

**URINARY TRACT INFECTION IN SPINAL CORD INJURIES**

**MONIREH RAHIMKHANI<sup>1</sup>, ABOLGHASEM NIKFALLAH<sup>2</sup>, MOSTAFA SABERIAN<sup>3</sup>, ALIREZA MORDADI<sup>4</sup>, SAJAD VARMAZYAR<sup>5</sup>, ALI TAVAKOLI<sup>6</sup>**

<sup>1</sup>Faculty of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran. <sup>2</sup>Brain and Spinal Injury Repair Research Centre, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran. <sup>3</sup>Faculty of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran. <sup>4</sup>Faculty of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran. <sup>5</sup>Faculty of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran. <sup>6</sup>Faculty of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran.

Email: rrahimkhani@sina.tums.ac.ir

Received: 7 February 2014, Revised and Accepted: 7 March 2014

**ABSTRACT**

**Objective:** Spinal cord injuries are typically associated with major trauma from motor vehicle accidents, falls, sports injuries, and violence. Urinary Tract Infections (UTI) is one of the most frequent conditions seen in spinal cord injuries patients. Diagnosis is not always easy due to lack of symptoms. Present study is survey about urinary tract infection and pyuria in these patients.

**Methods:** All of patients with spinal cord injuries, who admitted to "Brain and Spinal Injury Repair Research Centre" in Imam Hospital in duration one year, were included in this study. Clean catch midstream urine samples were collected of patients and were analyzed by biochemical and microscopically surveys.

**Results:** In total 103 patients, 22 patients have cervical spinal cord injury, 52 patients have thoracic spinal cord injury and 13 patients have lumbar spinal cord injury. 83 patients were urine culture positive with urinary tract infection and pyuria were seen in 65 patients. the highest incidence of UTI and pyuria were demonstrated in patients with cervical spinal cord damage. E.coli, Klebsiellapneumoniae and Enterobacter cloacae were isolated in urine samples respectively. the high incidence of resistancy to Nitrofurantoin and Imipenem in E.coli were seen.

**Conclusion:** Patients with spinal cord injuries have to use catheter for long time and or for all of life, and they are high risk to recurrent urinary tract infections and other infections. These patients need to monitor for urinary tract infection although without any symptoms of infections and sometimes they need to take prophylactic antibiotics.

**Keywords:** spinal cord injury, urinary tract infection, pyuria

**INTRODUCTION**

The spinal cord is the main pathway for information connecting the brain and peripheral nervous system. The length of the spinal cord is much shorter than the length of the bony spinal column. Spinal cord has three sections: cervical, thoracic, and lumbar region. The two areas of the spinal cord most commonly injured are the cervical spine (C1-C7) and the lumbar spine (L1-L5). A spinal cord injury (SCI) refers to any injury to the spinal cord that is caused by trauma instead of disease. Depending on where the spinal cord and nerve roots are damaged, the symptoms can vary widely, from pain to paralysis to incontinence. Spinal cord injuries are described at various levels of "incomplete", which can vary from having no effect on the patient to a "complete" injury, which means a total loss of function.

Treatment of spinal cord injuries starts with restraining the spine and controlling inflammation to prevent further damage. The actual treatment can vary widely depending on the location and extent of the injury. In many cases, spinal cord injuries require substantial physical therapy and rehabilitation, especially if the patient's injury interferes with activities of daily life.

Spinal cord injuries have traumatic or non-traumatic in etiology, but are typically associated with major trauma from motor vehicle accidents, falls, sports injuries, and violence. The incidence of motor vehicle accidents in Iran is high and thus patients with spinal cord injuries have high frequency rate in there. Usually, victims of spinal cord injuries will suffer loss of feeling in certain parts of their body. In milder cases, a victim might only suffer loss of hand or foot function. More severe injuries may result in paraplegia, tetraplegia (also known as quadriplegia), or full body paralysis below the site of injury to the spinal cord.

Individuals with spinal cord lesions may have many of the signs and

symptoms due to their spinal cord lesion or other problems. Many signs and symptoms do not constitute a justification for treatment. Urinary Tract Infections (UTI) is one of the most frequent conditions seen in SCI patients. Diagnosis is not always easy due to lack of symptoms. If symptoms occur, antibiotic therapy is indicated.

