Original Article

Prevalence, Characteristics, and Impacts of Urinary Tract Infection on Functional Outcomes: A Retrospective Study of Inpatient Stroke Rehabilitation at Siriraj Hospital, Thailand

Patcharee Aueaananratthakit and Kamontip Harnphadungkit
Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

ABSTRACT

Objectives: To investigate the prevalence, characteristics, associated factors, and impacts of urinary tract infections (UTI) on the Barthel Index (BI) during inpatient stroke rehabilitation.

Study design: Retrospective study

Setting: Inpatient Rehabilitation Unit, Department of Rehabilitation Medicine, Siriraj Hospital, Bangkok, Thailand

Subjects: Inpatients with stroke, aged ≥ 18 years old, admitted to the Rehabilitation Ward, Siriraj Hospital during 2019-2021

Methods: Demographic, clinical, and functional data of eligible patients were retrieved from the rehabilitation admission medical records in the hospital information system.

Results: Of 399 stroke patients identified, 11.5% had been diagnosed with UTI. Of these, 30.4% had catheter-associated UTIs (CAUTIs), while 69.6% had non-CAUTIs. *Escherichia coli* was identified as the most common pathogen. UTI was significantly associated with advanced age ($p < 0.001$), indwelling catheter use ($p < 0.001$), recurrent stroke ($p = 0.031$), and dysphagia ($p < 0.019$). Patients with UTI exhibited a statistically significant reduction in BI normalized gain per 21-day length of stay (BIg21days) ($p = 0.033$) and experienced longer rehabilitation length of stay (LOS) ($p = 0.002$). Using forward stepwise linear regression, only age and dysphagia, but not UTI, were found to be statistically significantly associated with BIg21days.

Conclusions: The prevalence of UTI is 11.5%, with higher rates in older individuals, those with recurrent stroke, dysphagia, and those using urinary catheters. Functional gain per 21 days of rehabilitation admission is associated with age and dysphagia, but not with UTI.

Keywords: prevalence, inpatients, rehabilitation, stroke, urinary tract infection

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Introduction

Stroke is a common health problem worldwide, including in Thailand.[1] The prevalence of stroke is increasing, particularly among individuals over 45 years old. The mean age of stroke onset is 65 years.[2] Although acute stroke treatment has advanced and improved, stroke survivors still face impairments and disabilities. Intensive rehabilitation programs are an important component of management to reduce impairments and disabilities in stroke patients and can also improve their quality of life.[3]

Urinary tract infection (UTI) is one of the most frequent infectious complications encountered in post-stroke patients.[4,5] Its prevalence varies, ranging from 3.7% to 19.0% in hospitalized stroke patients.[4,6-9] Many factors contribute to UTI, including the retention of indwelling catheters. Studies have suggested a link between indwelling catheters and poor clinical outcomes after stroke.[7] UTI is also associated with poor stroke outcomes, such as increased mortality, longer length of stay (LOS), and poorer functional outcomes as measured by the Barthel Index (BI).[10] Nevertheless, several factors may affect the BI in post-stroke patients admitted for intensive rehabilitation, including age, previous stroke history, dysphagia, and admission functional level.[11]

However, no prior studies have examined the prevalence of UTI during inpatient stroke rehabilitation at Siriraj Hospital. Therefore, this study aimed to determine the prevalence of UTI, their characteristics, and related factors, as well as to assess their impacts on functional outcomes during inpatient stroke rehabilitation at Siriraj Hospital. These findings are expected to enhance the prevention and management of UTI during stroke rehabilitation. This study was reported according to the STROBE guidelines for observational studies.

Methods

After receiving approval from the Siriraj Institutional Review Board (SIRB), the Faculty of Medicine, Siriraj Hospital, Mahidol University (Si 529/2022), on July 13, 2022, this retrospective study was conducted by reviewing the medical records of inpatients admitted to the rehabilitation ward at Siriraj Hospital from January 1, 2019, to December 31, 2021.

Correspondence to: Kamontip Harnphadungkit, MD, FRCPhysiatrT; Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Rd., Siriraj, Bangkok Noi, Bangkok 10700, Thailand; E-mail: kamontip.har@mahidol.ac.th; kamontip.har@gmail.com

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Patient informed consent was not required, as the data retrieved did not include the patient identification. The medical records of patients meeting the following criteria were included: aged 18 years or older and those with a stroke diagnosis. Patients missing required data, such as the BI or other information necessary for the study, were excluded. The sample size calculation was based on the prevalence reported by Kitisomprayoonkul et al.,[12] using a 95% confidence interval (95%CI) and a 3.75% allowable error. The calculated sample size was 400. A total of 399 patients met the inclusion criteria and were included in the study (Figure 1).

