

Occurrence of Urinary Tract Infection in Reference to Bladder-emptying Method and Etiological Agents among Spinal Cord Injury Patients: A Cross-sectional Study

Ratul Das¹, Mrinal Joshi², Keshav Dev³, Aruna Vyas⁴

ABSTRACT

Spinal cord injury (SCI) patients who develop neurogenic bladder can not have normal physiological voiding and require catheterization for bladder drainage. The method of bladder drainage influences risk of urinary tract infection (UTI) and most people on the indwelling catheter or intermittent catheterization develop urinary tract infection. A cross-sectional study among 138 SCI patients admitted in the Department of Physical Medicine and Rehabilitation, Sawai Man Singh Medical College, and Jaipur was done. Urine samples were sent to Microbiology department for culture and antibiotic sensitivity test. Bacteria found resistant to three or more of the envisaged antibiotics were considered multidrug-resistant. The study revealed that 87.68% patients had significant bacteriuria. Asymptomatic and symptomatic UTI developed in 65.94% and 21.74% respectively. Symptomatic UTI was significantly associated with indwelling catheter user (p value < 0.05). The most common organism isolated was *E. coli* (49.30%) followed by *Enterobacter aerogenes* (14%). About 50.70% isolated organisms were multidrug-resistant and 4.22% organisms were extensively drug resistant. Development of multidrug-resistant organism was highest who were using an indwelling catheter (p value < 0.05). Clean intermittent catheterization (CIC) should be preferred the option to manage the neurogenic bladder in spinal cord injury patients. Not urine culture with significant bacteriuria but symptomatic UTI should be treated.

Keywords: Asymptomatic bacteriuria, Multidrug-resistant organism, Symptomatic urinary tract infection.

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INTRODUCTION

Traumatic spinal cord injury (SCI) results in pain, paresis, and incontinence. Most of the patient with SCI develop neurogenic bladder, which is the causative factor of high mortality and morbidity. Renal complications remain an important cause of mortality in long-term SCI survivors. Clean intermittent catheterization (CIC) is a standard protocol for managing neurogenic bladder but it also leads to nonsignificant to significant bacteriuria. Many times physician treat culture reports without symptoms, thus promoting resistance in various bacterial strains. We all are aware of the rise in antibiotic resistance and atypical bacterial strains due to irrational antibiotic use. This study has explored the status of bacteriuria along with specific bacterial strains isolation and its antibiotic sensitivity pattern.

AIMS AND OBJECTIVES

- To assess the bacterial load of bacteriuria among SCI patients
- Causative agents of bacteriuria with an antibiotic sensitivity pattern
- The occurrence of symptomatic urinary tract infection (UTI) and asymptomatic bacteriuria in SCI patients using different bladder-emptying methods

MATERIALS AND METHODS

Study Design

Cross-sectional study.

Study Duration

From approval of the research review board (February 2016) till the desired sample size was obtained (November 2017).

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Setting

Patients with SCI were admitted in the Department of Physical Medicine and Rehabilitation (State Spinal Injury Centre), Sawai Man Singh Medical College, Jaipur, Rajasthan, India.

Sample Size

A total of 138 eligible patients with SCI satisfying our inclusion criteria were recruited in the study.

Inclusion Criteria

- Patients with SCI
- Patients who gave a valid and informed consent

Exclusion Criteria

- Patient on antibiotic during the study
- Not willing to participate

Procedure

The evaluation of patients included medical history, age, sex, etiology, clinical sign and symptom, level of injury, neurologic assessment, and determination of the neurological level according to the American Spinal Injury Association (ASIA) impairment scale.¹

The assessment of patients according to different bladder-emptying methods was done and the urine sample was sent to the Department of Microbiology, SMS Medical College, Jaipur, for the culture sensitivity test. The culture report containing causative organism, type of bacteriuria, and sensitivity to antibiotics was documented. Colony forming unit count $\geq 10^5$ was accepted as significant bacteriuria.²⁻⁵ A patient was considered to have asymptomatic bacteriuria if he/she had significant bacteriuria without clinical symptoms.^{2,5}

A patient was considered to have symptomatic UTI (SUTI) if he/she had significant bacteriuria with one of the following clinical findings: body temperature $>38^\circ\text{C}$, abdominal pain, urinary incontinence, suprapubic pain, flank pain, frequent urination, dysuria, urgency, urinary incontinence, foul smell in urine, and cloudy urine.^{2,5} Patients with bacteriuria and fever without any urinary complaint, whose fever was due to another cause, were considered to have "non-UTI infection."

