant	Y	ND	Y	Y	Y	Y
Antiseptic solution for cleaning of meatus during catheter insertion	U	ND	U	N	Y	ND
Barrier precaution	ND	U	Y	ND	Y	ND
Insertion of catheter by trained personnel	ND	Y	Y	Y	Y	ND
Train patients and family	ND	ND	Y	Y	ND	ND
Catheter maintenance						
Catheter review						
Minimize duration of catheterization	Y	Y	Y	Y	Y	Y
Regular review of ongoing need for catheter	ND	ND	Y	Y	Y	ND
System to identify and remove catheters that are no longer necessary: may include electronic or nursing reminders, automatic stop orders, or nurse led catheter removal protocols	ND	Y	Y	Y	Y	Y
Early removal of IUCs post-operatively	Y	ND	Y	ND	ND	Y
Catheter care						
Maintain closed drainage system	Y	Y	Y	Y	Y	Y
Replace system if there is any break in asepsis	ND	ND	Y	ND	Y	ND
No routine change in catheter	Y	U	Y	Y	Y	Y
Obtain urine samples aseptically	ND	ND	Y	Y	Y	ND
Routine hygiene for meatal care. Topical antiseptic/antibiotic applied to catheter, urethra or meatus are not recommended.	Y	Y	Y	Y	Y	Y
Secure catheter	ND	ND	Y	Y	Y	ND

	European & Asian guidelines 2008 [38]	IDSA 2009 [34]	CDC/HICPAC 2009 [33]	epic3 2014 [36]	SHEA/IDSA 2014 [35]	EAU 2015 [37]
Avoid irrigation for purpose of preventing infection	ND	Y	Y	Y	Y	Y
Maintain unobstructed urine flow	ND	ND	Y	ND	Y	ND
Keep collecting bag below level of bladder	ND	Y	Y	Y	Y	Y
Keep collecting bag off the floor	ND	ND	Y	Y	Y	ND
Empty collecting bag regularly using separate collecting container for each patient, avoid touching the draining spigot to the container	ND	ND	Y	Y	Y	ND
Separate patients with catheters	ND	U	U	ND	U	ND
Asymptomatic bacteriuria						
Do not routinely screen for bacteriuria in asymptomatic catheterized patients	Y	Y	Y	ND	Y	Y
Do not routinely treat asymptomatic bacteriuria in catheterized patients	Y	Y	ND	ND	Y	Y
Antiseptic & antimicrobial prophylaxis						
Routine use of systemic antimicrobial prophylaxis not recommended		Y	Y	ND	Y	
Short-term catheterization	ND					Y
Intermittent catheterization	Y					Y
Long-term catheterization	U					U
Routine use of long term antibiotic suppressive therapy not recommended	Y	ND	ND	ND	ND	Y
Routine use of urinary antiseptics (e.g. methenamine) not recommended	Y	Y	U	ND	U	Y
Routine addition of antiseptic or antimicrobial solutions to urinary drainage bags not recommended	ND	Y	Y	Y	ND	ND
Surveillance & audit						

	European & Asian guidelines 2008 [38]	IDSA 2009 [34]	CDC/HICPAC 2009 [33]	epic3 2014 [36]	SHEA/IDSA 2014 [35]	EAU 2015 [37]
Performance feedback to clinical staff	ND	Y	Y	Y	Y	ND
Surveillance: may include CAUTI rates and catheter utilization rates	ND	ND	Y	ND	Y	ND
Legend: Y: Recommended; N: Not recommended; U: Unresolved; ND: Not discussed						

5 Recommendations for CAUTI prevention

5.1 Principles of CAUTI prevention

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

- Avoiding unnecessary urinary catheterization and minimizing duration of catheterization;
- Preserving closed aseptic drainage of the urinary catheter system;
- Implementing urinary catheter care bundles and infection prevention programs.

In an American multicenter prospective surveillance study, Lewis et. al. found that 72% of CAUTIs occurred in patients not in intensive care units [69]. Hence, CAUTI prevention efforts should include patients in general wards.