The diagnosis of UTI was defined according to the diagnostic criteria established by the Centers for Disease Control and Prevention (CDC) and National Healthcare Safety Network (NHSN) 2021. UTI diagnosis required meeting all three of the following criteria: [13,14]

Criteria 1:

- Catheter-associated urinary tract infection (CAUTI): Indwelling urinary catheter > 2 consecutive days or removed the day before the event

- Non-CAUTI: Indwelling urinary catheter ≤ 2 consecutive days or no indwelling urinary catheter the day before the event

Criteria 2: At least one of the following symptoms: fever >38.0 °C, suprapubic tenderness, costovertebral angle pain or tenderness, urinary urgency, urinary frequency, dysuria

Criteria 3: Positive urine culture ≥ 10^5 colony-forming units/ml (≤ 2 species) or positive urinalysis (nitrite positive and/or leukocyte esterase positive and/or bacteria positive and/or WBC in urine > 4/high power field)

Only UTI diagnosed during admission to the rehabilitation ward were included in the data analysis.

Demographic, clinical, and functional data of eligible patients were obtained from the rehabilitation admission medical records within the hospital information system.

Functional outcomes after inpatient rehabilitation were assessed using BI gain, calculated as the BI score at discharge minus the BI score at admission. The maximum possible BI gain was defined as the full BI score (20) minus the admission BI score. To evaluate program effectiveness, the normalized BI gain (g) was calculated as the ratio of the absolute BI improvement to the maximum possible score change. The normalized gain scores were classified into three categories: high (g > 0.7), medium (0.3 ≤ g ≤ 0.7), and low (g < 0.3) gain.[15] The typical LOS for stroke rehabilitation at Siriraj Hospital is 21 days, approximately equivalent to the standard LOS of 23.5 days established by the National Health Security Office for neuromuscular inpatient rehabilitation. For comparative analysis, the BI normalized gain per LOS 21 days (BIg21days) was employed to evaluate each patient's functional improvement relative to the duration of their rehabilitation program.

Rehabilitation program interruption was defined as program suspension or discontinuation.

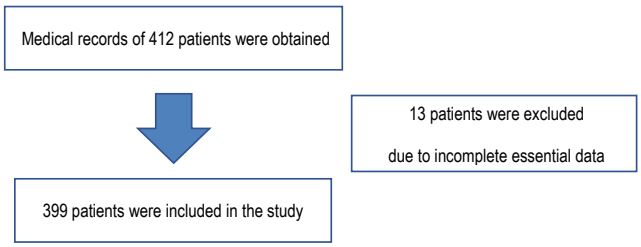

Figure 1. Flow diagram showing study recruitment

Statistical analysis

IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Descriptive statistics were used to compare characteristics of patients with UTI and those without UTI. Normally distributed continuous variables were summarized as mean and standard deviation and analyzed using an unpaired t-test. Non-normally distributed continuous variables were summarized as median and interquartile range and were analyzed using the Mann-Whitney U test. The categorical variables were summarized as numbers and percentages and were analyzed using the Chi-square test. Statistical significance was accepted if $p < 0.05$. Three linear regression models were evaluated to identify factors associated with the BI normalized gain: (1) a univariable analysis for UTI, (2) a multivariable analysis using forward stepwise selection for model 2, and (3) a multivariable analysis including UTI and the variables retained from model 2. In the stepwise selection, variables with a p-value of < 0.05 were included and those with *p*-value of > 0.1 were removed.

Results

Table 1 shows the demographic, stroke characteristics, and relevant clinical data of the 399 stroke patients recruited into the study. The overall prevalence of UTI was 11.5% (95%CI: 8.8, 15.0). Of the 46 UTI patients, 30.4% had CAUTI and 69.6% had non-CAUTI. When comparing patients with and without UTI, there was a significant difference in urinary catheter use between the UTI and non-UTI groups ($p < 0.001$) (Table 1). The mean age of patients with UTI was 71.7 years (SD = 9.9), which was significantly older than those without UTI at 65.2 years (SD = 14.0) ($p < 0.001$). There were no statistically significant differences in any comorbidities except for a history of previous stroke ($p = 0.031$), particularly previous ischemic stroke ($p = 0.042$).