Ciprofloxacin, gentamicin, cotrimoxazole, ceftriaxone, nitrofurantoin, imipenem, polymyxin B, and colistin antibiotic discs were used for the antibiotic sensitivity test. Organisms resistant to at least three of the antibiotics were considered as multidrug-resistant (MDR) strains.^{2,6}

Outcome Measures

- Bacterial colony count
- Asymptomatic bacteriuria (ASB) and SUTI
- Causative organism and the antibiotic susceptibility pattern

Statistical Analysis

All data were entered in the Excel sheet. Continuous data were summarized as mean and standard deviation. Nominal/categorical variables were expressed as proportions (%) and were analyzed by using the Chi-square test. The p value less than 0.05 was taken as significant. The Medcalc 17.9.7 version software was used for statistical calculations.

OBSERVATION AND RESULTS

One hundred thirty-eight patients with traumatic SCI were included. The maximum number of cases were in the age group of 21–30 years (34.06%), followed by 31–40 years (23.91%), 51–60 years (13.77%), 41–50 years (15.22%), and less than 20 (11.60%). Only two patients (1.45%) were over 60 years. The mean age of the study group was 35.90 ± 12.71 years. Regarding gender distribution, 80.43% were males and 19.57% were females.

The major cause of SCI was road traffic accident accounting for 44.20% of cases, followed by fall from height (43.48%), fall of heavy object (7.25%), and slippage on the ground (2.17%). Other causes were hit by animal, electric shock, fall from the train, and gunshot injury, each accounting for 0.72% of cases. The duration of injury in most cases was within 3–6 months (52.17% cases).

A total of 138 SCI patient's urine culture reports were analyzed in which 121 patients (87.68%) had significant bacteriuria, 14 patients (10.14%) had insignificant bacteriuria, and 3 patients (2.17%) had sterile sample. Out of 121 significant bacteriuria, 91 (65.94%)

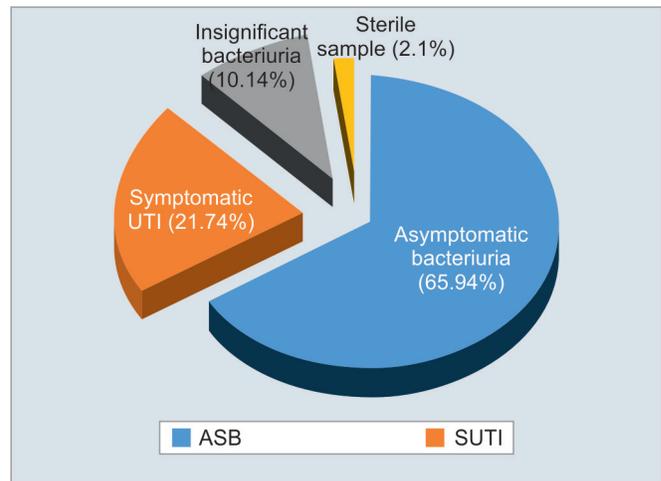


Fig. 1: Distribution of cases with asymptomatic bacteriuria (ASB) and symptomatic urinary tract infection (SUTI)

patients had asymptomatic bacteriuria and 30 (21.74%) patients had symptomatic UTI (Fig. 1).

Cases were distributed according to the American Spinal Injury Association (ASIA) impairment scale. Patients with the ASIA impairment scale A, B, C, D, and E were 78, 28, 6, 20 and 6, respectively. No significant relation was found between the asymptomatic bacteriuria group and the symptomatic UTI group with respect to the vertebral level of injury, the ASIA impairment scale, and the neurological level of injury.

Clean intermittent catheterization, indwelling catheter, self-voiding, reflex voiding, and the Crede's method were used by SCI patients to empty their bladder in our study group. A maximum number of cases were on CIC accounting for 67 cases (48.55%), whereas 42 patients (30.43%) were using an indwelling catheter as the bladder-emptying method. The number of patients on reflex voiding and the Crede's method were 8 (5.80%) and 2 (1.45%), respectively. There were 19 SCI patients (13.77%) who were able to do self-void with minimum residual volume in the bladder.

In 67 SCI patients who were using CIC, 50 patients (74.63%) had asymptomatic bacteriuria, 11 patients (16.42%) developed symptomatic UTI, and 6 patients (8.96%) had insignificant bacteriuria. Among 42 SCI patients using an indwelling catheter, 23 patients (54.76%) had asymptomatic bacteriuria, 16 patients (38.10%) developed symptomatic UTI, and 3 patients (7.14%) had insignificant bacteriuria.

