

BLADDER CATHETERIZATION AS A RISK FACTOR FOR URINARY TRACT INFECTION

Sylwia Kocur^{1A,B,C,D,E,F}, Mirosława Noppenberg^{2A,B,C,D,E,F}, Agnieszka Gniadek^{3C,D,E,F}, Izabela Sowińska^{4C,D,E,F}

¹Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

²Department of Clinical Nursing, Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

³Department of Nursing Management and Epidemiological Nursing, Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

⁴Department of Internal and Environmental Nursing, Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

Authors' contribution:

A. Study design/planning • B. Data collection/entry • C. Data analysis/statistics • D. Data interpretation • E. Preparation of manuscript • F. Literature analysis/search • G. Funds collection

Address for correspondence:

Sylwia Kocur
Faculty of Health Sciences
Jagiellonian University Medical College
Krakow, Poland
e-mail: sylwia.kocur@o2.pl

SUBMITTED: 26.01.2023

ACCEPTED: 10.02.2023

DOI: <https://doi.org/10.5114/ppiel.2022.126822>

ABSTRACT

Introduction: Bladder catheterization contributes significantly to the occurrence of urinary tract infections. This is a common problem in health care both in Poland and around the world. Urinary catheters weaken the human body's natural defences, damaging the mucosa of the urinary tract epithelium. There are many pathogens responsible for urinary tract infections. The most common ones include *Escherichia coli* and *Staphylococcus aureus*. Prevention of urinary tract infections is mainly based on adherence to the principles of aseptic and antiseptic during the catheterization procedure and minimizing the duration of urinary catheter maintenance.

The aim of the study was to evaluate the risk factor of bladder catheterization predisposing to urinary tract infection.

Material and methods: The research method used in the study was documentoscopy, and the technique used was the analysis of medical records. The study included 66 patients of all departments, hospitalized between January and December 2020, with diagnosed hospital-acquired urinary tract infection. The study was conducted from May 2021 to February 2022 at the Specialized Hospital. The study was retrospective in nature. The records of the Hospital Infection Control Team and the aggregate nursing records were analysed.

Results: It appeared that length of hospitalization (more than 14 days), advanced age, and bladder catheterization were risk factors responsible for urinary tract infections. Urinary catheters were inserted in 51 cases among the 66 subjects. Urinary catheters were maintained in the patients' bladders for an average of 30.59 days. The urinary catheter inserted in most cases was an 18 Ch (Charrier scale) latex Foley catheter. There was no correlation between the clinical course of infection and the presence of a urinary catheter, the type, the size of a urinary catheter, or the number of catheter exchanges.

Conclusions: Bladder catheterization is a risk factor for urinary tract infection.

Key words: urinary tract infections, risk factors, bladder catheterization.

INTRODUCTION

Catheter-associated urinary tract infections (CAUTIs) are responsible for increased mortality, prolonged hospital stay and increased healthcare costs [1]. In Poland, urinary tract infections (UTI) are the second most common bacterial infections among hospitalized patients, directly after respiratory tract infections [2]. Urinary tract infections affect 21% of women and 12% of men over the age of 65 years and about 40% of patients in long-term care [3]. Studies in the US indicate that UTIs are the fourth most common nosocomial infection and account for 12.9% of all hospital-acquired infections [4].

Among numerous risk factors for urinary tract infection, bladder catheterization contributes to 70-80%. The duration of urinary catheter maintenance is an important determinant of bacteriuria.

Maintaining a urinary catheter in a patient's bladder increases the risk of infection each day by 3-7% [4]. Urinary catheters disrupt host defences, including damaging the uroepithelial mucosal barrier. As a result, bacterial biofilm is more easily formed, providing a reservoir of potential pathogens that are in contact with the bladder. The biofilm formed prevents the action of immune cells and blocks the action of antibiotics [5, 6].

Bacteria such as *Escherichia coli*, *Staphylococcus*, and *Pseudomonas aeruginosa* are the main pathogens responsible for CAUTIs. Bacterial toxins lead to direct damage to host tissues and weaken the immune response. In addition, the resistance of microorganisms to antimicrobial agents hinders treatment options. The urine of patients with indwelling catheter is the major site of isolation of resistant Gram-negative organisms [7].