The three most common UTI symptoms were fever, dysuria, and increased urinary frequency (Figure 2). *Escherichia coli* was the most common pathogen, followed by *Klebsiella pneumoniae*; both pathogens were isolated from patients with UTI in the rehabilitation ward. *Escherichia coli* showed 100.0% susceptibility to nitrofurantoin, cefepime, piperacillin/tazobactam, imipenem, meropenem, and ertapenem, but only 23.0% susceptibility to ciprofloxacin (Figure 3). Regarding treatment, 12 patients (26.1%) received ciprofloxacin, while

Table 1. Patients' demographics, stroke characteristics, relevant clinical data, and comparison between patients with urinary tract infection (UTI) and those without UTI (non-UTI)

	Total (n = 399)	UTI (n = 46)	Non-UTI (n = 353)	*p*-value
Age (years)[1]	65.9 (13.7)	71.7 (9.9)	65.2 (14.0)	< 0.001*
Sex (male)[2]	245 (61.4)	31 (67.4)	214 (60.6)	0.375
Type of stroke (ischemic)[2]	300 (75.2)	36 (78.3)	264 (74.8)	0.608
Duration from onset to rehabilitation admission (days)[1]	220 (690)	109 (176)	234 (729)	0.750
Length of stay (days)[3]	20 (15-22)	21 (17-26)	20 (15-22)	0.016*
Interruption of rehabilitation program[2]	37 (9.3)	17 (36.9)	20 (5.7)	< 0.001*
Bedside rehabilitation program[2] (less intensive)	28 (7.0)	13 (28.3)	15 (4.3)	< 0.001*
Able to communicate[2]	336 (84.2)	38 (82.6)	298 (84.4)	0.751
Ambulatory status (non-ambulatory)[2]	219 (54.9)	29 (63)	190 (53.8)	0.237
Catheterization, indwelling catheter during admission[2]	34 (8.5)	14 (30.4)	20 (5.7)	< 0.001*
Urinary retention[2]	27 (6.8)	19 (41.3)	8 (2.3)	< 0.001*
Urinary incontinence[2]	114 (28.6)	18 (39.1)	96 (27.2)	0.092
Post-stroke consequences/complications				
Cognitive impairment[2]	176 (44.1)	25 (54.3)	151 (42.8)	0.137
Dysphagia[2]	170 (42.6)	27 (58.7)	143 (40.5)	0.019*
Pressure sore[2]	15 (3.8)	3 (6.5)	12 (3.4)	0.397
Comorbidities				
Diabetic mellitus[2]	162 (40.6)	20 (43.5)	142 (40.2)	0.673
Hypertension[2]	339 (85.0)	41 (89.1)	298 (84.4)	0.400
Dyslipidemia[2]	253 (63.4)	33 (71.7)	220 (62.3)	0.212
Chronic kidney disease[2]	38 (9.5)	5 (10.9)	33 (9.3)	0.788
Previous stroke[2]	82 (20.6)	15 (32.6)	67 (19)	0.031*
Ischemic[2]	70 (17.5)	13 (28.3)	57 (16.1)	0.042*
Hemorrhagic[2]	16 (4.0)	3 (6.5)	13 (3.7)	0.412

[1]Mean (SD), [2]number (%), [3]median (IQR); *Statistical significance $p < 0.05$
IQR, interquartile range

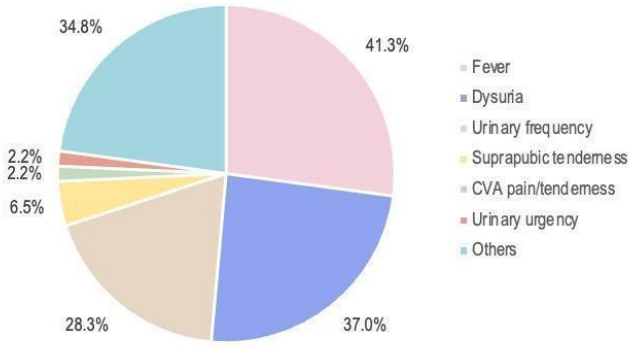

Figure 2. Symptoms of urinary tract infection

25 patients were initially treated with intravenous antibiotics and 21 patients with oral antibiotics. Eight patients required switching to more susceptible antibiotics.

Regarding LOS, the median LOS was 21 days (interquartile range, IQR = 17-26) in the UTI group and 20 days (IQR = 15-22) in the non-UTI group, with a statistically significant difference between groups ($p = 0.016$). Rehabilitation program interruptions occurred in 36.9% of patients in the UTI group compared to 5.7% in the non-UTI group. Consequently, bedside rehabilitation was required for 28.3% of patients in the UTI group and 4.3% in the non-UTI group. The percentages of interruptions and bedside rehabilitation programs in the two groups were statistically significantly different ($p < 0.001$). Furthermore, urinary retention was documented in 27 patients, occurring significantly more frequently in the UTI group ($p < 0.001$) (Table 1). No patients had a diagnosis of neurogenic bladder.

