ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2019 Oct 15; 7(19):3189-3194.
https://doi.org/10.3889/oamjms.2019.798
eISSN: 1857-9655
Clinical Science

Risk Factors Analysis for Catheter-Associated Urinary Tract Infection in Medan, Indonesia

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Citation: 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 Oct 15; 7(19):3189-3194. https://doi.org/10.3889/oamjms.2019.798

Keywords: Urinary Tract Infection; Catheter; Risk Factor

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Received: 30-May-2019; **Revised:** 14-Oct-2019; **Accepted:** 15-Oct-2019; **Online first:** 12-Sep-2019

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Catheter-associated urinary tract infection (CAUTI) is one of the most common infections in health care caused by several risk factors.

AIM: This study aims at analysing the risky factors triggering CAUTI.

METHODS: This research was designed by applying prospective study. It was conducted from July to November 2018 by involving 82 patients attached to the catheter and treated in the General Hospital of Medan as the sample. The study instrument used observational sheets by measuring the occurrence of urinary tract infection using urine culture analysis ≥ 105 CFU/ml.

RESULTS: The results showed that there was a relationship ($p < 0.05$) amongs age ($p = 0.01$; RR = 0.51), diabetes mellitus ($p = 0.00$; RR = 7.61), duration of catheterization ($p = 0.00$; RR = 0.01), indications for catheter use ($p = 0.00$; RR = 0.34) with CAUTI, and there were not significant relationship ($p > 0.05$) amongs genre ($p = 0.06$; RR = 1.72), drainage system ($p = 0.43$; RR = 0.43) and catheter care ($p = 0.08$; RR = 0.50) with CAUTI. Diabetes mellitus ($p = 0.00$; OR = 8.92 95% CI = 1.02-11.83) and duration of catheterization ($p = 0, 00$; OR = 32.84 95% CI = 3.81-322.74) were the most significant factor related to CAUTI.

CONCLUSION: CAUTI is influenced by various factors, and it can be controlled by understanding those factors so that the right interventions to prevent the infections can be taken and the quality of nursing care can be increased as well.

Introduction

Urinary tract infection is the most common infectious disease in healthcare services worldwide. Urinary tract infection is mostly caused by catheter placement. About 40% of infections in healthcare are urinary tract infection in which 80% of it is triggered by catheter placement [1]. Approximately 12%-16% of the adult patients used indwelling catheters during a stay in the hospital, and 3%-7% of patients had catheter-associated urinary tract infection [2]. Urinary tract infection is the most common infection, which 560.000 per year and 387.550 were catheter-associated urinary tract infection [3]. The number of urinary tract infection estimated 222 million people worldwide. The number of urinary tract infection estimated 90-100 cases of 100.000 people or 180.000 new cases for one year in Indonesia [4].

Infection often occurs after placement of urine catheter, and infection increases 5% urine bacteria for catheter placement every day [5]. The number of infections 3%-5% and 3%-10% every day for indwelling catheter placement in short-term and long-term [6]. Urinary tract infection increases morbidity, mortality, length of stay and charge in the hospital. Catheter-associated urinary tract infection spends maintenance cost as much as 876 dollars for diagnosis and 1.764 dollars for treating patients in the intensive care unit [7]. A patient suffering from urinary tract infection got the harmful impact the presence of bacteria in the urine [8], [9], [10]. The impact can cause harm to patients. The nurse has a big role in care patients with catheter placement [11].

The nurses are very important for preventing the infection at patient by identifying potential risk factor that can affect urinary tract infection through a methodology approach to nursing care, namely

assessment, diagnoses, planning, implementation and evaluation [12]. Data about risk factor analysis catheter-associated urinary tract infection was very required judgment to do appropriate nursing care as a measurement tool for assessing the success of nursing care provided. To prevent the occurrence of urinary tract infections, it is necessary to know the risk factor catheter-associated urinary tract infection as basic to care for the patient. This study aims at analysing the risk factor catheter-associated urinary tract infection.