Prevention of urinary tract infections is mainly based on adherence to the principles of aseptic and antiseptic when inserting a urinary catheter. An open catheterization system is not recommended. The urine bag must be placed below the level of the bladder and should be emptied on average every 4 to 6 hours to prevent urine from flowing back into the bladder from the tubing and urine bag. The use of external urinary catheters in men is an alternative to bladder catheterization and reduces the risk of urinary tract infection because it does not affect the urinary microflora. Bladder irrigation is not recommended, but it can be used in patients with bladder bleeding, which will minimize the risk of clots. Polyhexanidine or citric acid solution can be used for this procedure [8-10]. The CDC (Centres for Disease Control and Prevention) guidelines note that routine replacement of the catheter as well as individual components of the system is not recommended. Catheter replacement should be done if obstruction or urinary tract infection appears, according to the manufacturer's recommendations. According to the guidelines, the use of intermittent catheterization or suprapubic catheters (which should be replaced every 6 to 8 weeks) should be considered as an alternative to permanent catheters. Studies show that long-term catheters are associated with several complications, i.e. catheter obstruction, leakiness, and leakage of urine around the catheter, as well as pain and trauma [11, 12].

The study aimed to evaluate the risk factors associated with bladder catheterization, which predispose to urinary tract infections. The length of urethral catheter maintenance, the type and number of urinary catheter exchanges, and the size of the urinary catheters inserted were evaluated.

MATERIAL AND METHODS

The research was carried out at the J. Dietl Specialist Hospital in Krakow with a group of 66 patients who developed urinary tract infections in 2020. The information needed to conduct the study was obtained from the available medical records of the

Hospital Infection Control Team (ICT) and the nursing records. First, the number of all nosocomial infections was estimated, among which UTIs accounted for 28.27%, followed by an analysis of risk factors for urinary tract infections. The clinical course of the infection was divided into slight, mild, severe, and death, according to the records of ICT. The criteria for the division followed the criteria adopted by the ICT. Foley latex, Foley silicone, and suprapubic catheters were used. Necessary medical record data were collected from May 2021 to February 2022. Consent for access to medical records was obtained from the hospital director. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The research method used in the study was documentoscopy. The technique used was an analysis of the (Hospital) Infection Control Team's records and collective nursing records. The conducted study was retrospective in nature.

Analyses were performed using the IBM SPSS package. The results of nominal and ordinal variables were presented by absolute (*n*) and relative (%) counts. In order to assess the relationship between these variables, contingency tables were made, and χ^2 tests were used. The results of quantitative variables were presented using descriptive statistics and histograms. The statistical significance was adopted as $p < 0.05$.

RESULTS

Men constituted 45.5% of the study subjects, and women 54.5%. The average age of patients who developed urinary tract infections was 71.70 years. The oldest person was 97 years old while the youngest was 20. The majority of people (66.7%) resided in urban areas, while the remaining group, representing 33.3%, lived in rural areas.

Among all hospital-acquired infections, urinary tract infections accounted for 28.27% (Fig. 1).

Among the 66 studied patients with a UTI, urinary catheters were inserted in 51 patients. The mean duration of urethral catheter maintenance during hos-

