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Short Communication

Characteristics and susceptibility pattern of catheter-associated urinary tract infections (CAUTI) bacteria in Indonesia: A study in a national reference hospital of Sumatra region 2020–2021

Muhammad A. Perdana[1], Dian D. Wahyuni[2,3*] and Rina Yunita[2,3]

[1]Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [2]Department of Microbiology, Universitas Sumatera Utara, Medan, Indonesia; [3]Department of Clinical Microbiology, H. Adam Malik General Hospital, Medan, Indonesia

*Corresponding author: ddw_pane@yahoo.com

Abstract

Catheter-associated urinary tract infection (CAUTI) is defined as a urinary tract infection associated with catheter placement for more than two consecutive days. Hence, antibiotic resistance in the context of CAUTIs represents a substantial challenge. The aim of this study was to present the characteristics of patients with CAUTI and the susceptibility pattern of CAUTI bacteria in the national reference hospital of the Sumatra region of Indonesia. A cross-sectional study was conducted at H. Adam Malik General Hospital, Medan, Indonesia, from 2020 to 2021, using a total sampling. All CAUTI patients included were on catheterization and diagnosed based on the Centers for Disease Control and Prevention (CDC) guidelines. The patient's urine culture and antibiotic susceptibility test were carried out on the patient's admitted urine sample for further assessment. Identification of bacteria, antibiotic susceptibility test, and the extended-spectrum beta-lactamase (ESBL) test for *Escherichia coli* and *Klebsiella pneumoniae* were conducted using the VITEK-2 Compact. A total of 74 CAUTI patients were included in the study, 59.5% were female, 54.1% were 46–65 years old, and a third had cardiovascular disease comorbidities (33.8%). A total of 83 CAUTI-associated bacteria were isolated. The majority were Gram-negative bacteria (74.7%), and the most bacteria isolated was *E. coli* (31.3%), followed by *K. pneumoniae*, *Enterococcus faecalis*, *Acinetobacter baumannii*, and *Enterococcus faecium*. The ESBL test was positive mostly in *K. pneumoniae* (100%) and *E. coli* (76.9%). CAUTI-associated *E. coli* was susceptible to tigecycline, meropenem, ertapenem, nitrofurantoin, and gentamicin. The isolated *K. pneumoniae* was susceptible to tigecycline, meropenem, ertapenem, and amikacin. While *E. faecalis* showed susceptibility to tigecycline, nitrofurantoin, vancomycin, imipenem, linezolid, ampicillin, piperacillin/tazobactam, amoxicillin/clavulanic acid, ampicillin/sulbactam, and piperacillin.

Keywords: Urinary tract infection, UTI, CAUTI, uropathogens, susceptibility pattern

Introduction

The use of urinary catheters is a major predisposing factor for urinary tract infection (UTI) [1], resulting in catheter-associated urinary tract infection (CAUTI) [2]. The risk of CAUTI increases up to 3–7% per day following urinary catheter insertion, reaching nearly 100% in cases of prolonged urinary catheter use [3]. According to the United States (US) Centers for Disease

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Control and Prevention (CDC), 19,738 reported cases of UTI were due to urinary catheters [4]. The presence of urinary pathogens is observed in these urinary catheters.

Antibiotic resistance has become a global public health issue causing over 700,000 deaths annually. With antibiotic resistance on the rise, identifying the characteristics of bacteria and pathogens has become a significant challenge, especially since urinary pathogens have undergone significant growth over the past few decades [5-7]. With the incidence of CAUTI incidents in Indonesia still unclear [8], the aim of this study was to present the patients' characteristics and susceptibility pattern of CAUTI bacteria in the national reference hospital of the Sumatra region of Indonesia.

Methods

Study design and setting

A retrospective study design was conducted in the Clinical Microbiology Installation of H. Adam Malik General Hospital, Medan, Indonesia from 2020 to 2021. The study used a total sampling method where UTI patients included in the study were on urinary catheterization. A urine culture and antibiotic susceptibility test were carried out on the patient's admitted urine sample for further assessment.

Patients and inclusion criteria

This study included CAUTI patients who were presented in the H. Adam Malik General Hospital. CAUTI was diagnosed based on the CDC guidelines, namely UTI patients with (a) a urinary catheter retained for a duration exceeding 48 hours, with the initial day being the day of catheter insertion; (b) at least one of the following signs or symptoms, including fever, suprapubic tenderness, costovertebral angle tenderness, urinary frequency or urgency or dysuria; (c) urine culture with more than 10^5 CFU/mL of either one or two bacterial species. UTI patients with fungal infections, insignificant bacterial infections, and initial urinary catheterization that was not conducted in the H. Adam Malik General Hospital were excluded from the study.

