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ORIGINAL ARTICLE

Risk Factors for Hospital-Acquired Urinary Tract Infections in Patients with Acute Stroke

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Abstract

Background: Patients with acute stroke, due to the specific nature of the disease and treatment, represent a population of patients with an increased risk of hospital-acquired urinary tract infection (UTI). The aim of the study was to determine risk factors for hospital-acquired UTI in patients with acute stroke.

Methods: A retrospective case-control study has been conducted with 128 participants, 64 cases (patients with acute stroke and hospital-acquired UTI), and 64 controls (patients with acute stroke and without hospital-acquired UTI).

Results: The most common cause of UTI in male patients was *Enterococcus faecalis* (34.4%), while in female patients dominated *Escherichia coli* (48.3%). The two groups differed significantly in the presence of the following risk factors: diabetes mellitus (χ^2 = 3.81; p = 0.041), catheter placement (χ^2 = 10.93; p = 0.001), duration of catheterization (t = 2.38; p = 0.022), stroke subtype in male patients (χ^2 = 3.94; p = 0.047), stroke severity (χ^2 = 9.64; p = 0.001) and length of hospital stay (χ^2 = 8.81; p = 0.011). The results showed that there was no statistically significant difference between the two groups in terms of the following risk factors: coronary heart disease, heart failure, level of blood creatinine, the presence of cancer, the presence of COPD, and frequency of strokes. In multivariable logistic regression analysis, stroke severity ≥ 16, according to NIHSS (OR = 3.55; p = 0.011; 95%CI 1.34-9.40), and length of hospital stay (OR = 2.66; p = 0.012; 95%CI 1.37-6.22) were identified as predictors of hospital-acquired UTI.

Conclusion: Severity of stroke and pLOS are predictors for hospital-acquired UTI in patients with acute stroke.

Keywords

Acute stroke, Hospital-acquired UTI, Risk factors

Abbreviations

UTI: Urinary Tract Infections; LOS: Lenth of Hospital Stay; pLOS: Prolonged Length of Hospital Stay; NIHSS: National Institutes of Health Stroke Scale; χ^2: Chi-square Test; t: Student t-test; SD: Standard Deviation; OR: Odds Ratio; RR: Risk Ratio; CFU: Colony-Forming Unit; ECDC: European Centre for Disease Prevention and Control; CDC: Centre for Disease Prevention and Control; COPD: Chronic obstructive Pulmonary Disease; HAI: Hospital-Acquired Infections

Introduction

Urinary tract infections (UTI) are one of the most commonly reported hospital infections and it is estimated that hospital-acquired UTI account for 35-40% of the total number of hospital infections [1]. Approximately, 90% of patients with urinary tract infection have asymptomatic bacteriuria [2]. Patients with acute stroke, due to the specific nature of the disease and treatment, represent a population of patients with an increased risk of hospital-acquired UTI. UTI in patients with acute stroke may lead to complicated infections, and prolong the length of hospital stay [3]. Urinary tract infection is usually defined as an increase in the number of bacteria of 10^5 CFU or more, with the presence of symptoms such as frequent urge to urinate, suprapubic pain, and dysuria [4]. Previous studies showed that the most important risk factors for the colonization of a urinary

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tract are the duration of catheterization, female gender (RR = 1.7-3.7), presence of fatal underlying illness (RR = 2.5), age ≥ 50 years (RR = 2), elevated serum creatinine (≥ 150 µmol/l), catheter placement time (RR = 2.1) and diabetes mellitus (RR = 2.3) [5,6]. The most severe complication of UTI is secondary urosepsis (0.4 to 3.9%) [7]. However, hospital-acquired UTI are rarely symptomatic and most of them do not require treatment [8].

Determining the predictors of hospital-acquired UTI may be very important due to early detection and prevention of these infections, early adequate treatment, antibiotic stewardship, as well as to identify those groups of patients with stroke who are at risk of developing hospital-acquired UTI.

The aim of the study was to determine risk factors for hospital-acquired UTI among patients with acute stroke and to identify whether the severity of the illness can be a predictor of hospital-acquired UTI.

