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Retrospective Analysis of Nosocomial Urinary Tract Infections with Spinal Cord Injury Patients in a Rehabilitation Setting

Bir Rehabilitasyon Merkezindeki Spinal Kord Yaralı Hastalarda Görülen Nozokomiyal Üriner Sistem İnfeksiyonlarının Retrospektif Analizi

Bilge YILMAZ, Ferdi YAVUZ, Emre ADIGÜZEL

Department of Physical Medicine and Rehabilitation, Turkish Armed Forces Rehabilitation Center, Gülhane Military Medical Academy, Ankara, Turkey

Abstract

Objective: To define the distribution and antibiotic susceptibility of nosocomial urinary tract infections (NAUTIs) in patients with spinal cord injury (SCI).
Material and Methods: Records of the spinal cord injured patients were reviewed for NAUTIs between 2008 and 2010. Antibiotic resistance rates and factors that might affect urinary tract infection susceptibility were investigated retrospectively.
Results: The data of 276 patients were included, of whom 159 were acute SCI patients and 117 were chronic SCI patients; 166 (61%) infections were asymptomatic bacteriuria (ASB), and 110 (39%) infections were symptomatic urinary tract infections (SUTIs). In patients with acute SCI, *E. coli* was the most frequently isolated pathogen of SUTIs, followed by Pseudomonas. In patients with chronic SCI, *E. coli* was the most frequently isolated pathogen in SUTIs and ASBs. There was no statistically significant difference in the rates of NAUTI (ASB and SUTI) between acute and chronic SCI patients in terms of bladder drainage method. The susceptibility ratios for *E. coli* were very low in both acute and chronic SCI patients using Foley catheters. Although the susceptibility ratios for *E. coli* were not that low in SCI patients using clean intermittent catheterization, the resistance ratios were higher than 50% for most of the uropathogens.
Conclusion: These results reveal a blunt truth that the treatment of NAUTIs will be a great challenge in near future.
Key Words: Spinal cord injury, nosocomial urinary tract infection, rehabilitation

Özet

Amaç: Spinal kord yaralı (SKY) hastalarda nozokomiyal üriner sistem infeksiyonlarının dağılımı ve antibiyotik duyarlılığının tanımlanması.
Gereç ve Yöntemler: Spinal kord yaralanmalı bireylerin dosyaları 2008-2010 arasında nozokomiyal üriner sistem infeksiyonları açısından tarandı. Antibiyotik direnç sıklıkları ve üriner sistem infeksiyonu gelişimine etki edebilecek nedenler retrospektif olarak incelendi.
Bulgular: Çalışmaya 276 hastanın verileri dahil edildi. Bunların 159'u akut SKY ve 117'si kronik SKY idi. Infeksiyonların 166'sı (%61) asemptomatik bakteriüri (ASB) iken, 110'u (%39) semptomatik üriner sistem infeksiyonu (SUTI) idi. Akut SKY hastalarda, SUTI için en sık izole edilen patojen *Escherichia coli* iken bunu Pseudomonas takip ediyordu. Kronik SKY hastalarda SUTI ve ASB için en sık izole edilen patojen *E. coli* idi. Mesane boşaltım yöntemi dikkate alındığında, akut ve kronik SKY hastalar arasında NAUTI (ASB ve SUTI) dağılımı açısından anlamlı bir fark yoktu. Foley kateter kullanan akut ve kronik SKY hastalarda *E. coli* duyarlılık oranları çok düşüktü. Temiz aralıklı kateterizasyon uygulanan hastalarda duyarlılık oranları o kadar düşük olmasa da, direnç oranları üropatojenlerin çoğu için %50'nin üzerindeydi.
Sonuç: Bu sonuçlar, nozokomiyal üriner sistem infeksiyonlarının tedavisinin yakın gelecekte ne kadar büyük bir sorun olacağı konusundaki gerçeği ortaya koymaktadır.
Anahtar Kelimeler: Spinal kord yaralanması, nozokomiyal üriner sistem infeksiyonu, rehabilitasyon