Of 19 SCI patients who were self-voiding with minimum residual volume of the bladder (less than 100 mL), 12 patients (62.16%) had asymptomatic bacteriuria, 1 patient (5.26%) developed symptomatic UTI, 3 patients (15.79%) had insignificant bacteriuria, and 3 patients (15.79%) had a sterile sample. Spinal cord injury patients on the Crede's method were found to develop asymptomatic bacteriuria and symptomatic UTI, one in each group (Table 1).

Symptomatic UTI was found twice as likely to develop in an indwelling catheter user (38.10%) than a CIC user (16.42%) (p value < 0.05).

A total of 142 strains were isolated in which the most frequently occurring strain was *Escherichia coli* (*E. coli*) (49.30%) followed by *Enterobacter aerogenes* (*E. aerogenes*) (14.08%); *Pseudomonas* species (spp.), *Enterobacter cloacae* (*E. cloacae*), *Klebsiella* spp., *Acinetobacter* spp., *Citrobacter* spp., *Proteus* spp., and *Streptococci* spp. were the other organisms with a frequency of 11.27, 9.15, 7.04, 3.52, 3.52, 1.41,

Table 1: Distribution of cases according to different bladder-emptying methods

Type of bladder-emptying method	Significant bacteriuria		Insignificant bacteriuria	Sterile sample	Total
	ASB	SUTI			
CIC	50 (74.63%)	11 (16.42%)	6 (8.96%)	0	67
Indwelling catheter	23 (54.76%)	16 (38.10%)	3 (7.14%)	0	42
Self-void with minimum residual volume	12 (63.16%)	1 (5.26%)	3 (15.79%)	3 (15.79%)	19
Reflex voiding	5 (62.5%)	1 (12.5%)	2 (25%)	0	8
Crede's method	1	1	0	0	2
Total	91	30	14	3	138

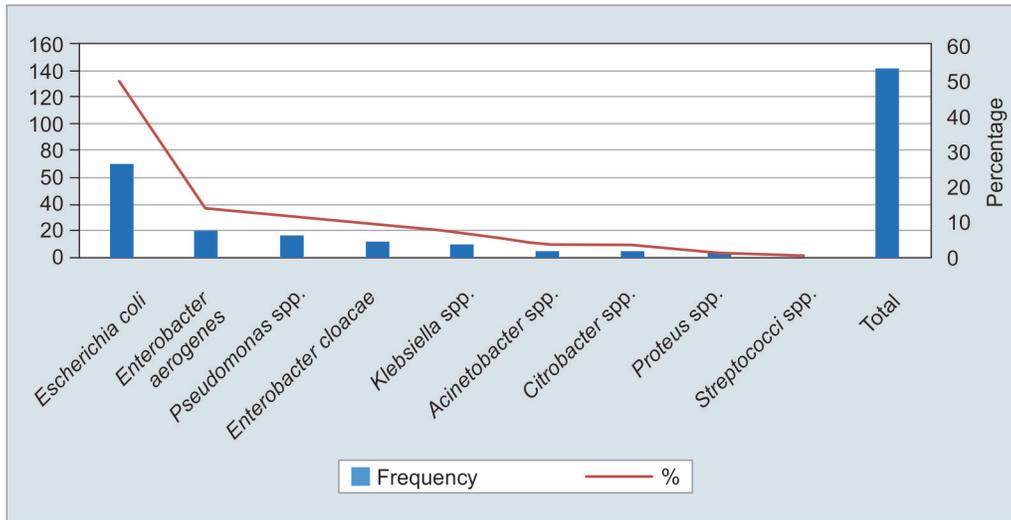


Fig. 2: Distribution of causative organisms

Table 2: Distribution of causative organisms according to asymptomatic bacteriuria and symptomatic urinary tract infection

Causative organism	SUTI causative organism	ASB causative organism
<i>E. coli</i>	13 (39.39%)	52 (53.61%)
<i>Enterobacter aerogenes</i>	6 (18.18%)	14 (14.43%)
<i>Enterobacter cloacae</i>	1 (3.03%)	12 (12.37%)
<i>Pseudomonas</i>	5 (15.15%)	8 (8.25%)
<i>Proteus</i>	0	1 (1.03%)
<i>Klebsiella</i>	4 (12.12%)	6 (6.19%)
<i>Citrobacter</i>	2 (6.06%)	2 (2.06%)
<i>Acinetobacter</i>	2 (6.06%)	2 (2.06%)
Total	33	97

and 0.70%, respectively (Fig. 2). Statistically, no significant difference was found between the causative organism of asymptomatic bacteriuria and the symptomatic UTI group (p value > 0.05) (Table 2).