5.2 Avoiding unnecessary catheterization and prompt removal

Establishing institutional guidelines to prevent inappropriate urinary catheterization reduces catheter use and CAUTI rates [1], [2], [3], [4] (LE/GR: 2b/B). Indications for catheterization which are considered appropriate by expert panels include the following [33], [35], [36], [70] (LE/GR: 4/B):

1. Acute urinary retention or bladder outlet obstruction;
2. Management of open sacral or perineal wounds in incontinent patients;
3. Urinary incontinence in patients for whom nurses find it difficult to provide skin care despite other urinary management strategies (e.g. hemodynamic or respiratory instability with movement, conditions requiring strict prolonged immobility);
4. Frequent measurement (e.g. in critically ill patients) and/or precise measurement of urine volumes required to provide treatment, that cannot be assessed by other strategies;
5. Single 24 hour urine sample collection for diagnostic tests that cannot be obtained by other strategies;
6. Reduce acute, severe pain with movement when other urine management strategies are difficult;
7. Improvement in comfort in end of life care if needed;
8. Management of gross hematuria with blood clots in urine;
9. Clinical conditions where non-indwelling strategies are inadequate, or where intermittent straight catheterization or external catheter placement are difficult;
10. Perioperative use in selected surgical procedures (e.g. urologic surgery, prolonged duration of surgery).

Reduction in utilization of IUCs and their early removal have been shown to reduce the risks of CAUTI [1], [3], [5], [6] and other complications, such as mortality [5] and bladder cancers [7] (LE/GR: 2b/B). A Cochrane study on early removal in patients with short-term IUCs showed lower risks of UTI and shorter hospitalization [71]. However, healthcare workers are often unaware about the presence of IUCs in patients [8], [9], contributing to unnecessary or inappropriate catheterization (LE/GR: 3/B). This may be prevented by nurse generated or electronic-based reminders and stop-order systems for the removal of urinary catheters, which have been shown in multiple studies and a systematic review to reduce utilization of IUCs and rates of CAUTIs [1], [3], [4], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24] (LE/GR: 1a/B). A restricted urinary catheterization policy together with daily chart review of appropriateness of new catheter insertions has also been shown to reduce catheterization rates [25] (LE/GR: 2b/B). Nurse-directed urinary catheter removal has also been shown to reduce catheter utilization and CAUTI rates [16], [20], [22], [26], [27] (LE/GR: 2a/B).

Alternative methods of bladder drainage other than IUCs may be considered, but evidence of efficacy in preventing CAUTI is limited (LE/GR: 1b/C). Recent trials were directed mostly at the use of suprapubic catheters (SPCs) and intermittent catheterization. A Cochrane review by Kidd et al. on short-term catheterization (of ≤14 days) in hospitalized adults found no conclusive evidence of reduction in symptomatic UTI with SPC compared to IUCs (LE: 1a), while results comparing IUC against intermittent catheterization were inconclusive and of low quality [28]. Two Cochrane reviews, one on alternative methods of long-term management of neurogenic bladder, and another comparing IUCs against intermittent and suprapubic catheterization for long term bladder drainage, could find no definitive evidence from randomized trials [29], [30]. A review by Hunter et al. found five non-randomized or retrospective studies showing no evidence of difference in UTI prevalence between IUC and SPC management of long term bladder drainage [31]. Despite these, there may be some evidence of benefit in reduction of asymptomatic bacteriuria and pain with the use of SPC [28] (LE: 1a), and more rapid return to normal micturition after urogynaecological surgery (LE: 1b) and acute urinary retention (LE: 2a) with the use of intermittent catheterization compared to IUCs [72], [73]. The weighing of incontinence pads for monitoring of urine output has also been shown to allow the removal of IUCs used for those purposes [74].

Education interventions (alone or as part of a bundle) are associated with reduction in IUC utilization, and may reduce inappropriate antimicrobial therapy for asymptomatic bacteriuria and CAUTI rates [2], [4], [32] (LE/GR: 2a/B).

Recommendation		LE/GR
1.	Establishing institutional guidelines to prevent inappropriate urinary catheterization has been shown to reduce catheter use and CAUTI rates [1], [2], [3], [4].	2b/B
2.	Early removal of IUCs reduces the risks of subsequent CAUTI [1], [3], [5], [6] and other complications [5], [7].	2b/B
3.	Health care workers are often unaware about the presence of IUCs in patients [8], [9]. This should be addressed, in order to minimize inappropriate use of IUCs and reduce duration of catheterization.	3/B
4.	Nurse generated or electronic-based reminder and stop-order systems for the removal of urinary catheters reduce utilization of IUCs and rates of CAUTIs [1], [3], [4], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24].	1a/B
5.	A restricted urinary catheterization policy with daily chart review of appropriateness of catheter insertion reduces urinary catheterization rates [25].	2b/B
6.	Nurse-directed urinary catheter removal reduces urinary catheter utilization and rates of CAUTI [16], [20], [22], [26], [27].	2a/B
7.	Alternative methods of bladder drainage such as SPCs and intermittent catheterization may be considered, but evidence of efficacy in preventing symptomatic UTI remains limited [28], [29], [30], [31].	1b/C
8.	Educational interventions may reduce IUC utilization [2], [4], [32].	2a/B