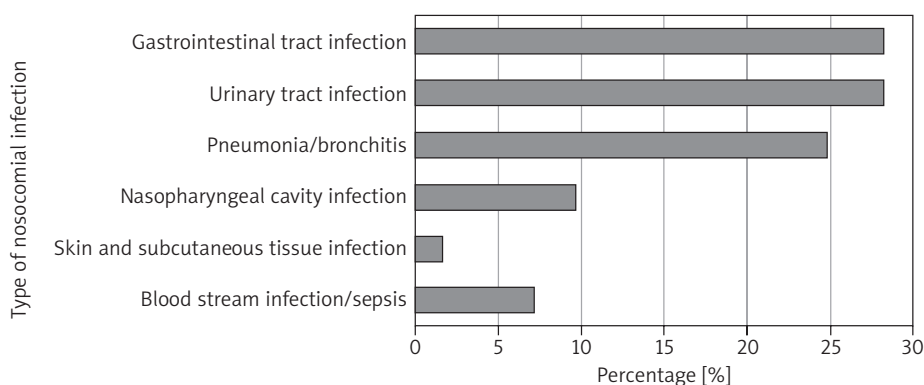


Figure 1. Percentage of individual hospital-acquired infections

Table 1. Cross-tabulation – the relationship between the clinical course of a urinary tract infection and the presence of a urinary catheter, the number of days of urinary catheter maintenance, the type of urinary catheter, and the number of urinary catheter exchanges

	Presence of a urinary catheter			Number of days of urinary catheter maintenance							Type of urinary catheter				Number of urinary catheter exchanges					
	Yes	No	Total	20	21-36	37	Total	Suprapubic catheterization	Foley latex	Foley silicone	Total	One	Two	Three	Four	Five	Six	Total		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	
The clinical course of a urinary tract infection	Slight	10	5	15	5	2	3	10	0	10	0	10	2	5	1	1	0	10		
		19.6	33.3	22.7	27.8	12.5	17.6	19.6	0.0	20.4	0.0	19.6	16.7	35.7	12.5	25.0	20.0	0.0	22.7	
Mild		31	9	40	10	9	12	31	1	29	1	31	8	5	5	3	4	1	26	
		60.8	60.0	60.6	55.6	56.3	70.6	60.8	100.0	59.2	100.0	60.8	66.7	35.7	62.5	75.0	80.0	100.0	59.1	
Severe		7	1	8	2	3	2	7	0	7	0	7	0	4	1	0	0	5		
		13.7	6.7	12.1	11.1	18.8	11.8	13.7	0.0	14.3	0.0	13.7	0.0	28.6	12.5	0.0	0.0	11.4		
Death		3	0	3	1	2	0	3	0	3	0	3	2	0	1	0	0	3		
		5.9	0.0	4.5	5.6	12.5	0.0	5.9	0.0	6.1	0.0	5.9	16.7	0.0	12.5	0.0	0.0	6.8		
Total		51	15	66	18	16	17	51	1	49	1	51	12	14	8	4	5	1	44	
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
χ^2 test	Value	df	P-value	Value	df	P-value	Value	df	Value	df	P-value	Value	df	Value	df	Value	df	P-value		
	2.321	3	0.509	4.088	6	0.665	1.343	6	0.969	6	0.969	13.985	15	0.527	15	0.527	15	0.527		
N	66			66			51		51		44									

n, N – number of observations, df – degree of freedom, p – significance level

pitalization was 30.59 days, the median was 29.0, and the standard deviation was 17.691. The shortest time for urinary catheter insertion was 1 day, and the longest was 76 days.

18 Ch (Charrier scale) catheters were most frequently inserted, accounting for 20 patients (39.2%). The second most frequently inserted urinary catheter was a 16 Ch catheter, which accounted for 14 people (27.5%), and the least frequently inserted catheters were 14 Ch, which accounted for 5 people (9.8%) as well as 20 Ch size, which accounted for 2 people (3.9%). In 7 cases the patients had 2 catheters of different sizes inserted at different intervals during hospitalization. In 3 cases the patients had 3 catheters of different sizes inserted during hospitalization.

The predominant clinical course of urinary tract infection among hospitalized patients was mild ($n = 40, 60.6\%$). A course of infection of a slight nature occurred in 15 cases (22.7%), a severe clinical course occurred in 8 cases (12.1%), and death occurred in 3 cases (4.5%).

The clinical course of urinary tract infection was not influenced by the presence of a urinary catheter (no statistically significant relationship, $p = 0.509$), the number of days of urinary catheter maintenance (no clinically significant relationship, $p = 0.665$), the type of urinary catheter inserted (no clinically significant relationship, $p = 0.969$), or the number of urinary catheter exchanges (no clinically significant relationship, $p = 0.527$) (Table 1).

The clinical course of urinary tract infection was also unaffected by the size of the inserted urinary catheter (no statistically significant relationship, $p = 0.403$) (Table 2).