Methods

This research was designed by applying prospective study. It was conducted from July to November 2018 by involving 82 patients attached to the catheter and treated in the General Hospital of Medan as the sample. The sampling technique was a nonprobability sampling, namely; convenience sampling. The inclusion criteria of sample were: 1) patient placed in a catheter placement at General Hospital Medan showing signs and symptoms such as fever ≥ 38°C, suprapubic and costovertebral pain > 48 hours; 2) the culture result ≥ 10^5 CFU/ml or more than two bacteria identified; and 3) length of stay patient was a least two days. The exclusion criteria of the sample were: 1) patients were diagnosed with an infectious disease; 2) patient placed in a catheter placement showing signs and symptoms such as fever ≥ 38°C, suprapubic and costovertebral pain < 48 hours; 3) patients were treated in paediatric room; and 4) patient didn't want to be respondent. The study has been approved by the Ethics Commission of Nursing Faculty Universitas Sumatera Utara number 1503/VI/SP/2018 and the researcher also asked for respondent's agreement with informed consent.

Measurement to determine catheter-associated urinary tract infection used Center Disease Control (CDC) criteria such as temperature ≥ 38ºC, suprapubic and costovertebral pain > 48 hours, the culture result ≥ 10^5 CFU/ml or more than two bacteria identified. The study steps have been performed by researchers, namely: 1) the researcher filled the respondents' demographic data, such as age, genre, diabetes mellitus, an indication of catheter placement in the observation sheet. The researcher observed the duration of catheter placement, drainage system, catheter care, and signs and symptoms of catheter-associated urinary tract infection, such as temperature ≥ 38°C, suprapubic and costovertebral pain, the culture result ≥ 10^5 CFU/ml or more than two bacteria identified; 2) The patients were observed about signs and symptoms of catheter-associated urinary tract infection after catheter placement by the researchers; 3) The patients were observed for seven days long-time according to signs and symptoms of catheter-associated urinary tract infection by the researchers, and 4) The urine specimen of patients were collected for urine culture.

The authors made the fifth day of catheterisation was taken as the cut-off point for this study because according the research by Al-Hazmi showed that 7 patients from 46 patient who got catheterised placement have infections at third days and 30 patients from 44 patients at the seventh days. The author estimated the seventh day as the longest of the day — fifth days as the cut-off point in this study and median in this research. CAUTI could occur at after second days of catheter placement. The CAUTI began on the third day.

A urine catheter was collected for culture. Hand hygiene was performed before, and after the specimen's collection, gloves were used during the procedure. The drainage port was cleansed with an antiseptic before and after specimen's collection. The drainage system was clamped under the port drainage. The specimen was collected with a sterile syringe. A urine sample was aspirated 3 ml to 5 ml. The clamp was removed to prevent urine reflux. The urine sample was transferred from the sterile syringe to the specimen cup. The specimen cup was put into cooler-box and transferred to the laboratory.

The urine culture was performed by microbiologists. The urine specimens were inoculated on Blood Agar and Mac Conkey. The plates were incubated at 35°C for 24 hours and counted the total plate (CFU/ml). The identification of bacteria morphology and type of bacteria used conventional microbiology methods. It was found that urinary tract infection occurred if there was ≥10^5 CFU/ml or more than two bacteria identified.

Statistical analysis test was performed by using SPSS. Chi-square and Fisher's exact test was used for bivariate analysis because the variable had an ordinal scale, and Logistic regression test was used for multivariate analysis. The p-value significance level was set at $p < 0.05$. The multivariate quantified analysis was the most influential variable to catheter-associated urinary tract infection. The significance level to enter the logistic regression models was set at $p < 0.25$. The logistic regression models were performed for six times. The Two most influential variables were obtained finally.