5.3 Care and maintenance of urinary catheter system

Maintaining sterility of urinary catheter systems is recommended, with all current guidelines reviewed above recommending aseptic catheterization technique and maintenance of closed drainage system [33], [34], [35], [36], [37], [38] (LE/GR: 3/B). Data from the Spanish national database of hospital infections and a Japanese multicenter prospective observational study showed closed urinary drainage systems were associated with significant reductions in CAUTI incidence [39], [40] (LE: 3). However, three randomized controlled trials examining the effect of pre-connected or sealed urinary catheter drainage systems on preventing bacteriuria showed differing outcomes [75], [76], [77] (LE: 1b). Also, a Cochrane systematic review [41] and multiple randomized controlled trials [78], [79], [80] comparing aseptic against clean techniques of catheterization have not shown differences in CAUTI rates (LE: 1a). All these studies however, had closed drainage in all systems.

The use of catheter securing devices has not been shown to reduce UTI rates [81] (LE: 1b), but should be considered to prevent catheter movement and urethral traction. Bladder irrigation [82], [83] (LE: 1b), antimicrobial additives to drainage bags [84] (LE: 1b), perineal cleansing with topical antiseptic agents [85], [86] (LE: 1b), daily bath with chlorhexidine washcloths [87], [88], [89] (LE: 2a) and complicated urinary drainage systems (e.g. anti-reflux valves and antiseptic release cartridge) [90], [91] (LE: 1b) have also not been shown to prevent CAUTI or bacteriuria and are not recommended (LE/GR: 1b/A). There is insufficient evidence to make recommendations on optimal time between catheter replacements [92].

Recommendation		LE/GR
1.	Maintaining sterility of closed urinary catheter systems is recommended to prevent the development of CAUTIs [33], [34], [35], [36], [37], [38], [39], [40].	3/B

5.4 Urinary catheter types

Large numbers of recent studies have looked at the use of various catheter materials for the prevention of CAUTI, and anti-infective-impregnated catheters may be considered in some settings if cost-effective.

Hydrophilic-coated catheters have been studied mainly for intermittent catheterization in patients with spinal cord injury (SCI) or neurogenic bladder, and conclusions by three systematic reviews were inconsistent. The reviews for The Cochrane Collaboration [41] and National Institute for Health and Clinical Excellence (NICE) [42] did not show reduction in CAUTI, while Li et al. [43] found significantly lower incidence of UTIs. As such, no recommendation can be made (LE: 1a).

A Cochrane review on short-term catheterization (of ≤14 days) in adult hospitalized patients showed slight reduction in risks of CAUTI with the use of nitrofurazone-impregnated catheters, and slight reduction in risks of bacteriuria but not symptomatic CAUTI with silver alloy catheters [44] (LE: 1a). Trials with economic analysis funded by the United Kingdoms (UK) National Institute for Health Research found that the chances of cost-effectiveness are greater than 70% for nitrofurazone-impregnated catheters, and very unlikely for silver alloy catheters, in the setting of the UK National Health Service [45], [46]. This may not apply to all health systems.

The Cochrane review by Jahn et al. on IUC choice for long-term bladder drainage (>30 days) in adults was unable to find sufficient quality trials to provide reliable recommendations [47] (LE: 1b).

Trials exploring the use of various novel catheter coatings with other anti-septics [93], [94], [95], [96], [97], [98], [99], [100], non-pathogenic *Escherichia coli* [101], [102], [103], anti-biofilm agents [104] and anti-quorum sensing agents [105], [106] have been published, and await further confirmatory clinical outcome results.

Recommendation		LE/GR
1.	Evidence for various urinary catheter types are as follows:	
	• No recommendations on the use of hydrophilic-coated catheters for intermittent catheterization can be made [41], [42], [43].	1a
	• Anti-infective-impregnated catheters reduce risks of CAUTI slightly in short-term catheterization of 14 days or less, and may be cost effective [44], [45], [46].	1b/B
	• Silver alloy catheters reduce risks of bacteriuria, but not CAUTI, and are unlikely to be cost effective [44], [45], [46].	1a/A
	• There are insufficient data to recommend the use of antibiotic-impregnated or silver alloy catheters for long-term catheterization [47].	1b

5.5 CAUTI prophylaxis

Multiple systematic reviews have examined the use of antibiotic prophylaxis in CAUTI prevention. Lusardi et al. examined adults on short-term catheters (≤14 days) [48], while Morton et al. examined persons with neurogenic bladder due to SCI [49], of whom many were on intermittent catheterization. Both studies found significant reduction in asymptomatic bacteriuria, but no strong evidence of reduction in symptomatic UTIs. In addition, Morton et al. found 4 of 5 trials reporting increase in proportion of antimicrobial resistance bacteria.