Methods

This was a retrospective case-control study. A sample of 128 participants with acute stroke was calculated on previously published studies evaluating the prevalence of hospital-acquired UTI in patients with acute stroke: The prevalence of hospital-acquired UTI in patients with a severe medical condition, including acute stroke [9], and the overall prevalence of UTI in hospitalized patients [10]. The group of cases consisted of patients with acute stroke, with hospital-acquired UTI. The control group consisted of patients with acute stroke who did not develop hospital-acquired UTI. Patients with symptoms of urinary tract infection or the presence of bacteriuria at the admission and patients who were on antibiotic therapy at the admission were not included in the study. All participants gave their permission to participate in the study. As a data source, we used medical documentation from the Department of Neurology, General Hospital Bijelo Polje. All patients who were admitted were initially reviewed. We collected data related to the demographic status of patients, urinary catheter placement, type of stroke, level of blood creatinine, frequency of strokes, length of hospital stay, and presence of the following comorbidity: Coronary heart disease, COPD, cancer, diabetes mellitus type 2, heart failure, and the severity of stroke which was assessed by hospital neurologist with NIHSS as part of routine practice. All patients were hospitalized and treated in the 2017 year.

This study was performed following the ethical standards of the Declaration of Helsinki and approved by the Ethical Committee of General Hospital Bijelo Polje (01-103/2017).

All urine samples have been analyzed in the microbiological laboratory in General Hospital Bijelo Polje. Samples were inoculated in blood agar and endoagar. The plates were incubated at 37 °C aerobically for 18-24 hours. Hospital-acquired urinary tract infection was defined according to ECDC criteria [11]. To determine the number of bacteria per 1 ml of urine, a filter paper method has been used.

Table 1: Bacterial strains isolated in patients with Hospital-acquired UTI and acute stroke.

Bacterial strain	Male %	Female %	Total %
Enterococcus faecalis	34.4	24.1	29.5
Citrobacter spp.	31.1	6.9	19.7
Pseudomonas spp.	3.1	13.8	8.2
E. coli	0	48.3	23.0
Klebsiella spp.	12.5	3.4	8.2
Staphylococcus spp.	18.8	3.4	11.5

Statistical analysis was performed using SPSS 20 statistical software. First, descriptive statistics methods including arithmetic means, frequencies, and percentages were performed in the study. Using the Student t-test, we analyzed the difference between continuous numerical variables in the case group and the control group, while for categorical variables we used the chi-square test (χ^2). To determine the independent risk factors for hospital-acquired UTI, we used binary logistic regression.

Results

The study included 128 participants, individually matched by gender and age. The most common cause of UTI in male patients was *Enterococcus faecalis* (34.4%), followed by *Citrobacter spp.* (31.3%), while in female dominated *Escherichia coli* (48.3%) and *Enterococcus faecalis* (24.1%) (Table 1). All tables are given separately, at the end of the article.

The urinary catheter has been placed in 114 patients (89.1%). The catheter has been majority placed in the hospital. Urinary tract infection was presence in 61 patients with catheter (53.5%) (χ^2 = 10.93; p = 0.001) (Table 2).

Duration of catheterization was statistically significant with hospital-acquired UTI (Mean = 14.76-10.55; SD = 6.22-5.53; t = 2.38; p = 0.022). The two groups differed significantly in the presence of diabetes mellitus as a risk factor. In patients with hospital-acquired UTI, this comorbidity was significantly more frequent compared to the control group (χ^2 = 3.81; p = 0.041) (Table 2). The length of hospital stay ≥ 8 days was also significantly more commonly seen as a risk factor among patients with hospital-acquired UTI (χ^2 = 8.81; p = 0.01). By analyzing the type of stroke, a statistically significant difference was found between male patients who had an ischemic stroke compared to their controls (χ^2 = 3.94; p = 0.047). Also, a statistically significant difference was found between patients with moderate to severe stroke (NIHSS ≥ 16) and the presence of hospital-acquired UTI (χ^2 = 9.64; p = 0.001) (Table 2). The results showed that

Table 2: Risk factors for hospital-acquired UTI in patients with acute stroke.