Antibiotic susceptibility test

Identification of bacteria, antibiotic susceptibility test, and the extended-spectrum beta-lactamase (ESBL) test for *Escherichia coli* (*E. coli*) and *Klebsiella pneumoniae* (*K. pneumoniae*) were conducted using the VITEK-2 Compact. The results were recorded in the patient's medical records and secondary data was obtained to be presented in the study.

Statistical analysis

All data collected was processed and statistically analyzed using SPSS version 26 (SPSS Inc., Chicago, USA). Results were displayed as frequency and percentage distributions in tables.

Results

Characteristics of the patients

A total of 74 CAUTI patients were included in the study, as presented in **Table 1**. The majority of patients were female (59.5%) and most were aged between 46–65 (54.1%). Among all the patients, a large proportion had comorbidities (75.7%), with 33.8% of patients experiencing cardiovascular system comorbidities.

Table 1. Characteristics of catheter-associated urinary tract infections (CAUTI) patients (n=74)

Variables	Frequency	Percentage (%)
Sex		
Male	30	40.5
Female	44	59.5
Age group (years)		
0–3	3	4.1
6–11	5	6.8
12–25	9	12.2
26–45	11	14.9

Variables	Frequency	Percentage (%)
46–65	40	54.1
>65	6	8.1
Comorbidities		
Yes	56	75.7
No	18	24.3
Type of comorbidities*		
Cardiovascular diseases	23	33.8
Metabolic diseases	13	19.1
Malignant diseases	9	13.2
Kidney and urinary diseases	8	11.8
Neurology diseases	6	8.8
Other diseases (anemia (2), systemic lupus erythematosus (SLE) (2), and dyspepsia (1))	5	7.4
Pulmonary diseases	4	5.9

*68 was the total number of comorbidities; each patient had one or more comorbidities or none

Identification of bacterial types

A total of 83 types of bacteria species were isolated and identified in the patient's urine samples. Gram-negative bacteria (74.7%) were most present in CAUTI patients, and only 21 patients detected Gram-positive bacteria. *E. coli* became the most prevalent bacteria (31.3%), followed by *K. pneumoniae* (16.9%), *Enterococcus faecalis* (15.7%), *Acinetobacter baumannii* (8.4%), and *Enterococcus faecium* (7.2%) (**Table 2**). While for the ESBL-producing bacteria, 76.9% tested positive for *E. coli* and 100% for *K. pneumoiae* (**Table 3**).

Table 2. Distribution of bacteria isolated from catheter-associated urinary tract infections (CAUTI) patients

Bacteria	Frequency (n=83*)	Percentage (%)
Gram-negative		
Escherichia coli	26	31.3
Klebsiella pneumoniae	14	16.9
Acinetobacter baumannii	7	8.4
Pseudomonas aeruginosa	6	7.2
Pseudomonas putida	3	3.6
Citrobacter freundii	2	2.4
Enterobacter cloacae	1	1.2
Enterobacter aerogenes	1	1.2
Burkholderia cepacia	1	1.2
Aeromonas salmonicida	1	1.2
Gram-positive		
Enterococcus faecalis	13	15.7
Enterococcus faecium	6	7.2
Enterococcus gallinarum	1	1.2
Staphylococcus epidermidis	1	1.2

*83 was the total number of bacteria; each patient had one or two bacteria detected

Table 3. Extended-spectrum beta-lactamase (ESBL) test for ESBL-producing bacteria

ESBL result	Type of tested bacteria	
	Escherichia coli (n=26)	*Klebsiella pneumoniae* (n=14)
Positive	20 (76.9%)	14 (100%)
Negative	6 (23.1%)	0 (0%)

Antibiotic susceptibility patterns

Five of the most prevalent isolated bacteria (i.e., *E. coli*, *K. pneumoniae*, *E. faecalis*, *A. baumannii*, *E. faecium*) were employed for the antibiotic susceptibility test to analyze the patterns. Tigecycline had the highest susceptibility among all five bacteria. *E. coli*, *E. faecalis*, and *E. faecium* showed the highest susceptibility (100%) against tigecycline. *K. pneumoniae* was most susceptible (84.6%) to meropenem and ertapenem. *E. faecalis* and *E. faecium* were both 100% susceptible to vancomycin (**Table 4**). The susceptibility percentages for the bacteria tested with each antibiotic differed, primarily due to the resistance exhibited by the remaining bacteria.