Duration depends mainly on severity of illness and upper urinary tract or prostatic involvement. Choice of antibiotic therapy should be based on local resistance profiles [1].

UTI is characterized by the new onset of symptoms accompanied by laboratory findings (bacteriuria, leukocyturia and positive urine culture) of a UTI. The symptoms of UTI included [2]:

- Fever: elevated body temperature. In presence of a fever, one should check for signs of sepsis. Spinal cord-lesioned people, particularly those with cervical and high thoracic lesions, are prone to poikilothermia (inability to regulate core body temperature). Therefore, ambient temperature levels need to be taken into consideration while assessing fever.

- Urinary incontinence/failure of control or leaking around the catheter
- Spasticity report on new or increased muscular hypertonicity
- Malaise, lethargy or sense of unease: feeling tired or unwell, different from the person's usual state of health.
- Cloudy urine report that the urine is not clear. There may be report of mucus or sediment.
- Malodorous urine a distinct change in urine odor, with a strong foul smell that persists on change of catheter equipment.
- Pyuria/leukocyturia presence of white blood cells generated by the mucosal lining and observed on urinalysis.

- Back pain in the lower back below the rib cage complaints of pain located on one or other side of the back just below the ribs (costovertebral angle region corresponding to the location of the kidney). Pain is elicited by palpation or percussion of the space over the kidneys. The costovertebral angle is formed by the lateral and downward curve of the lowest rib and the vertical column of the spine. This pain is frequently observed due to inflammation of a kidney.
- Bladder pain report of pain felt in the suprapubic or retropublic region (midline lower abdomen above the pubic symphysis), or with palpation. Usually increases with bladder filling and may persist after voiding.
- Dysuria pain and discomfort while voiding. Usually associated with localized inflammation but may be referred from pain in the bladder, prostate or sphincter.
- Autonomic dysreflexia in individuals with spinal cord lesions at T6 and above, patients complain of feelings related to a sudden onset of elevated blood pressure and other symptoms such as headache, sweating, flushing brought on by a noxious stimuli, such as bladder distention/bladder infection [3].

Present study was about survey of Urinary Tract Infection and Pyuria in Spinal cord injuries in Iran.

**MATERIAL AND METHODS**

The present research was cross sectional study in 12 months period. All of patients with spinal cord injuries, who admitted to "Brain and Spinal Injury Repair Research Centre" in Imam Hospital in duration one year, were included in this study and were surveyed about urinary tract infection.

Patients with spinal cord injury manifest with varying degrees of bladder dysfunction, because damage to the spinal cord affects the innervation of the bladder and urethra, resulting in functional impairment of urine storage and/or voiding of the bladder. Recent surveys indicated that patients with neurogenic bladder may receive suboptimal management, indicated by a high incidence of urinary tract complications and hospitalizations. As bladder dysfunction may induce severe urinary incontinence or retention, UTIs, vesicoureteral reflux and even chronic renal failure (which may result in death), treatment and improvement of spinal cord injury-induced bladder dysfunction is of great clinical significance [4], [5].

Our patients in present study based on the severity of spinal damage and region of trauma were used different urination methods, permanent catheter, temporary catheter, urinary by pressure and also some patients have regular urinary. Urine samples were collected with clean catch midstream based on procedure of methods urination and immediately transferred to lab and was analyzed by microbial culture and microscopic surveys. Urine samples were cultured on Blood agar, E.M.B agar and M.C agar Medias and colonies of bacteria were identified by biochemical methods. Biochemical methods were included: Triple Sugar Iron agar, Citrate agar, SIM media, MR-VP test and Urease test. Isolated bacteria were cultured on Muller Hinton agar and surveyed for antibiotic sensitivity. The method of antibiotic sensitivity was disk diffusion method by standard 0.5 Mac farland.

Number of WBC, RBC, Puss cell, epithelial cell and bacteria were analyzed by microscopic surveys.

This study was carried out with the approval of the Medical Ethics Committee of Tehran University of medical Sciences and was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

**RESULTS**

Present study included 103 patients who admitted to "Spinal Cord Injuries Centre" in period of 12 months. Patients included 12 women and 91 men.(table 1)

**Table 1: distribution of sex in patient group**

Gender	Number	Percent
Female	12	11.7
Male	91	88.4

The highest incidence of spinal cord injuries in patients group was acquired in age between 20 to 29 years old (41.7%) and the lowest incidence was acquired in age more than 60 years old (1.04%).(table2)

**Table 2: Distribution of age in patient group**

Age	Number	Percent
<20	4	4.17
20-29	40	41.7
30-39	31	32.3
40-49	12	12.5
50-59	8	8.3
60-69	1	1.04

In total 103 patients, 22 patients (25.3%) have cervical spinal cord injury, 52 patients (59.8%) have thoracic spinal cord injury and 13 patients (14.9%) have lumbar spinal cord injury. Sixteen patients (15.5%) have combined sites of spinal damage.

