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Risk Factors for Catheter-Associated Urinary Tract Infection and Uropathogen Bacterial Profile in the Intensive Care Unit in Hospitals in Medan, Indonesia

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Keywords: Catheter-associated Urinary Tract Infection (CAUTI); Catheter; Uropathogen; ICU

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Abbreviations: ANOVA: Analysis of variance; BRS: brain relaxation scale; CVP: central venous pressure; MAP: mean arterial pressure; GDT: goal-directed fluid therapy; PPV: pulse pressure variation; SPSS: Statistical package for social science;

Abstract

AIM: To evaluate the risk factors of CAUTI in ICU patients at Haji Adam Malik General Hospital and Universitas Sumatera Utara Hospital, Medan, Indonesia.

METHODS: This hospital-based observational research was an observational analytic research with a cross-sectional study. This research was conducted at Haji Adam Malik General Hospital Medan, Universitas Sumatera Utara Hospital, and Department of Microbiology Medical Faculty of Medicine Universitas Sumatera Utara, on July to August 2018 until the number of samples was fulfilled. The samples were adults aged ≥18 years, admitted to an ICU between July until August 2018 with an indwelling urinary catheter during their admission, admitted in ICU with different complaints and presentations and developed clinical evidence of infection that did not originate from patient's original admitting diagnosis, in accordance which corresponded to the inclusion criteria by using consecutive sampling technique were included in the study. Patients who were shifted out of the ICU within 48 h of admission were excluded from the study. These critical patients were referred for monitoring, observation, and management from different departments, e.g., medic, general surgery, neurosurgery, gynaecology/obstetrics, and accident/emergency departments.

RESULTS: From this research, it was found that fifty-four patients with catheter were screened for UTI infection. Of those, 24 patients (44.4%) were confirmed to have UTI by urine culture. Pseudomonas aeroginosa (16.7%) and Enterococcus faecalis (12.5%) were the most common pathogens. Patients aged > 50 years old ($P < 0.03$) and catheter use > 6 days ($P < 0.03$) were both significantly associated with increased risk of developing UTI.

CONCLUSION: There are eleven uropathogens identified in this study: *Pseudomonas aeruginosa, Enterococcus faecalis, Escherichia coli, Klebsiella pneumonia, MRSA, Salmonella enteric, Acinetobacter baumanii, Acinetobacter lwoffi, Acinetobacter haemoliticus, Burkholderia cepacia,* and *Staphylococcus sciur.*

Introduction

The definition of urinary tract infection (UTI) is an infection in any part of the urinary system, including kidney, ureter, bladder, or urethrae. Urinary tract infection is the presence of the microorganism in the urine [1]. *Hospitals in Europe Link for Infection Control through Surveillance (HELICS)* divided urinary tract infection into three classifications; UTI-A (symptomatic with microbiology confirmation urinary tract infection), UTI-B (symptomatic without microbiology confirmation urinary tract infection), and UTI-C (asymptomatic bacteriuria urinary tract infection). The *Centers for Disease Control and Prevention* (*CDC*) simplified these criteria based on the growth of mycobacteria in the urine culture. UTI is determined when the urine culture had ≥ 10^5 *colonies forming unit* (CFU)/ml urine with evidence of one or two species of microorganisms, and with or without clinical features. Hospitalised UTI developed in approximately 96.2% of patients with a history of catheter use (*HELICS*, 2005). Long term using catheter urine is the major risk factor to develop UTI as a nosocomial infection [2], [3]. *Catheter-Associated Urinary Tract Infection* (*CAUTI)* is defined as the infection in patients who use urine catheter for a minimal of three days [4]. Long term duration of urine

catheter use become a predisposition factor for *CAUTI* event [5]. The *National Healthcare Safety Network* (*NHSN*) showed that *CAUTI* cases in ICU patients were more common in critical illness patients, due to the use of invasive equipment, like urine catheter, vein and artery catheter, an endotracheal tube [6]. The use of urine catheter interrupts the innate immune defence mechanism system by affecting the mucous barrier, which has a function to prevent uropathogenic adhesion and its migration to vesica urinary [6], [7]. Catheter stimulates the inflammatory responses and causes trauma in the mucous of the urethra and bladder neck. Inflammatory and mechanical damages in the urinary tract epithelium do not only increase the risks for UTI but also influencing one's immune response to uropathogenic [5].