Results

The study population: Characteristics of Patients

During the study period, there was 82 patient who attracted by urine catheter. Which, 36 patients were suffering from catheter-associated urinary tract

infection, and 46 patients did not suffer from catheter-associated urinary tract infection. The characteristic of patients is illustrated in Table 1.

Table 1: Characteristics of Patients in the Study (n = 82)

Characteristic	Absolut Frequency (n)	Relative Frequency (%)
Gender		
Male	44	53.66
Female	38	46.34
Age		
< 60 Years ± Mean	54 ± 45.66	65.85
> 60 Years ± Mean	28 ± 62.10	34.15
Diabetes mellitus (DM)		
Type II DM	42	51.22
No DM	40	48.78
Long History of Diabetes Mellitus		
> 10 Years ± Mean	20 ± 4.30	24.40
< 10 Years ± Mean	22 ± 12.63	26.80
Immobilisation		
Yes	71	86.59
No	11	13.41
Type of Immobilization		
Total	19	23.20
Partial immobilization	52	63.40
Duration of catheterisation		
< 5 days ± Mean	34 ± 3.42	41.46
> 5 days ± Mean	48 ± 6.42	58.53
Indication catheter used		
Surgery	37	45.12
Urology noninfection	14	17.07
Cardiology	7	8.53
Others (noninfectious disease)	24	29.28
Catheter care		
Yes	20	24.39
No	62	75.61
Catheter Size		
16 fr	50	60.98
18 fr	32	39.02

Based on Table 1. the proportion of males was higher than females 53.66%. The mean age was ± 45.66 to ± 62.10 years. The percentage of patients with diabetes mellitus 51.22% with long history was ± 4.30 to ± 12.63 years. Majority patient has immobilisation 86.59% with type partial immobilisation 63.4%. The mean duration of catheterisation was ± 3.42 to ± 6.42 days. The indication catheter used was surgery at 45.12%. Majority of urine catheter care was not done by nurses 75.61%. The catheter size was 16 as much as 60.98%.

Description of Research Result

Based on Table 2, Data was analysed by Chi-square. There was a significant relationship ($p < 0.05$) amongst age, diabetes mellitus, duration of catheterisation, indication catheter used and catheter size with catheter-associated urinary tract infection. There was not a significant relationship ($p > 0.05$) amongst gender and catheter care catheter-associated urinary tract infection. Diabetes mellitus and duration of catheterisation were the most influencing variable with catheter-associated urinary tract infection by logistic regression. It showed that the significant variable ($p < 0.05$) have a relationship with catheter-associated urinary tract infection, diabetes mellitus ($p = 0.001$) and duration of catheter used ($p =$ 0,001). If the strength relationship according to the value of Odds Ratio (OR), so the most influential variable on catheter-associated urinary tract infection were diabetes mellitus (OR = 8.92; 95%CI, 2.09–37.95) and duration of catheter used (OR = 32.84; 95%CI, 3.71–290.30).

Table 2: Analysis of Relationship between risk factor with Catheter-Associated Urinary Tract Infection (n = 82)

Variable	CAUTI		No CAUTI		Relative Risk	95% CI	*P*-value
	N	%	N	%			
A. Bivariate[a]							
Gender							
Female	12	31.58	26	68.42	0.57	0.33–0.99	0.06
Male	24	54.54	20	45.45			
Age							
< 60 Years	18	33.33	36	66.67	1.92	1.20–3.07	0.01
> 60 Years	18	64.29	10	35.71			
Diabetes mellitus (DM)							
Type II DM	32	76.91	10	23.81	7.61	2.96–19.60	0.001
No DM	4	10.00	36	90.00			
Immobilisation							
Yes	35	49.30	36	50.70	5.42	0.82–35.66	0.03
No	1	9.09	10	90.00			
Duration of catheterisation							
< 5 days	1	2.94	33	97.05	24.79	3.56–172.27	0.001
> 5 days	35	72.92	13	27.08			
Indication catheter used							
Medical	28	62.22	17	37.78	2.87	1.49–5.53	0.001
Surgery	8	21.62	29	78.38			
Catheter care							
No	3	50.00	31	50.00	2.00	0.90–4.46	0.08
Yes	5	25.00	15	75.00			
Catheter Size							
16 fr	16	32.00	34	68.00	1.95	1.02–3.17	0.01
18 fr	20	62.50	12	37.50			
B. Multivariate[b]							
Diabetes mellitus (DM)	-	-	-	-	8.92	2.09–37.95	0.001
Duration of catheterization	-	-	-	-	32.84	3.71–290.30	0.001