Address for Correspondence / Yazışma Adresi: Bilge Yılmaz, MD, Department of Physical Medicine and Rehabilitation, Turkish Armed Forces Rehabilitation Center, Gülhane Military Medical Academy, Ankara, Turkey. Phone: +90 312 291 16 00 E-mail: bilgeyilmaztr@hotmail.com

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Introduction

Nosocomial infections are common among patients with spinal cord injury (SCI) admitted to rehabilitation centers (1). A high prevalence rate of nosocomial infections, especially nosocomial acquired urinary tract infections (NAUTIs), has been determined in rehabilitation units. They cause a vicious circle, by prolonging the length of hospital stay and rehabilitation procedure, increasing the potential for a new nosocomial infection (2). Therefore, they are associated with negative physical and psychological effects and socio-economic costs (3,4).

The literature that is focused on nosocomial infections has recorded high urinary tract infection (UTI) rates in patients with SCI (1). About one-half of all nosocomial infections are reported to originate from the urinary tract in association with urinary catheters and other drainage devices. On the other hand, a high frequency of antibiotic use also increases the risk of infection with antibiotic-resistant organisms, further complicating the treatment of NAUTI (5).

Despite the fact that a UTI is a common complication, what exactly constitutes a UTI in catheterized patients is controversial. Symptoms of fever associated with cloudy or foul-smelling urine strongly suggest the presence of a UTI and the need for treatment (6). Spinal cord injury patients with neurogenic bladder often have bacteriuria without signs and symptoms of infection due to catheterization. These asymptomatic cases generally do not require any treatment (7).

In this retrospective study, we reviewed the records of spinal cord injury patients and described the 2-year data of NAUTIs in our rehabilitation center. We aimed to report the distribution of NAUTIs and the spectrum of antibiotic resistance in patients with SCI.

Material and Methods

In this retrospective study, 2-year data (2008-2010) of NAUTIs recorded by the Infection Control Committee were retrieved. NAUTI was defined as an infection occurring in a patient during the process of care in a hospital or other health care facility that was not present or incubating at the time of admission according to the Centers for Disease Control and Prevention (CDC, Atlanta, USA) (8). Inpatient records from 276 spinal cord injured patients diagnosed with NAUTI were included in the current study. Since the isolation of more than one organism from a single specimen of urine must always be interpreted with caution, and considering contamination, the patients whose culture results had polymicrobic bacteriuria samples were excluded from the study. Ethics committee approval was obtained from the local hospital ethics committee of Gülhane Military Medical Academy.

The data gathered for each patient were as follows: definition of UTI (symptomatic UTI [SUTI] or asymptomatic bacteriuria [ASB]), time of injury, hospitalization date, date of UTI diagnosis, length of hospital stay, method of bladder emptying, isolated pathogens, and their susceptibility to antimicrobial agents. Antimicrobial susceptibility of the following pathogens was recorded: *Escherichia coli* (*E. coli*), extended spectrum beta-lactamase (ESBL) (+) *E. coli*, *Klebsiella species pluralis (spp)*, *Proteus spp.*, *Enterobacter spp.*, *Pseudomonas aeruginosa* (*P. aeruginosa*), *Enterococcus spp.*, and *Acinetobacter spp.* The resistance rates against the following antibiotics were analyzed: amoxicillin, ampicillin in combination with sulbactam, amikacin, gentamicin, imipenem, levofloxacin, norfloxacin, ciprofloxacin, doxycycline, and trimethoprim in combination with sulfamethoxazole (TMP-SMX).

The isolated pathogens and the resistance rates against antibiotics were compared between acute (first 6 months after injury) and chronic (6 months-2 years after injury) spinal cord injury patients.

The incidence density rate of nosocomial infections was calculated by dividing the total number of nosocomial infections by the total patient-days (×1000) during the defined period of time. The total patient-days were calculated by summing the days of all patients hospitalized in the SCI unit.

Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) software, version 10.0. The qualitative variables were described as proportion and percentage. One-way ANOVA was used to compare mean differences between the subgroups. Any differences between the two groups were compared using the independent samples t-test. The level of statistical significance was set at $p<0.05$.