DISCUSSION

According to the international study conducted by Antimicrobial Resistance Epidemiology Survey on Cystitis (ACRES), urinary tract infections are the second most common nosocomial infections occurring in hospital wards after pneumonia [2]. In turn, research conducted by the Centres for Disease Control and Prevention (CDC) in 2014 shows that UTIs rank fourth among nosocomial infections and account for 12.9% of all nosocomial infec-

Table 2. Cross tabulation – relationship between the clinical course of a urinary tract infection and the size of the inserted urinary catheter

		Size of inserted urinary catheter [Ch]			
		All catheters of size ≤ 16 (14/16/14&16)	At least 1 exchanged catheter of size ≥ 18	Total	
Clinical course of urinary tract infection	Slight	<i>n</i>	6	4	10
		%	26.09	14.29	19.61
	Mild	<i>n</i>	14	17	31
		%	60.87	60.71	60.78
	Severe & Death	<i>n</i>	3	7	10
		%	13.04	25.0	19.61
Total	<i>n</i>	23	28	51	
	%	100.0	100.0	100.0	
		Value	df	P-value	
χ^2 test		1.8176	2	0.403	
<i>N</i>		51			

n, N – number of observation, *df* – degree of freedom, *p* – significance level

tions [13]. In Germany, urinary tract infections occur at a frequency of 21.6% and are second only to respiratory infections [14]. In Irish hospitals, urinary tract infections have been proven to account for 22.5% of hospital-acquired infections. In contrast, the results of the European Centre for Disease Prevention and Control (ECDC) pilot study showed that UTIs account for 30% of hospital-acquired infections (HAIs) [15]. The research results presented here show that urinary tract infections and gastrointestinal infections were the most common nosocomial infections and accounted for equally 28.27%, largely confirming the ECDC study.

In the publication of Nicolle, bladder catheterization was a major risk factor for urinary tract infection, with a prevalence of 70-80% [7]. Similar results of 70-80% were obtained in a study conducted by Gad and AbdelAziz [15]. According to studies conducted by Kranz *et al.*, bladder catheterization was responsible for urinary tract infection in 60% of cases [14]. Studies conducted in the United States confirmed that 67.7% of UTI patients had a urinary catheter inserted [4]. In the authors' research, bladder catheterization was the second most common risk factor for UTIs.

The study conducted in the General Hospital of Medan in Indonesia with a group of 82 patients showed that a duration of catheterization longer than 5 days increased susceptibility to urinary tract infection [16].

Similar dependencies were obtained by Verma *et al.*, who showed that catheterization lasting longer than 5 days increased the risk of developing a urinary tract infection by as much as 6 times [17]. According to our research, the average duration of urinary catheter maintenance was 30.59 days. This is significantly longer than in other studies.

The risk of urinary tract infection is also affected by the size of the urinary catheter. This relationship

was proven in a study conducted by Wilde *et al.*, which showed that urinary catheters larger than 16 Ch and 18 Ch are more likely to irritate the bladder sphincter and worsen leakage predisposing to the development of UTIs [18]. Our own research reveals that the catheters of size 16 Ch (27.5%) and 18 Ch (39.2%) were most frequently inserted. These catheter sizes greatly predispose to UTIs.

Urinary tract infections are influenced by the material of which the urinary catheters are made. In a study of 1000 hospitalized patients in 6 hospitals in India, it was proven that patients with latex Foley catheters were twice as likely to get an infection compared to patients with a silicone Foley catheter coated with a noble metal alloy (gold, silver, or palladium) [19]. Our own study showed that among the 66 patients who developed UTIs, 49 had a latex Foley catheter inserted. This may have been related to the clinical condition of the patient.

In a prospective study of 315 people with a urinary catheter in place for more than 7 days, it was proven that frequent catheter replacement predisposed to urinary tract infections. In 98 subjects the catheter was replaced, and in 217 subjects the catheter was not replaced. In the group in which the catheter was replaced, the frequency of UTI was 35.7%, and in the group without replacements, it was 18.4% [20]. In our own study, as many as 44 patients had their urinary catheter replaced.