Out of 67 patients on CIC, 25 cases (37.31%) developed MDR organism. Among 42 patients using an indwelling catheter, 28 cases (66.67%) developed MDR organism. Development of MDR organism was highest in cases with an indwelling catheter (p value < 0.05) (Fig. 3).

Out of 34 strains causing symptomatic UTI, 21 (61.76%) had multidrug resistance whereas 47 (48.96%) of 96 strains causing asymptomatic bacteriuria developed multidrug resistance. Multidrug resistance significantly more in the strains causing symptomatic UTI (p < 0.05).

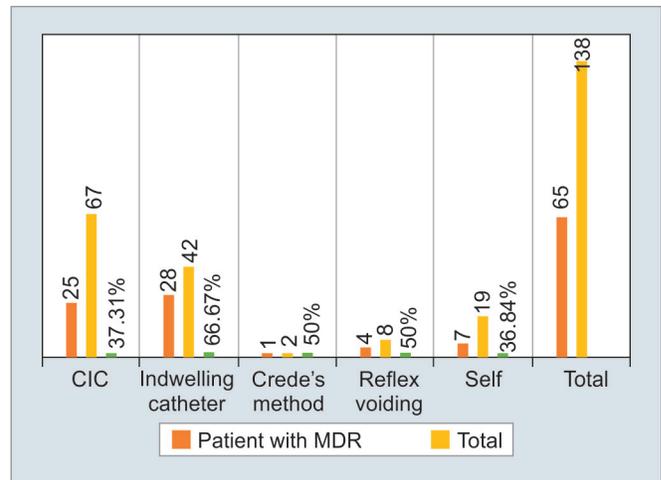


Fig. 3: Distribution of patients with multidrug-resistant (MDR) organism according to different bladder-emptying methods

A total of 50.70% isolated organisms were MDR and 4.22% organisms were extensively drug-resistant (XDR). *Enterobacter cloacae*, *Acinetobacter* spp., each two in number, and *E. coli*, *Klebsiella* spp., each one in number, were tagged as XDR organisms that were sensitive to polymyxin B and colistin (Table 3).

DISCUSSION

In this study, 87.68% had significant bacteriuria, out of which 64.94% had asymptomatic bacteriuria while 21.74% developed

Table 3: Antibiotic resistance pattern to different organisms

Antibiotics	<i>E. coli</i> (%)	<i>Enterobacter aerogenes</i> (%)	<i>Enterobacter cloacae</i> (%)	<i>Klebsiella spp.</i> (%)
Ciprofloxacin	66.67	57.89	69.23	60
Cotrimoxazole	73.91	52.63	84.62	77.78
Gentamicin	21.74	21.05	30.77	60
Ceftriaxone	71.01	52.63	69.23	60
Nitrofurantoin	12.07	46.15	54.55	50
Imipenem	11.59	10.53	23.08	30

symptomatic UTI. A similar ratio was observed by Togan et al.² and Martins et al.⁷ where patients with asymptomatic bacteriuria were 67.70 and 65.70%, respectively.

The predominant bladder drainage method adopted by the patients was CIC (48.55%), followed by indwelling catheter (30.43%), reflex voiding (5.80%), and the Crede's method (1.45%). In the group that was using, CIC, 16.42% developed symptomatic UTI whereas the group that was on an indwelling catheter had 38.10% symptomatic UTI, which reiterates that CIC should be a preferable method for neurogenic bladder management to prevent recurrent UTI. Togan et al.² also reported 29.80% symptomatic UTI cases in patients with an indwelling catheter whereas the CIC group had a lower percentage. Symptomatic UTI was most common in indwelling catheter users, which was also observed by Togan et al.,² Singh et al.,⁸ Afsar et al.,⁹ and De Ruz et al.¹⁰

The commonest group of microorganism isolated in the urine culture was gram-negative *Enterobacteriaceae* and almost 50% of the cases (49.30%) had *E. coli*. Other studies, namely by Togan et al.² (49.9%), Martins et al.⁷ (60%), Singh et al.⁸ (54.67%), Hinkel et al.¹¹ (35–48%), and Rahimkhani et al.¹² (36.94%), also had similar results.

An alarming pattern of antibiotic susceptibility was observed where *E. coli* was resistant to the commonly prescribed drugs like ciprofloxacin, cotrimoxazole, gentamicin, and ceftriaxone and 52.17% of isolates were MDR. It poses a significant challenge in low and medium economic groups of countries where comprehensive low-cost management remains imperative.