In total 103 patients, 83 patients were culture positive with urinary tract infection. the highest incidence of UTI were in patients with cervical spinal cord damage and there is the significant different between these patients with patients have thoracic and lumbar of spinal cord injuries. (P=0.03) (Table 3)

**Table 3: UTI in Cervical, Thoracic and Lumbar spinal cord injuries**

Variable Lesion	Urinary Tract Infection		
	positive	negative	Total
Cervical	20 (28.2)	2 (12.5)	22 (25.3)
Thoracic	44 (62)	8 (50)	52 (59.8)
Lumbar	7 (9.9)	6 (37.5)	13 (14.9)
Combined	12 (14.5)	4 (20)	16 (15.5)

In total urine samples, 65 patients had pyuria (WBC > 5/HPF). The highest incidence of pyuria was seen in patients with cervical spinal cord injury but there is not significant different between this group of patient with patients who have thoracic and or lumbar of spinal cord injuries. (P=0.7) (Table 4)

**Table 4: Pyuria in Cervical, Thoracic and Lumbar spinal cord injuries**

Variable Lesion	Pyuria		
	positive	negative	Total
Cervical	16 (27.6)	6 (20.7)	22 (25.3)
Thoracic	34 (58.6)	18 (62.1)	52 (59.8)
Lumbar	8 (13.8)	5 (17.2)	13 (14.9)
Combined	7 (10.8)	9 (23.7)	16 (15.5)

The most common bacteria isolated from urine samples were E.coli (36.94%) and there is significant different between this group with other bacteria isolated in urine samples. (P<0.05) some patients (6.8%) had urinary tract infection with two genous of bacteria.(Table 5)

**Table 5: Microorganisms isolated from urine samples**

	Number	Percent
Culture negative	18	17.5
Klebsiella oxiotoca	3	2.9
Hafnie alvei	2	1.94
Staph saprphyticus	1	1
Staph saprphyticus&Citrobacter freundii	1	1
Providencia	1	1
Proteus vulgaris	1	1
Staph epidermidis	1	1
Gram negative bacilli	2	1.94
yeast	1	1

Strep group D	1	1
E.coli	34	33
E.coli&Proteus mirabilis	1	1
E.coli&Psodumonas spp	2	1.94
E.coli&proteus mirabilis	1	1
Klebsilla pneumonia	11	10.7
Klebsilla pneumonia& pseudomonas spp	1	1
Proteus mirabilis	3	2.9
Proteus mirabilis &Klebsilla pneumonia	1	1
Proteus penneri	2	1.94
Psodumonas spp	2	1.94
Staph haemolyticus	4	3.9
Entrobacter aerogenes	1	1
Entrobacter cloace	8	7.8

In present study, patients had different methods urination based on the severity of spinal cord lesion. Methods urination included catheter, CIC, urination by pressure, condom shit, regular urination and a few patient uses combined of procedures. The highest incidence of UTI were seen in patients who using catheter as method urination (43.9%).( Table 6)

**Table 6: Incidence of UTI in patients based on methods urination**

Methods Urination	Urinary Tract Infection		
	Positive (%)	Negative (%)	Total (%)
Catheter	36 (43.9)	3 (15.8)	39 (38.6)
CIC	21 (25.6)	5 (26.3)	26 (25.7)
Regular	7 (8.5)	8 (42.1)	15 (14.9)

urination			
Condom	10 (12.2)	1(5.3)	11 (10.9)
With Pressure	8 (9.8)	2(10.5)	10 (9.9)
Combined	1 (1.2)	1 (5)	2 (1.9)

The same of incidence of UTI in patients with spinal cord injuries, the highest incidence of pyuria were seen in patients who using catheter for urination. (46.9%) (Table 7)

**Table 7: Incidence of pyuria in patients based on methodsurination**

Methods urination	Pyuria		
	Positive (%)	Negative (%)	Total (%)
Catheter	30 (46.9)	9 (24.3)	39 (38.6)
CIC	14 (21.9)	12 (32.4)	26 (25.7)
Regular urination	7 (10.9)	8 (21.6)	15 (14.9)
Condom	8 (12.5)	3 (8.1)	11 (10.9)
With Pressure	5 (7.8)	5 (13.5)	10 (9.9)
Combined	1 (1.5)	1(2.6)	2 (1.9)

After identification of isolated bacteria from urine samples, resistances to some routine antibiotics were done by disk diffusion method with used standard 0.5 MC farland.