Considering the results of other authors' and our own studies, it is important to note the need for further research into the risk factors of bladder catheterization.

Urinary tract infections and the risk factors associated with them are a current and significant topic of discussion, as it is a common problem in health care.

CONCLUSIONS

Bladder catheterization predisposes to urinary tract infections.

Length of urinary catheter maintenance, type and size of catheters, and number of replacements should be considered as a risk factor for urinary tract infection.

The need for bladder catheterization should be considered in every case.

Disclosure

The authors declare no conflict of interest.

References

1. Bagchi S, Watkins J, Norrick B, et al. Accuracy of catheter-associated urinary tract infections reported to the National Healthcare Safety Network, January 2010 through July 2018. *Am J Infect Control* 2020; 48: 207-208.
2. Zalewska-Piątek B, Piątek R, Krawczyk B, et al. Patomechanizm zakażeń dróg moczowych wywołanych przez uropatogenne szczepy *E. coli*. *Postępy Hig Med Dosw (online)* 2019; 73: 270.
3. Sheerin SN, Glover EK. Urinary tract infection. *Medicine* 2019; 47: 546-550.
4. Słojewska-Poznańska E, Zuchowski A, Bartoszewicz M. Epidemiologia zakażeń dróg moczowych u pacjentów cewnikowanych. *Forum Zak* 2017; 8: 27-31.
5. Walsh C, Collins T. Pathophysiology of urinary tract infections. *Surgery (Oxf)* 2020; 38: 191-196.
6. Piecha T. Rola gospodarza i patogenu w zakażeniu układu moczowego. *Przegl Urol* 2017; 1: 88-94.
7. Nicolle LE. Catheter associated urinary tract infections. *Antimicrob Resist Infect Control* 2014; 3: 2-3.
8. Oleksy M, Dydak K, Król G. Nieantybiotykowe metody ograniczania zakażeń związanych z założonym cewnikiem moczowym (CAUTI). *Forum Zak* 2019; 9: 181-188.
9. Babska K. Prewencja zakażeń układu moczowego u pacjentów z cewnikiem moczowym. *Forum Nefrol* 2020; 13: 98-102.
10. Silva VSTD, Torres MVACR, Silva MAO, et al. Male external catheter in adults: a glance at nursing care practice. *Rev Bras Enferm* 2019; 72: 450-454.
11. Gould CV, Umscheid CA, Agarwal RK, et al. Guideline for prevention of catheter-associated urinary tract infections. *Infect Control Hosp Epidemiol* 2019; 31: 319-326.
12. Murphy C, Cowan A, Moore K, et al. Managing long-term indwelling urinary catheters. *BMJ* 2018; 363: 1-7.
13. Monegro AF, Muppidi V, Regunath H. Hospital acquired infections. StatPearls Publishing, 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK441857/>
14. Kranz J, Schmidt S, Wagenlehner F, et al. Catheter-associated urinary tract infections in adult patients. *Dtsch Arztebl Int* 2020; 117: 83.
15. Gad MH, AbdelAziz HH. Catheter-associated urinary tract infections in the adult patient group: a qualitative systematic review on the adopted preventative and international protocols from the literature. *Cureus* 2021; 13: 1.
16. 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: 3190-3192.
17. Verma S, Naik SA, Deepak TS. Etiology, and risk factors of catheter associated urinary tract infections in ICU patients. *IP Int J Med Microbiol Trop Dis* 2017; 3: 65-70.
18. Wilde MH, McMahon JM, Crean HF, et al. Exploring relationships of catheter-associated urinary tract infection and blockage in people with long-term indwelling urinary catheters. *J Clin Nurs* 2016; 26: 2558-2571.
19. Kai-Larsen Y, Grass S, Mody B, et al. Foley catheter with noble metal alloy coating for preventing catheter-associated urinary tract infections: a large, multi-center clinical trial. *Antimicrob Resist Infect Control* 2021; 10: 4-8.
20. Babich T, Zusman O, Elbaz M, et al. Replacement of urinary catheter for urinary tract infections: a prospective observational study. *J Am Geriatr Soc* 2018; 66: 1779-1784.