Table 4. Antibiotic susceptibility pattern of the bacteria isolated from catheter-associated urinary tract infections (CAUTI) patients

Antibiotics	Susceptibility pattern				
	E. coli (n=26)	*K. pneumoniae* (n=14)	*E. faecalis* (n=13)	*A. baumannii* (n=7)	*E. faecium* (n=6)
Tigecycline	26 (100%)	8 (57.1%)	13 (100%)	4 (57.1%)	6 (100%)
Meropenem	24 (92.3%)	11 (84.6%)	(-)	3 (42.9%)	(-)
Ertapenem	23 (88.5%)	11 (84.6%)	(-)	(-)	(-)
Nitrofurantoin	21 (80.8%)	1 (7.1%)	13 (100%)	(-)	0 (0%)
Ceftriaxone	1 (3.8%)	0 (0%)	(-)	0 (0%)	(-)
Cefazolin	1 (4.0%)	(-)	(-)	0 (0%)	(-)
Ofloxacin	1 (5.9%)	(-)	1 (10%)	0 (0%)	0 (0%)
Cefepime	6 (30%)	3 (25%)	(-)	0 (0%)	(-)
Aztreonam	(-)	0 (0%)	(-)	(-)	(-)
Ceftazidime	(-)	0 (0%)	(-)	0 (0%)	(-)
Gentamicin	15 (60%)	1 (7.7%)	(-)	1 (14.3%)	(-)
Tetracycline	(-)	(-)	0 (0%)	(-)	2 (3.3%)
Erythromycin	(-)	(-)	1 (7.7%)	(-)	0 (0%)
Benzylpenicillin	(-)	(-)	1 (7.7%)	(-)	0 (0%)
Levofloxacin	(-)	(-)	1 (7.7%)	(-)	0 (0%)
Ciprofloxacin	(-)	(-)	1 (7.7%)	0 (0%)	0 (0%)
Norfloxacin	(-)	(-)	1 (10%)	0 (0%)	(-)
Amoxicillin	(-)	(-)	(-)	(-)	0 (0%)
Amikacin	(-)	9 (75%)	(-)	4 (57.1%)	(-)
Vancomycin	(-)	(-)	13 (100%)	(-)	6 (100%)
Imipenem	(-)	(-)	12 (92.3%)	(-)	(-)
Linezolid	(-)	(-)	12 (92.3%)	(-)	6 (100%)
Ampicillin	(-)	0 (0%)	12 (92.3%)	(-)	0 (0%)
Piperacillin/Tazobactam	12 (46.2%)	4 (33.3%)	11 (91.7%)	1 (14.3%)	0 (0%)
Amoxicillin/Clavulanic acid	(-)	(-)	11 (91.7%)	(-)	(-)
Ampicillin/Sulbactam	4 (16%)	0 (0%)	11 (84.6%)	3 (42.9%)	0 (0%)
piperacillin	(-)	(-)	11(84.6%)	(-)	0 (0%)
Trimethoprim/Sulfamethoxazole	8 (30.8%)	3 (27.3%)	(-)	5 (71.4%)	(-)

Note: (-) meaning the antibiotic susceptibility was not tested.

Discussion

Theoretically, high-risk factors for CAUTI include women and older individuals due to the anatomical structure of the shorter urethra in women compared to men. This facilitates the movement of perineal and anal flora towards the urethra, potentially causing an infection that can extend through the urinary catheter into the bladder [9,10]. In contrast, older individuals experience an increased susceptibility to diseases, characterized by a functional decline in the thymus and the immune system, resulting in a decrease in the ability to sterilize the bladder and urethra [11]. As this study found most CAUTI patients were women, it aligns with a previous study that found women (88%) were more susceptible to CAUTI than men (12%) [11]. Another study found that among 90 patients, most patients (53.3%) in the age 41–60 age group had CAUTI [12].

Another risk factor for CAUTI is comorbidities, especially diabetes mellitus and urinary tract disorders [13]. The most frequently observed comorbidity in this study was cardiovascular diseases. A study reported that hypertension is associated with increased activity in the renin-angiotensin-aldosterone system, leading to increased urine excretion, potentially a trigger for bacterial growth [14]. Another study showed similar findings that revealed hypertension was the most common comorbid (47.4%), followed by diabetes mellitus (36.8%) and impaired kidney function (15.8%) [15]. As this study also reported malignant disease as the third most common comorbidity, a different study highlighted an increased prevalence of CAUTI in patients with malignancies, particularly those affecting the genitourinary region [16].