The duration of urine catheter use is the main risk factor for the development of *CAUTI* and bacteriuria [7], [8], [9]. The other potential risk factors, including female gender, pregnancy, and conditions like poor nutrition, faecal incontinence, illness severity, and immunocompromised status [2], [9].

Several uropathogens related to *CAUTI* have been described, including *Escherichia coli* (21.4%), *Candida spp*. (21.0%), *Enterococcus spp*. (14.9%), *Pseudomonas aeruginosa* (10.0%), *Klebsiella pneumonia* (7.7%), and *Enterobacter spp*. (4.1%) [2], [7]. The emergence of resistance to these microorganisms has been increased in the last decades, probably contributed by increased use of antimicrobial treatment, long term use of urine catheter, and treatment without indication [7], [10].

Material and Methods

This study aims to evaluate the risk factors of CAUTI in ICU patients at Haji Adam Malik General Hospital and Universitas Sumatera Utara Hospital, Medan, Indonesia, an observational analytic study with a cross-sectional study approach. This research was conducted at Haji Adam Malik General Hospital Medan, starting in July 2018 until the sample was fulfilled then the sample was taken to the Department of Microbiology, Medical College and Hospital of University Sumatera Utara and H. Adam Malik Medan Laboratory for examination. The study population was all adult patients, aged ≥ 18 years, admitted to an ICU between July until August 2018 with an indwelling urinary catheter during their admission, admitted in ICU with different complaints and who were infection that did not originate from patient's original admitting diagnosis, were included in the study who agreed to take urine culture examination.

The method of selecting samples in this study was done by consecutive sampling, where all ICU patients who met the inclusion and exclusion criteria and agreed to be examined after informed consent was included in the study until the required number of subjects was fulfilled.

The sample size is calculated statistically based on the formula:

$$n = \frac{Z^2_{1-\alpha/2} PQ}{d^2}$$

Exp:

n = Amount number of samples needed

Z = If α = 0.05 then Z score = 1.96

p = Proportion of significant bacteriuria infection in CAUTI confirmation by electrical and traditional finding = 0,438

q = 1- p = 0.526

d = Precision = 15%

$$n = \frac{1,96^2 \text{ x } 0,438 \text{ x } 0,526}{(0,15)^2} = \frac{3,8416 \text{ x } 0,438 \text{ x } 0,526}{0,0225} = 42,04$$

= 42.04≈ 42

Based on the above formula, the minimum number of samples obtained in this study were 42 subjects.

Inclusion Criteria

1. ICU patients aged ≥ 18 years old.
2. All ICU patients wore urine catheter at the time of the study (minimal for recent 48 hours).
3. Patients with pyuria.
4. Who are willing to do urine culture examinations.
5. Willing to take part in the study and sign the consent form to take part in the study.

Exclusion Criteria

1. Patients who used antibiotics for UTI for 2-4 weeks before the time of the study.
2. Cystitis.
3. Benign Prostat Hyperplasia patients.

Work Arrangement

The urine sample was aseptically collected from the sampling port of indwelling urinary catheter with sterile syringe and needle from suspected cases of *CAUTI*. The patient was labeled as a case of suspect *CAUTI* after 48 hours admission to ICU. Urine culture tests were performed on clean and sterile

urine samples from the study to observe bacterial growth than in microbiology laboratories have been checked for 30 minutes or been saved in the refrigerator in 4°C for about 24 hours. The present study was conducted in the Department of Microbiology, Medical College and Hospital of University Sumatera Utara and H. Adam Malik Medan (University of Sumatera Utara), Medan, Indonesia for a period of 2 months (July to August 2018).