Note: [a]) *Chi-Square;* [b]) *Logistic Regression.*

Based on Table 3, the result of urine culture identified as various organisms caused by catheter-associated urinary tract infection. The majority organism was Escherichia coli 13 (36.11%).

Table 3: Organism (n = 36)

Organism	n	%
Escherichia coli	13	36.11
Enterococcus	1	2.78
Klebsiella pneumonia	1	2.78
Staphylococcus aureus	7	19.44
Staphylococcus epidermis	3	8.33
Pseudomonas aeruginosa	5	5.56
Enterobacter aerogenes	1	2.78
Proteus mirabilis	1	2.78
Acinetobacter baumannii	2	5.56
Enterococcus faecalis	2	5.56

Discussion

The catheter placement was a major common urinary tract infection in healthcare. Our finding shows that approximately 43.90% of patients had catheter-associated tract infection [13]. We used the *Center Disease Control* criteria to set as catheter-associated tract infection [14]. Bacteria type found was Escherichia coli 36.11%. Similarly, the study [8], [9], [15] that Escherichia coli was the most commons catheter-associated urinary tract infection. Type 1 Fimbriae was Escherichia coli gen causing infection [16]. These bacteria would locate and require the right antibiotic therapy. The risk of inappropriate antibiotic therapy could cause Multidrug Resistance (MDR) to the microorganism in the urinary tract [17].

We found that the genre has not a relationship with catheter-associated tract infection. Male and Female have the same opportunity to suffer from infection, but the numbers of a male suffering from infection were more than female in proportion. The study was contradictive with the theories found

that females had more risk to suffer from infection because females have a short urethra [18]. However, the study similarity with) [19] catheter-associated urinary tract infection. The increasing of catheter-associated urinary tract infection at male caused the difference of hormone and microorganism in urine [20]. The same opportunities to have catheter-associated urinary tract infection were caused by personal hygiene. The poor personal hygiene in the male and female, especially the genital area had risk suffer from disease-related infection [21].

Not surprisingly, we found that more than 60-year-old have more risk to suffer from catheter-associated urinary tract infection. It is consistent with theories of immunosenescence [22] and the previous study [21] with cohort study that high rates catheter-associated urinary tract infection in elderly patients with average age 64.6 years.

Diabetic Mellitus was as an independent factor for catheter-associated urinary tract infection and has been shown in another study [23]. We found that diabetes mellitus patient had 8.92 times risk have catheter-associated urinary tract infection. The increasing would continue with length to suffering from diabetes mellitus. The Diabetic Mellitus patient has a risk suffer from catheter-associated urinary tract infection because of autonomy neuropathy [24]. This problem can cause incomplete bladder emptying and cause microorganism colonisation. Furthermore, the diabetic Mellitus patient has pancreatic betta cells damage or do not produce enough insulin and cause hyperglycaemia. If there is a hyperglycaemia condition, the kidneys cannot reabsorb glucose. The glucose levels will be high in the urine. The glucosuria influences leukocyte function and performs as a growth medium of pathogenic microorganisms. The poor control and decreasing immune system become a risk factor of diabetic mellitus patients to suffering from catheter-associated urinary tract infection [24], [25].