Several other studies have demonstrated similar results of bacterial distribution in this study (**Table 2**). A study that was conducted at the University of Sumatera Utara Hospital in 2019 reported that *E. coli* was the most commonly isolated bacteria found (37.14%), and Gram-negative bacteria was more predominant than the Gram-positive bacteria [17]. Furthermore, a study also reported that *E. faecalis* was the most prevalent isolated Gram-positive bacteria in CAUTI

patients [18]. Other studies revealed parallel findings to this study, where *E. coli* and *K. pneumoniae* was frequently observed and tested positive for ESBL-producing bacteria in patients with CAUTI [19,20].

Our study revealed *E. coli* were susceptible to tigecycline (100%), meropenem (92.3%), ertapenem (88.5%), and nitrofurantoin (80.8%). This result was consistent with the previous studies, demonstrating that *E. coli* was susceptible to nitrofurantoin (89.4%) [16] and meropenem (84%) [21]. The second most common bacteria isolated from CAUTI patients were *K. pneumoniae*, exhibited susceptibility to ertapenem (84.6%), meropenem (84.6%), and amikacin (75%). These results were supported by another study, *K. pneumoniae* was substantially susceptible to amikacin (100%) and meropenem (66.7%) [22], with comparatively low resistance to ertapenem (37.5%) [23]. *E. faecalis* in this study was subsequently found susceptible with nitrofurantoin (100%), vancomycin (100%), tigecycline (100%), imipenem (92.3%), linezolid (92.3%), ampicillin (92.3%), piperacillin/tazobactam (91.7%), amoxicillin/clavulanic acid (91.7%), ampicillin/sulbactam (84.6%), dan piperacillin (84.6%). This aligns with other studies that showed *E. faecalis* had high susceptibility to ampicillin/sulbactam (100%), imipenem (100%), linezolid (96%), ampicillin (68%) [24], nitrofurantoin (100%), and amoxicillin/clavulanic acid (84.2%) [25].

This study had limitations in data collection, we relied the data based on the secondary data from the patient's medical records. Thus, there were several incomplete data that was found and resulted in a limited amount of study participants, only 74 CAUTI patients. Furthermore, each patient underwent different variations of antibiotic susceptibility tests, consequently, posing challenges in observing consistent antibiotic susceptibility patterns.

Conclusion

Our study found that the majority of the CAUTI patients were female, aged 46–65 years old, and cardiovascular disease being the most common comorbidity. *E. coli* was the most frequently isolated in CAUTI patients, followed by *K. pneumoniae*, *E. faecalis*, *A. baumannii*, and *E. faecium*. CAUTI-associated *E. coli*, the most prevalent Gram-negative bacteria found, was susceptible to tigecycline, meropenem, ertapenem, nitrofurantoin and gentamicin. The isolated *K. pneumoniae* was susceptible to tigecycline, meropenem, ertapenem and amikacin. While *E. faecalis* showed susceptibility to tigecycline, nitrofurantoin, vancomycin, imipenem, linezolid, ampicillin, piperacillin/tazobactam, amoxicillin/clavulanic acid, ampicillin/sulbactam and piperacillin.

Ethics approval

Ethical approval was obtained from the Ethical Committee of Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia (066/KEPK/USU/2022).

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Competing interests

The authors declare no conflict of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