The culture assessment and bacterial identification from urine samples were inoculated by calibrated loop (0.01 mL) technique onto blood agar, MacConkey's agar, *cysteine-lactose-electrolyte-deficient (CLED)* agar, and Sabouraud dextrose agar (SDA) supplemented with 100 µg/ml of chloramphenicol. The culture plates were incubated at 37°C for 24-48 h. The urine culture results have done after 48-72 hours. Colony count of > 10^4 colony form units (CFU)/mL was considered as significant for bacteriuria, colony count of 10^5 CFU/mL was considered as significant. Additionally, a Gram-stained smear was prepared from a centrifuged urine sample.

Analysis of Statistical

After all the data was collected, a descriptive analysis was conducted to determine the characteristics of the research subjects. Then bivariate analysis was performed to determine the relationship between patient's risk factors and CAUTI infection also the incidence or proportion of uropathogenic of patients in ICU Adam Malik General Hospital and University of Sumatera Utara Hospital, Medan from July until August 2018. To see the strength between the two variables, researchers used the Chi-square test in table 2 x 2 with a value of $p < 0.05$ and 95% confidence interval to assess the relationship of risk factors with positive CAUTI results.

Ethical Consideration

This study was approved by the Ethical Committee of Research, Faculty of Medicine Universitas Sumatera Utara (ID 165 / KEPK FK USU-RSUP HAM / 2018). Informed verbal consent was ensured before administration of the questionnaire. The beneficiaries were taken into consideration; subjects were not coerced to participate in the study and confidentiality was maintained.

Results

A total of 54 patients were admitted to the ICU of Haji Adam Malik General Hospital and Universitas Sumatera Utara Hospital. Of which, 24 (44.4%) were diagnosed with CAUTI. Baseline characteristics are described in Table 1. Male was found to be more common (*N* = 30, 55.6%), and catheter use between 3 and 6 days was the most prevalent (*N* = 40, 74.1%).

Table 1: Demographic Characteristic of Research Subjects in ICU

Demographic Characteristic	N = 54%
Gender	
Male	30 (55.6)
Female	24 (44.4)
Age	
21-30 Year	5 (9.3)
31-40 Year	6 (11.1)
41-50 Year	16 (29.6)
51-60 Year	11 (20.4)
> 60 Year	16 (29.6)
Duration of catheter	
3-6 days	40 (74.1)
7-10 days	7 (13)
> 10 days	7 (13)

CAUTI was also more common among patients aged ≤ 50 years old (16/27, 59.3%) compared to patients aged > 50 years (8/27, 29.6%), with younger patients had a higher risk to acquire infection (OR = 2, 95% CI 1.034-3.870, *P*-0.028) (Table 2). Higher risk to develop UTI was also seen in patients who used catheter longer than 6 days (11/14, 78.6%) than those with a shorter duration than 6 days (13/40, 32.5%). The prolonged use increased the risk to 2.418 (CI 95% 1.432-4.082, *P* = 0.003).

Table 2: Relationship between Risk Factor Gender, Age, Duration of Catheter with CAUTI Events in ICU

Characteristic Subject	CAUTI		P*	95% IK
	Positive n = 24 (%)	Negative n = 30 (%)		Lower-Upper
Gender				
Male	10 (33.3)	20 (66.7)	0,066	0.571
Female	14 (58.3)	10 (41.7)		(0.311-1.05)
Age				
≤ 50 Year	16 (59.3)	20 (66.7)	0,028	2
> 50 Year	8 (29.6)	10 (41.7)		(1.034-3.870)
Duration of catheter				
> 10 days				7 (13)
≤ 10 days				7 (13)

Of 24 confirmed CAUTI cases, we identified eleven microorganisms including *Pseudomonas aeruginosa, Enterococcus faecalis, Escherichia coli, Klebsiella pneumonia, MRSA, Salmonella enteric, Acinetobacter baumanii, Acinetobacter lwoffi, Acinobacter hemolytic, Burkholderia cepacia,* and *Staphylococcus scour* (Figure 1). The most bacteria found in this research was *Pseudomonas aeruginosa* in 4 subjects (16.7%), followed by *Enterococcus faecalis* in 3 subjects (12.5%) and *Escherichia coli ESBL (+),* then *MRSA* and *Salmonella enteric* each in 2 subjects (8.4%).