Table 8 indicated the results of antibiotic resistance in isolated bacteria. Routine antibiotics were included Ciprofloxazine (CP), Nitrofurantoin (FM) and Imipenem(IMP).

There was no significant different between resistances and sensitive isolated bacteria to these three antibiotics. (P<0.05)(Table8)

**Table 8: Resistance to Ciprofloxazin(CP), Nitrofurantoin(FM) and Imipenem(IMP) in isolated bacteria**

Bacteria genus	CPresistance		FM resistance		IMPesistance	
	Resistance	Total	Resistance	Total	Resistance	Total
Klebsilla oxitoca	2 (4.3)	3 (3.9)	0	3 (3.8)	2 (5.3)	3 (3.9)
Hafnie alvei	1(2.1)	2 (2.6)	0	2 (2.5)	1 (2.6)	2 (2.6)
Staph.saprphyticus	0	1(1.3)	0	1(1.3)	.....	.....
Staph.saprphyticus&Citrobacter freundii	0	1(1.3)	0	1(1.3)	0	1(1.3)
Providencia	1(2.1)	1(1.3)	1 (5.9)	1(1.3)	0	1(1.3)
Proteus vulgaris	1(2.1)	1(1.3)	0	1(1.3)	1 (2.6)	1(1.3)
Streptococcus group D	0	1(1.3)	1 (5.9)	1(1.3)	0	1(1.3)
E.coli	24(51.1)	33(43.4)	3 (17.7)	34 (43)	19 (50)	34 (43.6)
E.coli&Proteus mirabilis	1(2.1)	1(1.3)	0	1(1.3)	0	1(1.3)
E.coli&Psodumonas spp	2 (4.3)	2 (2.6)	0	2 (2.5)	1 (2.6)	2 (2.6)
E.coli&proteus mirabilis	0	1(1.3)	1 (5.9)	1(1.3)	0	1(1.3)
Klebsilla pneumonia	7 (14.9)	10(13.2)	3 (17.7)	11(13.9)	6 (15.8)	11 (14.1)
Klebsilla pneumonia&pseudomona spp	0	1(1.3)	1 (5.9)	1(1.3)	1 (2.6)	1(1.3)
Proteus mirabilis	2 (4.3)	3 (4)	1 (5.9)	3 (3.8)	1 (2.6)	3 (3.9)
Proteus mirabilis&Klebsilla pneumonia	0	1(1.3)	0	1(1.3)	1 (2.6)	1(1.3)
Proteus penneri	0	2 (2.6)	0	2 (2.5)	0	2 (2.6)
Psodumonas spp	0	1(1.3)	2(11.8)	2 (2.5)	0	2 (2.6)
Staph. haemolyticus	0	2 (2.6)	0	2 (2.5)	1 (2.6)	2 (2.6)
Entrobacter aerogenes	0	1(1.3)	1 (5.9)	1(1.3)	0	1(1.3)
Entrobacter cloace	6 (12.8)	8 (10.5)	3 (17.7)	8 (10.1)	4 (10.5)	8 (10.3)

**DISCUSSION**

Spinal cord injuries have traumatic or non-traumatic in etiology, but are typically associated with major trauma from motor vehicle accidents, falls, sports injuries, and violence.

Spinal cord injury seriously diminishes a patient's well-being and results in heavy burdens to both family and society. Spinal cord injury not only causes impairment to motor and sensory functions, but also induces neurological bladder dysfunction, resulting in severe urine retention, urinary tract infection (UTI) and chronic renal failure, which is one of the primary causes of death in patients with paraplegia. Bladder management is, therefore, of great

significance for improving health-related quality of life and reducing mortality in patients with spinal cord injury [6].