How to cite

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References

1. Seifu WD, Gebissa AD. Prevalence and antibiotic susceptibility of Uropathogens from cases of urinary tract infections (UTI) in Shashemene referral hospital, Ethiopia. BMC Infect Dis 2018;18:1-9.
2. Kusbaryanto K, Listiowati L. Risk factors for of urinary tract infection in catheter installation in hospitals. Prosiding International Conference on Sustainable Innovation (ICoSI). 2021;1(1):3.
3. Flores-Mireles A, Hreha TN, Hunstad DA. Pathophysiology, treatment, and prevention of catheter-associated urinary tract infection. Top Spinal Cord Inj Rehabil 2019;25:228-240.
4. CDC. Catheter-associated urinary tract infections | A.R. & Patient Safety Portal. 2020. Available from: https://arpsp.cdc.gov/profile/infections/cauti?redirect=true. Accessed: 17 March 2022.
5. Srinivasan R, Karaoz U, Volegova M, *et al*. Use of 16S rRNA gene for identification of a broad range of clinically relevant bacterial pathogens. PLoS One 2015;10:e0117617.
6. Oumer Y, Dadi BR, Seid M, *et al*. Catheter-associated urinary tract infection: Incidence, associated factors and drug resistance patterns of bacterial isolates in southern ethiopia. Infect Drug Resist 2021;14:2883.
7. Ginsburg AS, Klugman KP. COVID-19 pneumonia and the appropriate use of antibiotics. Lancet Glob Health 2020;8:e1453-e1454.
8. Isman Sitepu W. Pengaruh penerapan Healthcare Infection Control Practices Advisory Committee terhadap kejadian infeksi saluran kemih terkait penggunaan kateter. J Admin Rumah Sakit Indonesia 2019;5.
9. Potter PA, Perry AG. Fundamentals of nursing. 8th edition. Canada: Elsevier Inc 2013.
10. Patel C, Shah MB, Singh S, *et al*. Biofilm production and antimicrobial resistance in catheter associated urinary tract infection (CAUTI) pathogens isolated from ICU patients. EJMCM 2021;8:3143-3152.
11. Risdinar RR, Kumala I, Triswanti N, *et al*. Karakteristik pasien infeksi saluran kemih yang terpasang kateter di ruang rawat inap penyakit dalam RSUD Dr. H. Abdul Moeloek Provinsi Lampung. J Medika Malahayati 2021;5.
12. Asepty MRP, Amirah A, Jamaluddin J. The effect of healthcare infection control application committee in patients using urine cateters on cost containtment. J La Medihealtico 2022;3:136-141.
13. Fauziah W, Mahayu Adiutama N, Aldy Mandhatyi F, *et al*. Karakteristik pasien dengan catheter urinary tract infections (CAUTI). J Keperawatan 2022;1:54-58.
14. Liu F, Ling Z, Xiao Y, *et al*. Alterations of urinary microbiota in type 2 diabetes mellitus with hypertension and/or hyperlipidemia. Front Physiol 2017;8:126.
15. Karisma DA, Riwayati NY, Jayanti SF. Hubungan lama pemasangan kateter dengan kejadian infeksi saluran kemih pada pasien di ruang penyakit dalam Rumkit Tk Ii Dr. Soepraoen Malang. J Ilmiah Ilmu Kesehatan 2020;8:138-145.
16. Michno M, Sydor A, Wałaszek M, *et al*. Microbiology and drug resistance of pathogens in patients hospitalized at the nephrology department in the South of Poland. Pol J Microbiol 2018;67:517-524.
17. Hariati H, Suza DE, Tarigan R. Risk factors analysis for catheter-associated urinary tract infection in Medan, Indonesia. Open Access Maced J Med Sci 2019;7:3189-3194.
18. Kline KA, Lewis AL. Gram-positive uropathogens, polymicrobial urinary tract infection, and the emerging microbiota of the urinary tract. Microbiol Spectr 2016;4(2):10.1128/microbiolspec.UTI-0012-2012.
19. Ashraf F, Iram S, Riaz G, *et al*. Comparison between non-catheterized and catheter associated urinary tract infections caused by extended spectrum β-lactamase producing *Escherichia Coli* and *Klebsiella Pneumoniae*. bioRxiv 2015.
20. Liu X, Sai F, Li L, *et al*. Clinical characteristics and risk factors of catheter-associated urinary tract infections caused by *Klebsiella Pneumoniae*. Ann Palliat Med 2020;9:2668-2677.
21. Birhman N, Mohan S, Kakru DK. Efficacy of nitrofurantoin in catheter associated urinary tract infection. Acta Sci Microbiol 2020;3:77-80.
22. Mohd S, Sajid Syed Khaja A, Hossain A, *et al*. Catheter-associated urinary tract infection in intensive care unit patients at a tertiary care hospital, Hail, Kingdom of Saudi Arabia. Diagnostics 2022;12:1695.

23. Mohamed AH, Omar NMS, Osman MM, *et al*. Antimicrobial resistance and predisposing factors associated with catheter-associated uti caused by uropathogens exhibiting multidrug-resistant patterns: A 3-year retrospective study at a tertiary hospital in Mogadishu, Somalia. Trop Med Infect Dis 2022;7(3):42.
24. Lee G. Ciprofloxacin resistance in *Enterococcus faecalis* strains isolated from male patients with complicated urinary tract infection. Korean J Urol 2013;54:388-393.
25. Datta P, Banerjee S. Community-acquired urinary tract infection: A study on responsible bacteria with their antibiotic susceptibility pattern in Kolkata, India. Int J Sci Study 2015;3(8).