Results

A total of 276 spinal cord injury patients diagnosed with NAUTI were included; 159 of them were chronic spinal cord injury patients, and 117 of them were acute spinal cord injury patients. The frequency rate of ASB and SUTIs was 166 (61%) and 110 (39%), respectively. The demographic and clinical characteristics of the patients are documented in Table 1.

E. coli, *Klebsiella* spp., and ESBL(+) *E. coli* were the most common pathogens for NAUTIs in patients with spinal cord injury. In patients with acute spinal cord injury, *E. coli* was the most frequently isolated pathogen, accounting for more than half of the pathogenic population of SUTIs, followed by *Pseudomonas*. The most frequently isolated pathogen in ASBs of acute spinal cord injury patients was *Klebsiella* spp. On the other hand, in patients with chronic spinal cord injury, *E. coli* was the most frequently isolated pathogen in ASBs and SUTIs (Table 2).

The comparison of the microorganisms' resistance rates against antibiotics between acute and chronic spinal cord injury patients is documented in Table 3. More than half of the *E. coli* and *Klebsiella* spp. isolates were sensitive to amikacin and gentamicin in patients with acute SCI. No imipenem resistance was detected for *E. coli* and *Klebsiella* spp. isolates in the acute period. More than half of the Pseudomonas isolates were sensitive to amikacin and imipenem in patients with acute SCI.

Most of the *E. coli* and ESBL(+) *E. coli* isolates had the lowest rates of resistance to amikacin and gentamicin in patients with chronic SCI. No imipenem resistance was detected for *E. coli*

and ESBL(+) *E. coli* isolates in chronic spinal cord injury patients. Klebsiella spp. isolates generally had the lowest rates of resistance to amikacin, gentamicin, imipenem, levofloxacin, norfloxacin, ciprofloxacin, and trimethoprim/sulfamethoxazole (TMP/SMX) in patients with chronic SCI. The difference in resistance rates of all uropathogens between acute and chronic spinal cord injury patients was statistically significant ($p<0.05$).

We investigated the bladder drainage method among 117 acute spinal cord injury patients; 88 of them were using clean intermittent catheterization (CIC), 17 patients were using an indwelling Foley catheter, and 12 patients had catheter-free voiding function. Among 159 chronic spinal cord injury patients, 119 patients were using clean intermittent catheterization (CIC), 24 patients were using an indwelling Foley catheter, and 16 patients had catheter-free voiding function. We also analyzed the infection rates among the patients, and we found that the infection rate was significantly higher in patients with SCI using an indwelling Foley catheter (52%) than those who were using CIC (37%) and those who had catheter-free voiding function (25%) ($p<0.05$) (Table 4). There was no statistically significant difference in the rates of NAUTI (ASB and SUTI) between acute and chronic spinal cord injury patients ($p>0.05$) (Table 5).

Table 1. The demographic and clinical characteristics of the patients

Age, mean±SD	**35.47±18.59 years**	
LOS for hospitalization	**37.8±9.8 days**	
HAI rate per 1000 patient-days	**7.2**	
	n	**%**
Time of injury		
Acute SCI	117	42.4
Chronic SCI	159	57.6
Male	195	70.6
Tetraplegia	94	34.1
ASIA-A	151	54.7
ASIA-B	42	15.2
ASIA-C	38	13.8
ASIA-D	39	14.1
ASIA-E	6	2.2
CIC	207	75
IC	41	14.9
CF	28	10.1

SD: standard deviation; CIC: clean intermittent catheterization; IC: indwelling catheterization; CF: catheter-free; LOS: length of stay; HAI: hospital-acquired infection

The mean length of stay (LOS) for hospitalizations in spinal cord injury patients with NAUTIs was 37.8±9.8 days. The mean time from admission to the onset of UTIs was 21.5±11.1 days (median, 17.0 days; range, 10-60 days). A total of 416 hospital-acquired infections (HAIs) occurred during 57,104 patient-days in the spinal cord injury unit (incidence rate, 7.2 HAIs per 1000 patient-days). The most common HAIs were UTIs (276 [66.3%] of the 416 HAIs; incidence rate, 4.8 cases per 1000 patient-days).