Variable	Hospital-Acquired UTI		χ^2/t	p
	Yes	No		
Gender				
Male	32 (50.0%)	32 (50.0%)	0.00	1.000
Female	32 (50.0%)	32 (50.0%)		
Age				
35-54	8 (53.3%)	7 (46.6%)		
55 -64	7 (43.8%)	9 (56.2%)	1.29	0.796
65-74	20 (55.4%)	16 (44.6%)		
75-95	28 (46.7%)	32 (53.3%)		
Catheter placement				
Yes	61 (54.0%)	1 (7.1%)		
No	52 (46.0%)	13 (92.9%)	10.93	0.001
Stroke frequency				
1	45 (45.9%)	53 (54.1%)		
2-3	17 (58.6%)	12 (41.7%)	1.44	0.229
Coronary heart disease				
Yes	21 (50.0%)	21 (50.0%)		
No	42 (48.2%)	44 (51.8%)	0.03	0.852
Diabetes mellitus				
Yes	22 (62.9%)	13 (31.1%)		
No	40 (43.5%)	52 (56.5%)	3.81	0.041
COPD				
Yes	7 (46.7%)	8 (53.8%)		
No	56 (49.1%)	57 (50.9%)	0.03	0.859
Heart Failure				
Yes	28 (57.4%)	20 (42.6%)		
No	35 (48.8%)	45 (51.2%)	2.22	0.136
Cancer				
Yes	2 (50.0%)	2 (50.0%)		
No	62 (50.0%)	62 (50.0%)	0.00	1.000
Length of hospital stay				
1-7	10 (31.1%)	22 (68.8%)		
≥ 8	52 (54.7%)	43 (45.2%)	8.81	0.012
Duration of catheterization			2.28	0.022
Level of blood creatinine				
< 104	49 (46.7%)	56 (53.3%)		
≥ 104	13 (59.1%)	9 (40.9%)	1.12	0.289
Stroke subtype (Male)				
Ischemic	22 (43.1%)	29 (56.9%)	3.94	0.047
Hemorrhagic	9 (75.0%)	3 (25.0%)		
Stroke subtype (female)				
Ischemic	23 (47.9%)	25 (52.1%)		
Hemorrhagic	8 (50.0%)	8 (50.0%)	0.21	0.885
Stroke Severity (by NIHSS)				
1-15	62 (68.8%)	28 (31.1%)		
≥ 16	15 (39.4%)	23 (60.6%)	9.64	0.001

Table 3: Statistical significant variables assessed by multivariable logistic regression analysis[1].

Variable	Coefficient	SE	p	OR	95% CI
Stroke severity (NIHSS) ≥ 16	2.633	1.228	0.011	3.55	1.34-9.40
Length of hospital stay ≥ 8 days	0.527	1.168	0.012	2.66	1.37-6.22
Cathteter placement	2.599	0.460	0,069	2.387	0.85-0.94
Diabetes mellitus	3.162	0.429	0.075	0.466	0.20-1.08
Duration of catheterization	0.441	1.521	0.119	0.922	0.86-0.99

[1]The results for the variables that are not statistically significant according to MLRA in the Table 3, but they are processed in the same, are given based on the last step of multivariable analysis in which these variables appeared.

there was no statistically significant difference between the two groups in terms of the following risk factors: Coronary heart disease, heart failure, level of blood creatinine, presence of cancer, presence of COPD, and frequency of strokes (Table 2).

In multivariable logistic regression analysis, stroke severity ≥ 16, according to NIHSS (OR = 3.55; P = 0.011; 95%CI 1.34-9.40), and length of hospital stay (OR = 2.66; P = 0.021; 95% CI 1.37-6.22) identified as a predictor of hospital-acquired urinary tract infection (Table 3). The χ^2 for the Hosmer-Lemeshow test is 6.324, with a p-value of 0.611. Cox & Snel and Nagelkerke R Square for the percentage of variance that can be explained by the model is between 22.9% and 31.7%.

Discussion

In this study we found that prolonged length of hospital stay (OR = 2.66; P = 0.021; 95% CI 1.37-6.22) and stroke severity (OR = 3.55; P = 0.011; 95 % CI 1.34-9.40) are predictors of hospital acquired urinary tract infection in patients with acute stroke.