UTI is the leading cause for septicemia in patients with spinal cord lesions, which is associated with a significantly increased mortality. Furthermore, symptomatic UTI is often bothersome for the patients and are therefore related to a decreased health-related quality of life. As UTIs are often recurrent and the bacterial strains are increasingly resistant to antibiotic treatment [7].

In this study more than 41% of total patients with spinal cord injuries were 20 to 29 years old and more than 90% was male. These results indicated the most of spinal cord injuries acquired in

young men who driving motorcycle vehicles and have accident, because the rate of motor vehicle accidents in Iran is high.

Persons with spinal cord injuries have significantly high odds of other complications included heart disease, hypertension, diabetes, and obesity than health people [8]. Besides these chronic diseases, Urinary Tract infection is the other common complication in spinal cord injuries.

There is an increased risk of early mortality due to heart disease, hypertension, diabetes, obesity and also urinary tract infection. It has been demonstrated that this risk increase is attributable to physical inactivity sedentary living depression, autonomic dysreflexia, changes in body composition levels of high-density lipoprotein cholesterol, and increased adipose tissue. In addition, persons with disabilities, and persons with lower socioeconomic status are at substantial risk for developing heart disease, hypertension, and diabetes. Obesity is a major precursor of heart disease, hypertension, and diabetes [8].

In summary Commonly occurring conditions after spinal cord injuries include spasticity, pressure sores, bowel and bladder problems, urinary tract infections, neuropathic pain, shoulder and joint pain, fragility fractures, autonomic dysreflexia, psychological distress/depression, and respiratory complications [9],[17]

Urinary tract infection is a common problem among patients with spinal cord injuries and based on LuoDy's study accounting for 67.1% of complications following nontraumatic and traumatic spinal cord injuries. In his study, the prevalence of UTI was 43.89%. Certain structural and physiological factors, such as bladder overdistention, vesicoureteral reflux, high-pressure voiding, large postvoid residuals, stones in the urinary tract, and outlet obstruction, increase the risk of infection. The method of bladder drainage also influences the risk of UTI, and most persons with spinal cord injury and an indwelling urinary catheter developed a UTI [10]. Almost all of the complications of urinary catheterization are the result of subsequent bacteriuria [11].

In our study the prevalence of UTI was 80% of total 103 patients with spinal cord injury and the rate were more than other papers. The incidence of UTI and pyuria in patients with cervical spinal cord injuries is much more than patients with thoracic and lumbar spinal cord injuries because in upper spinal cord injury more nerves were damaged and this result is the same results were obtained from other surveys.

For indwelling catheterization, a urinary catheter is inserted into the bladder transurethraly or through an abdominal fistula. It is not limited by bladder contraction or coordinated actions of the sphincter mechanism. However, when the bladder is in a long-term nonfilling state, indwelling catheterization may inhibit bladder contraction, resulting in a decrease in bladder capacity and compliance. In addition, long-term indwelling catheterization increases the frequency of UTI and may be associated with lithiasis.

Clean intermittent catheterization, in which bladder voiding via a disposable catheter is implemented at frequent intervals, is recommended as a primary supportive measure in bladder care as it provides complete bladder emptying and offers a practical means of obtaining a catheter-free state [6].

In some studies meta-analysis found UTI and hematuria less frequently associated with the use of hydrophilic-coated catheters for IC in patients with spinal cord injury. These findings support the use of hydrophilic catheters in this patient population [12].

In present study patients with spinal cord injuries were used different methods urination. The prevalence of UTI (43.9%) and Pyuria (56.9%) was more in patients who were used catheter method urination than other methods urination. In these patients UTI have often exogenous origin.

E.coli was the predominant isolated bacteria (33%) in urine samples, same the previous studies but Klebsiellapneumoniae (10.7%) and Enterobacter cloacae (7.8%) were the next isolated bacteria respectively in our study and is different to other papers [13],[18].

Patients with a long-standing spinal cord injuries, smoking history, a history of frequent UTI or indwelling catheter usage for >5 years may be at the highest risk for bladder cancer. Although screening these patients is a common practice, there is no evidence that the

use of annual urinary markers or cystoscopy is effective, or that these investigations meet the principles of a screening test. However, they are generally minimally invasive tests, and the potential benefit of detecting an early malignancy may outweigh the potential risks associated with screening practices in this population. Further research is required to assess independent risk factors for bladder cancer among spinal cord injury patients, in order to identify high-risk populations for potential surveillance strategies [14].