Discussion

The results of this study revealed that the most frequent type of NAUTI is asymptomatic bacteriuria, and the most frequently isolated nosocomial pathogen is *E. coli* in patients with spinal cord injury. These findings are consistent with previous studies and indicate that NAUTIs are often associated with the use of invasive devices (9-11).

E. coli and *Klebsiella* spp., members of gram-negative enteric bacilli, have been reported as almost the most common causes of catheter-associated UTIs (12). Two-thirds of all urinary infections are caused by organisms ascending from the perineum along the surface of the catheter, such as gram-negative enteric bacilli, which are common commensals of the perineum. However, *Pseudomonas*, *Enterobacter,* or *Acinetobacter* may use the intraluminal route from the collection bag.

Table 2. The distribution of NAUTIs

	Spinal Cord Injury Patients					
	Acute period (6 months after injury)			**Chronic period (6 months-2 years after injury)**		
Pathogens	**ASB**	**SUTI**	**Total**	**ASB**	**SUTI**	**Total**
Acinetobacter	3	2	5	7	4	11
E. coli	18	22	40	32	31	63
E. coli ESBL(+)	12	-	12	11	5	16
Enterococ	2	5	7	6	5	11
Enterobacter	-	-	-	10	1	11
Klebsiella	25	2	27	20	7	27
Proteus	3	5	8	6	6	12
Pseudomonas	9	9	18	2	6	8
Total	72	45	117	94	65	159

ASB: asymptomatic bacteriuria; SUTI: symptomatic urinary tract infection; ESBL: extended spectrum beta-lactamase; NAUTIs: nosocomial urinary tract infections

Table 3. The comparison of the microorganisms' resistance rates against antibiotics between acute and chronic spinal cord injury patients

	Amp+Sulbac	Amoxicillin	Amikacin	Gentamicin	Imipenem	Levofloxacin	Norfloxacin	Ciprofloxacin	Doxycycline	TMP-SMX
E. coli	100%	64%	34%	24%	NR*	67%	64%	67%	87%	64%
Klebsiella sp.	100%	72%	20%	34%	NR	67%	72%	67%	62%	72%
Pseudomonas	100%	93%	8%	58%	36%	58%	72%	65%	80%	NR
E. coli	72%	55%	15%	30%	NR	55%	60%	58%	72%	54%
Klebsiella sp.	91%	55%	14%	22%	5%	40%	45%	45%	55%	25%
ESBL(+) E. *coli*	100%	100%	50%	33%	NR	92%	100%	100%	92%	60%

*NR: No resistance

Table 4. Relationship between the drainage methods and NAUTI

	Indwelling catheter	Clean intermittent catheterization	Catheter-free voiding	p*
SUTI	21/41 (52%)	76/207 (37%)	7/28 (25%)	0.036
ASB	20/41 (48%)	131/207 (63%)	21/28 (75%)	0.028

*: a One-way ANOVA test was used. ASB: asymptomatic bacteriuria; SUTI: symptomatic urinary tract infection; NAUTI: nosocomial urinary tract infection

Table 5. Comparison of the rates of NAUTI between acute and chronic spinal cord injury patients

	Acute Spinal Cord Injury Patients	Chronic Spinal Cord Injury Patients	p*
ASB	72 /117 (61%)	94/159 (59%)	0.45
SUTI	45/117 (39%)	65/159 (41%)	0.75

*: independent-samples t-test was used. ASB: asymptomatic bacteriuria; SUTI: symptomatic urinary tract infection; NAUTI: nosocomial urinary tract infection

Esclarin de Ruz et al. (13) found that SCI patients had more risk factors, but the only independent significant factor was indwelling catheterization. In this study, the risk factors were age, injury level, hyper-reflexic bladder with detrusor-sphincter dyssynergia, dependency level, and bladder catheterization. In our study, we could not assess the risk factors, since only patients who had NAUTIs were included. However, we found that infection rates were higher in patients with SCI using an indwelling Foley catheter. Therefore, in order to reduce the rate of NAUTIs, the use of an indwelling catheter should be removed as soon as possible with CIC.