Marschall et al. performed a meta-analysis on the effects of antibiotic prophylaxis given upon removal of short-term IUC, and found a 5.8% absolute risk reduction in symptomatic UTI (number needed to treat to prevent one symptomatic UTI of 17) [50] (LE: 1a). However, the study authors and other reviews [51] have expressed reservations about routine antimicrobial prophylaxis upon catheter removal, in light of the likely increase in antibiotic consumption and its association with increased antimicrobial resistance. More research is needed to identify patient groups who will best benefit from this, such as kidney transplant recipients after transplant surgery [110] (LE: 2a).

Niël-Weise et al. performed a systematic review on antimicrobial prophylaxis for long-term catheterization of greater than 14 days, but data were sparse and outcomes inconsistent (LE: 1b) [30]. One observational prospective study examined prophylaxis with weekly high dose oral cycling antibiotic in adult patients with SCI and recurrent UTIs who are on long-term clean intermittent catheterization [111]. It found significant reduction in frequency of UTIs, mean duration of antimicrobial therapy for UTIs, and hospitalization days over a median follow-up duration of 29 months (LE: 2b), but routine use for long term prophylaxis remains controversial.

Studies on cranberry extract [112], [113] and oral vinegar [114] found no evidence of effect on CAUTI prevention (LE: 1b). Methenamine hippurate may have some benefit in UTI prevention in patients without renal tract abnormalities (LE: 1a) [115], and bacterial interference may reduce risk of UTI in patients with SCI (LE: 1b) [116], [117].

Recommendation		**LE/GR**
1.	No recommendation can be made for the routine use of antibiotic prophylaxis for the prevention of CAUTI due to inconsistent and insufficient evidence, and potential risks of increased antimicrobial resistance. It may be considered where benefits are deemed to outweigh risks.	1a
	• Use of antibiotic prophylaxis during short-term urinary catheterization of up to 14 days in adult patients is associated with significant reduction in asymptomatic bacteriuria, but there is no strong evidence showing reduction in symptomatic UTIs [48], [49].	
	• Antibiotic prophylaxis at time of short-term IUC removal is associated with significant reduction in symptomatic UTI, but cannot be recommended routinely due to high numbers needed to treat, and the potential to increase antimicrobial resistance rates [50], [51].	
	• There is insufficient evidence to recommend antimicrobial prophylaxis for long-term catheterization of more than 14 days [30].	

6 Treatment of CAUTI

Choice of empiric antibiotic therapy may be guided by local uropathogens susceptibility patterns, and also recent prior urine culture results [52] (LE/GR: 2b/C). This should be de-escalated to culture guided narrow-spectrum antibiotics when possible (LE/GR: 4/C). Duration of treatment remains controversial, and guideline recommendations vary from 5 to 21 days [34], [38], [118], [119]. A shorter 5 day course of antibiotics with catheter exchange may be considered in the treatment of CAUTI in patients with SCI [53] (LE/GR: 1b/B). Routine treatment of catheter-associated asymptomatic bacteriuria is not recommended (LE/GR: 1b/B), with the exception of pregnancy and prior to traumatic genitourinary procedures [34], [54], [120].

Recommendation		LE/GR
1.	Empiric antimicrobial therapy may be guided by recent prior urine culture results, where possible [52]. Catheter removal and if necessary reinsertion remains the key to treatment.	2b/C
2.	Early de-escalation of antibiotic therapy, as guided by urine culture results, to the narrowest spectrum antibiotic available.	4/C
3.	Shorter 5 day course of antibiotics with catheter exchange may be considered in the treatment of CAUTI in patients with spinal cord injury [53].	1b/B
4.	Catheter-associated asymptomatic bacteriuria should not be routinely treated with antibiotics [35], [54].	1b/A

Conflicts of interest

Paul Anantharajah Tambyah has received research support from GlaxoSmithKline, Sanofi, Fab'entech, Teleflex, and Inviragen.

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Glossary

CAUTI: Catheter-associated urinary tract infection

EAU: European Association of Urology

HICPAC: Healthcare Infection Control Practices Advisory Committee (HICPAC)

IDSA: Infectious Diseases Society of America **IUC:** Indwelling urinary catheter

NICE: National Institute for Health and Clinical Excellence **SCI:** Spinal cord injury

SHEA: Society for Healthcare Epidemiology of America **SPC:** Suprapubic catheters

UK: United Kingdoms **UTI:** Urinary tract infection

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