A pLOS is a significant risk factor for hospital-acquired urinary tract infection. According to Alexander J. George, et al. patients with acute stroke and pLOS more often developed hospital-acquired infections, of which 32.1% are urinary tract infections [12]. In the same study, patients with the combination of pLOS and HAI were at greater odds of discharge NIHSS being greater than baseline NIHSS. In the study, conducted in Spain, patients with acute stroke who developed hospital-acquired UTI were hospitalized for 14.9 days averaged, while patients who did not develop UTI were hospitalized for 8.4 days averaged (P < 0.0001) [13]. In our study, patients with pLOS more often had moderate to severe or severe stroke than patients without pLOS (62.4%).

Patients with moderate-severe to severe stroke (NIHSS ≥ 16), according to our research, are at greater risk of developing hospital-acquired urinary tract infection than patients with a minor or moderate stroke. According to a study conducted at the University Hospital in Texas, any subsequent stroke degree assessed using the NIHSS scale increases the risk of UTI and prolonged LOS [13]. In the study of Friedant and al., patients with NIHSS score > 15 are much more likely to develop UTI (OR = 5.67; 95% CI 3.28-9.81; P < 0.0001) [14]. Greater risk for the development of UTI in patients with severe stroke is attributed to the effects of several factors. First, neurological damage caused by stroke causes immunodepression, which can cause impairment of the function of natural killers T cells, reduced cytokine production, and reduction in blood peripheral leukocytes count [15]. The changes in the immune system are accompanied by neurological deterioration of the diseases most pronounced in the first three days when the patient is exposed to invasive procedures when colonization takes place [16]. Patients with severe stroke often have comorbidities, that could be a risk factor for UTI [17]. In our study, the most common comorbidities were hypertension, heart failure, diabetes mellitus, and coronary heart disease. Patients with diabetes mellitus are at a significantly higher risk of developing hospital-acquired urinary tract infection (χ^2 = 3.81; p = 0.041). In the multivariable analysis, this variable did not appear statistically significant. Numerous studies suggest that the presence of diabetes mellitus as a comorbidity in patients with acute stroke may be a significant risk factor for the development of hospital-acquired urinary tract infections and hospital infections in general [18].

The duration of catheterization does not often correlate with the length of hospital stay. This is one of the important reasons why this variable (duration of catheterization) does not appear as an independent risk factor for hospital-acquired UTI.

The most often isolated bacterial strain in males was *Enterococcus faecalis* (34.4%), while the most common cause of urinary tract infection in females was *Escherichia coli* (48.3%). The most common isolated bacteria in both genders was *Enterococcus faecalis* (29.5%). According to the American National Database of the Center for Disease Control and Prevention in Atlanta, 2009 and 2010, the most common cause of hospital-acquired urinary tract infection was *Escherichia coli* (26.8%), followed by *Enterococcus spp.* (12.7%), *Pseudomonas aeruginosa* (11.3%) and *Klebsiella spp.* (11.2%) [19]. In the point prevalence study conducted in Turkey, the most common cause of hospital-acquired UTI was *Escherichia coli* (45.5%), followed by *Klebsiella spp.* (10%) and *Enterococcus spp.* (10.2%) [20], while in Germany, also in the point prevalence study, the most commonly isolated pathogen was *Escherichia coli* (27.7%), followed by *Klebsiella spp.* (23.1%) and *Enterococcus spp.*

(16.9%) [21]. In our study, *Klebsiella spp.* was isolated in 8.2% of patients. We may conclude that the results of our study, in terms of finding the cause of hospital-acquired urinary tract infection, are similar to the results of other studies.

Limitations

There are a few limitations of the study. First, due to the design of the study, it was not possible to calculate the incidence and prevalence of hospital-acquired UTI among patients with acute stroke. Second, the study was carried out with a relatively small sample. This may be an explanation why some of the known risk factors for hospital-acquired UTI such as age, presence of comorbidity, duration of catheterization, have not been shown as predictors for hospital-acquired UTI.

Conclusion

Our study showed that the severity of stroke ≥ 16, according to NIHSS, and pLOS are predictors for hospital-acquired urinary tract infection in patients with acute stroke. Comparable results with other studies indicated the need for further research and the implementation of more effective measures for the prevention of hospital infections.

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Disclosure of Potential Conflicts of Interest

The authors Admir Šabanović, Marina Kostić, and Janković M Slobodan have no conflict of interest regarding this article.

Statement of Equal Authors' Contribution

All authors participated in the design of the study. Slobodan Jankovic and Admir Šabanović performed data analyzing. All authors read and approved the final manuscript.

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