There are limited data concerning the epidemiology of nosocomial infections among patients admitted for acute rehabilitation after medical stabilization of spinal cord injury patients. Studies have reported that the most common nosocomial infections are urinary tract infections (14). However, none of these studies provided specific data on the organisms causing nosocomial infections. In the present study, we detailed our data on nosocomial NAUTIs according to uropathogen, method of bladder emptying, and resistance testing of isolated pathogens.

According to our study's results, the most common cause of SUTI in acute spinal cord injury patients was *E. coli*, followed by Pseudomonas. The most frequently isolated pathogen in ASB with acute spinal cord injury patients was *Klebsiella* spp. In patients with chronic spinal cord injury, *E. coli* was the most frequently isolated pathogen in ASB and SUTIs. The most commonly used method for bladder emptying was intermittent bladder catheterization (75%) in patients with SCI. The rest of the SCI patients used indwelling catheters (14.9%) and the reflex voiding (10.1%) method for bladder emptying.

On the other hand, the patients who have been evaluated in the literature have varied, from those who were just beginning acute rehabilitation to those who have had chronic disabilities for many years. This variation in the characteristics of the patients makes comparisons difficult. Thus, we compared the results of acutely injured and chronic spinal cord injury patients. In patients with acute SCI, *E. coli* and *Klebsiella* spp. isolates had the lowest rates of resistance to amikacin and gentamicin, and no imipenem resistance was determined. All other remaining antibiotics had a much higher overall resistance rate. *Pseudomonas* isolates also showed the lowest rate of resistance to amikacin and imipenem in patients with acute SCI. The resistance rate of *P. aeruginosa* against fluoroquinolone was the highest. In patients with chronic SCI, *E. coli* and ESBL(+) *E. coli* isolates had the lowest rates of resistance to amikacin and gentamicin, and no imipenem resistance was determined. Therefore, the options for adequate empiric antibiotic therapy in hospitalized SCI patients with NAUTI are limited.

The results of our study revealed that the difference in resistance rates of all uropathogens between acute and chronic spinal cord injury patients was statistically significant ($p<0.05$). In general, the lowest resistance rates were seen in chronic spinal cord injury patients, while the highest resistance rates against most of the antibiotics tested were seen in acute spinal cord injury patients. We think that this finding might be caused by resistant flora in our acute care unit.

The resistance rates were lower for amikacin, gentamicin, and imipenem in common uropathogens in both acute and chronic SCI patients. Amikacin and gentamicin are not commonly used antibiotics because of their potential nephrotoxicity, which might be a cause for this result.

Previous studies have focused on the antibiotic resistance of *P. aeruginosa* (15-19) or *K. pneumoniae* in patients with SCI (16,19-22). Although *Klebsiella* was the second most common uropathogen seen in our SCI patients, its distribution was not significantly different between acute and chronic patients. We could not be sure that this was because of the colonization described in the studies above.

The increase in fluoroquinolone-resistant *E. coli* infections in patients with SCI is frightening. It was first pointed out by Canavati et al. (23) in a rehabilitation setting in the late 1990s. The resistance rate reported was 5.9% at that time, and it reached 70% in our findings. We believe that this increase in fluoroquinolone-resistant *E. coli* infections might be because of their common use in general practice.

In the present study, the incidence rate of HAIs was 7.2 per 1000 patient-days. The most common HAIs were UTIs, and the incidence rate of UTIs was 4.8 per 1000 patient-days. According to the data on the incidence rate, our study showed consistent results with the literature. When the results of this study were assessed in terms of the method of bladder emptying, we found out that the susceptibility rates for *E. coli* were very low in both acute and chronic SCI patients using Foley catheters. Fortunately, the number of patients using indwelling catheters was lower. Although the resistance rates for *E. coli* were not so bad in SCI patients using CIC, the resistance rates were higher than 50% for most of the uropathogens.

Conclusion

The results that we obtained from this study reveal a blunt truth-that the treatment of NAUTIs will be a great challenge in near future. Although this study has some limitations because of its retrospective nature, such as the lack of data on risk factors, the picture presented here may give rehabilitation specialists important clues for future studies.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gülhane Military Medical Academy.

Informed Consent: Informed consent was not obtained because of the retrospective design of the study.

Peer-review: Externally peer-reviewed.

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