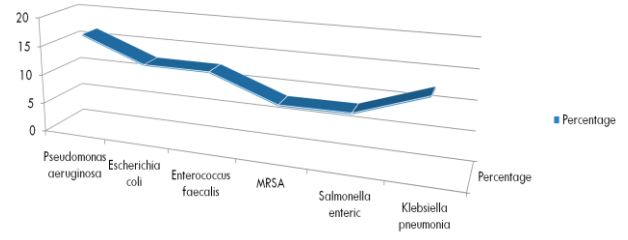

Figure 1: Uropathogen in CAUTI

Discussion

This study described the prevalence of CAUTI in Haji Adam Malik General Hospital and Universitas Sumatera Utara Hospital Medan, Indonesia. The prevalence in this study was relatively higher compared to findings in other published studies. In Indonesia, the prevalence rates of CAUTI ranged between 2.7% to 16% (REF).

This proportion is bigger than the prevalence rate of *CAUTI* infections in another country all over the world (2,4-35/1000 days of urine catheter using), data of *NHSN* in 2006-2007 (3,1/1000 days of urine catheter using), and study in other country such as at KNH hospital in East Africa (18%), other developing countries (9,9-35/1000 days of urine catheter using), developed countries (3,3-17,4/1000 days of urine catheter using), Europe (5,4/1000 days of urine catheter using), and United States of America (rate of *CAUTI* incidence 560.000/year).

The rate of *CAUTI* was expressed as the number of *CAUTI* per 1000 device days and was calculated using the following formula:

$$\frac{\text{Number of patients developing CAUTI}}{\text{Total number of catheter days}} \times 1000$$

In contrast to previous reports, younger age than 50 years old was found to be at higher risk for CAUTI in this study. While Nicole (2014) and Smeltzer & Bare (2008) described the opposite that elderly patients, having the age above 65 years old, and acute bacterial sepsis to increase the risk of the infection. Other factors, including poor environmental sanitation and health conditions, also contribute to the incidence of CAUTI. Patient's condition including nutritional status, history of previous antibiotic administration, immunological status, and the use of immunosuppressive drugs also enhance the risk for CAUTI [2], [10], [11]. In this study, we only evaluated the role of catheter duration in increasing the risk of CAUTI. We found a longer duration of 6 days had increased risk for infection, as also described in a study by Parida and Mishra (2013) and Xie (2011). In the latter studies, the authors explained the use of catheter longer than 5 and 7 days, respectively, allowed bacteria to multiply and cause infection. This duration of time is sufficient for the biofilm of the pathogen to form on the surface of the catheter and the drainage system leading to CAUTI [10].

There are a few limitations in this study. First, the numbers of samples enrolled in this study was relatively small, causing non-significant results in some of the analysis. Second, we only determined few risk factors to be evaluated the association with CAUTI. However, this study shows that CAUTI is prevalent in ICU patients in the two studied hospitals. Further study needs to be done to evaluate the cause of a higher prevalence of CAUTI in comparison to other hospitals in Medan, and more comprehensive risk factors need to be included in the data analysis.

In conclusion, a significant relationship was obtained between *CAUTI* infection with age as a risk factor, a value of $p = 0.028$ ($p < 0.05$), with the most research subjects being the age group 21 ≥ 60 years. The subject who aged ≤ 50 years has two times risk than a subject who aged > 50. A significant relationship was obtained between *CAUTI* infection with duration of the catheter as a risk factor, a value of $p = 0.003$ ($p < 0.05$), with the most research in 3-6 days of duration. The subject who uses a catheter for > 6 days has two times the possibility of *CAUTI* infected than a subject who uses a catheter for ≤ 6 days. The frequency of CAUTI infection with the urine culture examination found that 24 subjects (44.4%) of the 54 subjects studied.

There are eleven uropathogens identified in this study: *Pseudomonas aeruginosa, Enterococcus faecalis, Escherichia coli, Klebsiella pneumonia, MRSA, Salmonella enteric, Acinetobacter baumanii, Acinetobacter lwoffi, Acinobacter haemoliticus, Burkholderia cepacia,* and *Staphylococcus sciur.*

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