Dysphagia was identified as another significant factor associated with UTI in our study ($p = 0.019$). A statistically significant association was also found between dysphagia and urinary catheterization ($p = 0.002$).

Table 2 compares mean BI scores at admission and discharge, and BI normalized gain between patients with and without UTI during rehabilitation admission. The mean scores at admission and discharge were lower in the UTI group than in the non-UTI group. However, only the mean discharge BI score was statistically significantly different between the groups ($p = 0.034$). The mean BI gain and BI normalized gain were also lower in the UTI group but without statistically significant differences. However, the mean BIg21days in the UTI group was statistically significantly lower than that in the non-UTI group ($p = 0.033$)

Using linear regression analysis as shown in Table 3, age and dysphagia were identified as significant factors associated with BIg21days, while UTI did not demonstrate a significant decrease in BIg21days. In the adjusted model, the significant negative associations persisted for age ($p < 0.001$) and dysphagia ($p = 0.006$), but the association between BIg-21days and UTI remained not statistically significant ($p = 0.323$).

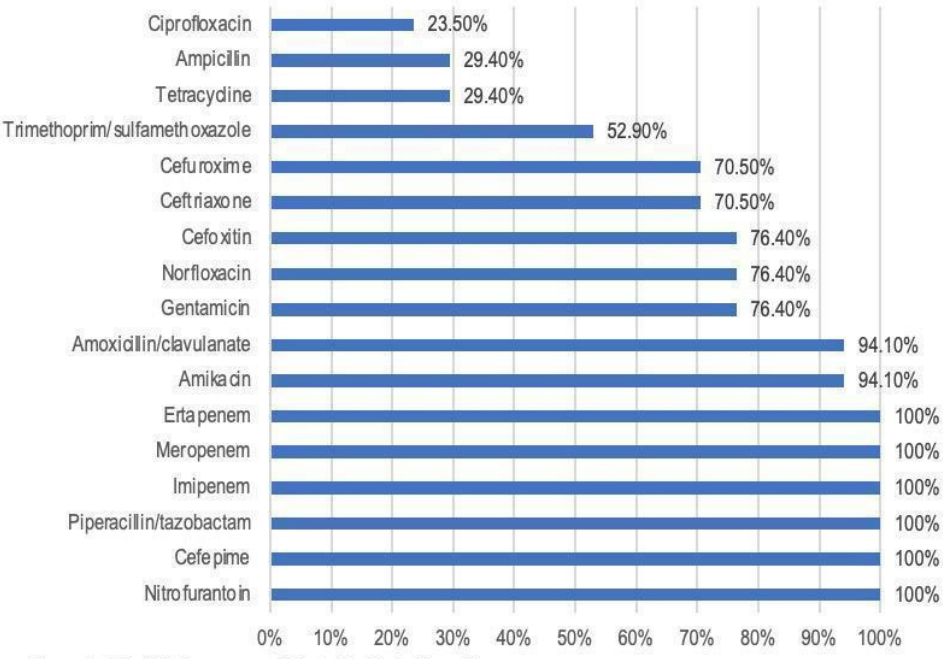

Figure 3. Antibiotics susceptibility to *Escherichia coli*

Table 2. Comparison of Barthel Index (BI) scores at admission and at discharge plus BI normalized gain between those with urinary tract infection (UTI) and without UTI (non-UTI) during rehabilitation admission

Variables	Total (n = 399)	UTI (n = 46)	Non-UTI (n = 353)	*p*-value
Barthel index				
Admission[1]	8.10 (5.21)	6.85 (4.99)	8.26 (5.22)	0.084
Discharge[1]	12.40 (6.05)	10.63 (6.11)	12.63 (6.01)	0.034*
Mean difference BI gain[1]	4.29 (3.59)	3.78 (3.48)	4.36 (3.61)	0.302
Barthel index normalized gain[1]	0.44 (0.34)	0.36 (0.32)	0.45 (0.34)	0.110
Low gain[2]	166 (41.60)	23 (50.00)	143 (40.50)	
Medium gain[2]	116 (29.10)	13 (28.30)	103 (29.20)	
High gain[2]	117 (29.30)	10 (21.70)	107 (30.30)	
Barthel index normalized gain per LOS 21 days[1]	0.5 (0.55)	0.37 (0.37)	0.55 (0.57)	0.033*

[1]Mean (SD), [2]number (%); *Statistical significance $p < 0.05$

Barthel index normalized gain: low gain < 0.3, medium gain = 0.3-0.7, high gain > 0.7