In our study, 50.70% isolated organisms were MDR and 4.22% organisms were XDR. Even though the sample size of the study is small but it clearly reflects the emerging multidrug resistance that has been pointed out by the World Health Organization in its recent updated antimicrobial fact sheet¹³ where a concern has been raised that infection with MDR bacteria will increase the worst clinical outcomes, deaths, and consume more healthcare resources. A similar observation was expressed by Basak et al. where they evaluated an antibiotic sensitivity pattern in a tertiary care hospital in India and found that 37.1% bacterial strains were MDR and 13.8% strains were XDR.¹⁴

Togan et al.² also observed that the efficacy of ciprofloxacin (fluoroquinolone antibiotic), which was once most widely used medication for *E. coli*, showed a decreasing pattern of sensitivity and their study revealed that 53.74% isolated organisms were MDR. Martins et al.⁷ reported that the microorganisms isolated were resistant mainly to ampicillin, sulfamethoxazole–trimethoprim, and norfloxacin, where resistance rates were 73.3, 60, and 33.3%, respectively. Yoon et al.¹⁵ concluded that isolates from hospital-dwelling patients showed lower susceptibility to ampicillin, amoxicillin–clavulanic acid, trimethoprim–sulfamethoxazole, and all generations of cephalosporin. Dedeić-Ljubović et al.¹⁶ observed that 55.3% isolates were MDR.

Carbapenem antibiotics like imipenem was effective in the treatment of UTI caused by gram-negative bacteria like *Enterobacteriaceae* but we have observed that imipenem resistance is also emerging in commonly isolated bacteria like *E. coli*, *E. aerogenes*, *E. cloacae*, *Klebsiella*, and *Pseudomonas* to be 11.59, 10.53, 23.08, 30, and 18.18%, respectively. This resistance was not observed in the previous studies done by Togan et al.,² Martin et al.,² and Dedeić-Ljubović et al.¹⁶

Klebsiella pneumoniae that is a major cause of hospital-acquired infection has shown higher resistance (30%) against imipenem, which is similar to the World Health Organization observation¹³ and it seems that it is slowly spreading in all the regions of the world.

The study revealed that nitrofurantoin had lesser resistance (12.07%) against *E. coli* compared to other common antibiotics like ciprofloxacin, ceftriaxone, gentamicin, and cotrimoxazole. Gupta et al. reported that nitrofurantoin, trimethoprim–sulfamethoxazole, fosfomycin, and pivmecillinam were preferred agents for uncomplicated UTI.¹⁷ McKinnell et al. also suggested that nitrofurantoin is a better drug than trimethoprim–sulfamethoxazole and fluoroquinolone for empirical treatment of uncomplicated UTI.¹⁸

Enterobacteriaceae group is a nonspore-forming, nonacid fast, gram-negative bacilli that are predominantly present in the large intestine, thus *E. coli* remains the most common coliform responsible for UTI.¹⁹ Infection of the lower urinary tract usually seems to be an ascending infection caused by fecal coliforms. Bacteriologically diagnosis of UTI has undergone a marked challenge following the concept of significant bacteriuria. Patients with neurogenic bladder having significant bacteriuria is usually not treated until it amounts to symptomatic UTI. It is thus necessary to sensitize the physicians to differentiate between the above two situations and prescribe antibiotics accordingly.

In our study, we have observed not only MDR but also XDR bacteria. Recent antibiotic use is a well-documented risk factor for infection or colonization with resistant pathogens but despite this recognition, unnecessary antibiotic prescribing remains common.²⁰ Factors that contribute to antibiotic overuse include lack of education, patient's expectations, past experience, and economic incentives. The challenge is now to develop the newer drug at a faster rate than the bacteria resistance speed. Judicious antibiotic use is at most important concern to be recognized by every health professionals to prevent antibiotic resistance.

CONCLUSION

- Clean intermittent catheterization should be the preferred option to manage the neurogenic bladder in SCI patients.
- Do not treat urine culture but treat only symptomatic bacteriuria/UTI.
- Treat symptomatic UTI as per the antibiotic sensitivity pattern.
- In Indian scenario of drug resistance, nitrofurantoin appears to be an appropriate empirical choice for uncomplicated UTI.
- The sample size of this study is not representative of the prevalence and incidence of UTI and the antibiotic susceptibility pattern in patients with a neurogenic bladder, yet the results are in concurrence with other studies and the World Health Organization antibiotic resistance fact sheet; it surely gives a direction to update our clinical practice to manage significant bacteriuria in SCI patients.

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