A patient who has catheter placement continuously and bed rest can complicate to infection. We found the immobilisation has a relationship with catheter-associated tract infection. Immobilisation could cause urine flow to become static. Urine was flowing from renal pelvis to the bladder through ureter because of gravity in an upright position. When the patient was in the supine position, the peristaltic of the ureter is unable to produce gravity [26]. Urine would reflux from bladder to kidney [27].

Duration of catheterisation was the most influential independent factor with catheter-associated urinary tract infection. It has been shown in another study [21], [28], [29]. The odds of the duration of catheterisation 32.85 higher for a patient who inserted a catheter for five days or more. The length the catheter insertion, the more susceptible to infection [30]. Patients who insert the indwelling catheter have a risk to growth bacteriuria [31]. The catheter urine will form a biofilm. Bacteria can enter after catheter insertion or after three days [32]. Biofilm development occurs when cells (planktonic) contact with the surface of the catheter with the thin film [33].

Indication of catheter placement was indicated by medical and similar with previous studies [10], [28] that indication of catheter placement was indicated by medical, such as orthopaedic, urology and urine incontinence. The appropriate indication can decrease catheter-associated urinary tract infection. The inappropriate indication could cause 1.86-time to decrease catheter-associated urinary tract infection [34].

We found that catheter care did not have a relation with catheter-associated urinary tract infection. Because of all the number of the patient hadn't performed catheter care were more than the patient had performed. This finding is puzzling because it contradicts with theories of catheter urine care can decrease infection [26], [35]. Catheter urine care is a nurse's duty. In this study, the nurse is more likely to do the non-nursing job so it can increase nursing workload. The survey in 2017 conducted by AMN Healthcare in California America that approximately 35% of nurses performed a non-nursing job [36]. The relationship between catheter care and catheter-associated urinary tract infection warrants more research.

Catheter size affects the incidence of urinary tract infections in patients with catheters. Larger urine catheter sizes are used for the management of blockages or sediments. The nurses also believe that a larger catheter size prevents urine leakage. But on the other hand, a larger catheter size can irritate the bladder sphincter and aggravate leakage [37]. A smaller catheter size recommendation is recommended [38]. Small catheters can reduce trauma during insertion [39].

Our study had several limitations. First, patients may have been performed catheter-associated urinary tract infection. This is suspected that the use of diapers in patients. The organism enters the urinary tract from anal or area around the perineum. Second, the error location of urine catheter fixation caused urine catheter touch with perineal area. Third, clinical specimens may have been collected incorrectly and contaminated by the organism. It can be possible to caused bias in this study.

Besides our study have a limitation, our study has an implication too. Our finding is useful as information for health workers especially nurse and for hospital staff decided hospital's policies in infection prevention control by considering risk factor catheter-associated urinary tract infection, namely: maintaining hand hygiene, training infection prevention control for all hospital staff, socializing the catheter-associated

urinary tract infection bundle and removing catheter before seven days.

In conclusion, catheter-associated urinary tract infection can be influenced by various factors. This infection can be controlled by understanding the risk factor infection so that it can determine the right intervention to prevent infection the number of infection and increase the quality of nursing care as well. The specific nursing care is necessary from the nurse for a patient who has inserted a urine catheter with diabetes mellitus and duration of catheterisation for five days or more. Future research is needed to clarify the relationship between drainage system, catheter care, and catheter-associated urinary tract infection.

Acknowledgement

The author, thanks to Prof.DR.Runtung Sitepu as a Rector of Universitas Sumatera Utara, Setiawan, BSN., MNS., PhD as a Dean of Nursing Universitas Sumatera Utara, Dr.dr.Syah Mirsya Warli, as a Director of Universitas Sumatera Utara Hospital who has permitted to do research and Dr R. Lia Kusumawati, MSc, PhD. (clinical microbiologist) for supporting this research.

Authors Contribution

Hariati conceived and carried out the research and wrote the manuscript. Dewi Elizadiani Suza and Rosina Tarigan reviewed the research process, design and results analysis of research.

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