Table 3. Association between the Barthel index normalized gain per length of stay 21 days and statistically significant urinary tract infection (UTI)-related factors

Variables	Model 1	Model 2	Model 3
UTI	-0.184 (-0.350, -0.010), $p = 0.033$*	-	-0.081 (-0.241, 0.080), $p = 0.323$
Age	-	-0.010 (-0.013, -0.006), $p < 0.001$*	-0.009 (-0.013, -0.006), $p < 0.001$*
Dysphagia	-	-0.149 (-0.252, -0.046), $p = 0.005$*	-0.146 (-0.249, -0.043), $p = 0.006$*

Coefficients (95% confidence interval), *p*-value; *Statistical significance $p < 0.05$

CI, Confidence interval

Model 1: UTI enter method linear regression analysis; Model 2: Forward stepwise linear regression

Model 3: Adjusted UTI into model 2

Discussion

This retrospective study found that the prevalence of UTI during inpatient stroke rehabilitation, with an LOS of approximately 3 weeks, was 11.5%, which falls within the range of previously reported rates (3.7-19.0%) in hospitalized stroke patients.[4,6-9] The UTI rate was higher in patients using urinary catheters than those without catheters (41.2% and 8.8%), consistent with finding reported by Bogason et al. (2017), who demonstrated that Foley catheter use was associated with increased risk of UTI in ischemic stroke patients.[7]

Similar to findings from Mukapa et al. (2022) at a teaching hospital in Zimbabwe[16] and the National Antimicrobial Resistant Surveillance in Thailand (NARST) (2022),[17] *Escherichia coli* was the most common pathogen isolated from infected urine samples in our study. This organism demonstrated high susceptibility to nitrofurantoin but resistance to ciprofloxacin, emphasizing the importance of considering antibiotic resistance patterns when physiatrists select optimal UTI treatment during inpatient rehabilitation.

The univariable analysis in our study identified several significant factors associated with UTI, including older age, a history of previous stroke(s), dysphagia, and urinary catheter use. These finding are consistent with previous studies.[4,8,18,19] Moreover, a meta-analysis by Westendorp et al.[6] concluded that stroke severity affects the probability of UTI occurrence. A recent study also reported an association between post-stroke dysphagia and UTI, suggesting that dysphagia increases dehydration risk, which may contribute to UTI development. Additionally, patients with severe stroke and dysphagia are more likely to require urinary catheterization.[19] Stepwise linear regression analysis in our study further revealed that both increased age and dysphagia significantly impacted BIg21days.

Regarding the impact of UTI on stroke rehabilitation outcomes, our study found that UTI was significantly associated with lower BI score at discharge, less BIg21days, one day longer rehabilitation LOS, and higher rates of rehabilitation program interruption, reflecting the negative impact of UTI on functional outcomes. Although the mean BI normalized gain was higher in the non-UTI group than in the UTI group, the highest percentage of patients in both groups fell within the low-gain class, and these differences were not statistically significant. The linear regression analysis confirmed that UTI alone significantly contributed to decrease BIg21days. Similar associations with the BIg21days have been reported for both increased age and dysphagia. However, in the present study, a significant association between UTI and BIg21days was not observed after adjusting for age and dysphagia. Therefore, the statistically significant findings observed in the entire sample should be interpreted cautiously due to potential confounding effects of factors such as age and comorbidities.

The significant limitations of our study were using a retrospective review of medical records from a single tertiary hospital and using BI, a generic tool for functional assessment, rather than the National Institute of Health Stroke Scale (NIHSS), which has been demonstrated to be a predictor of functional outcomes in stroke patients.[20,21] Consequently, our findings may not be applicable to other populations receiving care at different facilities. Furthermore, we could not exclude confounding factors that may have influenced some of our findings. Future studies should prospectively analyze additional potential risk factors for UTI and factors associated with BI outcomes, including other functional measurements.

Conclusions

UTI is common during stroke rehabilitation, occurring in 11.5% of inpatients. It occurs more frequently in older patients, those with recurrent strokes, dysphagia, and those requiring urinary catheters. UTI negatively impacts functional outcomes by interrupting rehabilitation program and increasing rehabilitation LOS. *Escherichia coli* was the most commonly identified pathogen. In the linear regression model, age and dysphagia, but not UTI, were identified as factors associated with BI gain per 21 days.

Conflict of interest disclosure

The authors report no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author, Kamontip Harnphadungkit, upon reasonable request.

Author contributions

Patcharee Aueaananratthakit: conceptualization, methodology, investigation, writing - review & editing,

Kamontip Harnphadungkit: conceptualization, methodology, investigation, writing - review & editing.

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