In present study, isolated bacteria were identified by biochemical methods and then were tested for sensitivity of resistancy to routine antibiotics with disk diffusion method. Antibiotics were included Nitrofurantoin, Ciprofloxazine and Imipenem.

Deciding which antibiotic drug to use cannot merely be based on the results of microbiologic testing; several other factors must be taken into account. Nitrofurantoin, e.g. achieves only poor parenchymal concentrations and should not be used in patients with pyelonephritis, prostatitis, or epididymitis. Other drugs, such as cotrimoxazole, third-generation cephalosporins, and fluoroquinolones, cover a broad spectrum of bacteria, reach adequate parenchymal and urine concentrations, and can be administered orally. Consequently, these drugs were among the most frequently used medications in the survey [15].

In this study the incidence of resistancy to Nitrofurantoin, Ciprofloxazine and Imipenem in Klebsiellapneumoniae and Enterobacter cloacae was not high rate but the incidence of resistancy to Nitrofurantoin and Imipenem in E.coli was high (51.1% and 43.7% respectively). Imipenem for treatment of UTI were used recently by physicians and the result of this study show that the high rate of resistancy to this antibiotic and this is alarm for treatment of urinary tract infection in spinal cord injuries.

A prophylactic antibiotic in retrograde investigations such as an urodynamic study was suggested by the European Association of Urology in order to prevent urinary tract infection (UTI) in the neurogenic bladder however finding an appropriate antibiotic is questionable since bacterial types and their sensitivities are variable in different settings [16].

Since the patients with spinal cord injuries have to use catheter for long time and or for all of life, they are high risk to recurrent urinary tract infections and other infections. These patients need to monitor for urinary tract infection almost every month although without any symptoms of infections and sometimes need to apply prophylactic antibiotics.

#### ACKNOWLEDGEMENTS

Many thanks to physician and nurses who working in "Brain and Spinal Injury Repair Research Centre" Imam Hospital.

Many thanks to Miss Shadi Seedmahmood for cooperation.

#### REFERENCES

1. DHondt F, Everaert K. Urinary tract infections in patients with spinal cord injuries. *Curr Infect Dis Rep.* 2011 Dec; 13(6):544-51.
2. Balsara ZR, Ross SS, Dolber PC, Wiener JS, Tang Y, Seed PC. Enhanced susceptibility to urinary tract infection in the spinal cord-injured host with neurogenic bladder. *Infect Immun.* 2013 Aug;81(8):3018-26
3. Linsenmeyer TA, Bodner DR, Creasey GH, Green BG, Groah SL, Joseph A, Lloyd LK, Perkash I, Wheeler JS. Consortium for Spinal Cord Medicine. Bladder management for adults with spinal cord injury: a clinical practice guideline for health care providers. *J Spinal Cord Med.* 2006; 29: 537-573.
4. Manack A, Motsko SP, Haag-Molkenteller C, Goehring EL JR, Domochofski RR, Nguyen-Khoa BA., Jones JK. *Epidemiology*

- and healthcare utilization of neurogenic bladder patients in a US claims database. *NeurourolUrodyn.* 2011; 30: 395–401.
5. Tauqir SF, Mirza S, Gul S, Ghaffar H, Zafar A. Complications in patients with spinal cord injuries sustained in an earthquake in Northern Pakistan. *J Spinal Cord Med.* 2007; 30: 373–377.
  6. Shen, L, Zheng, X, Zheng, S, Hou, C. Influence of different urination methods on the urinary systems of patients with spinal cord injury. *J Int Med Res.* 2012; 40(5): 1949-57.
  7. Biering-Sorensen F, Bagi P, Hoiby N. Urinary tract infections in patients with spinal cord lesions: treatment and prevention. *Drugs.* 2001; 61(9): 1275–87.
  8. Selassie A, Snipe L, Focht KL, Welldaregay W. Baseline prevalence of heart diseases, hypertension, diabetes, and obesity in persons with acute traumatic spinal cord injury: potential threats in the recovery trajectory. *Top Spinal Cord Inj Rehabil.* 2013 summer; 19(3): 172-82.
  9. Craven C, Hitzig SL, Mittmann N. Impact of impairment and secondary health conditions on health preference among Canadians with chronic spinal cord injury. *J Spinal Cord Med.* 2012 Sep; 35(5): 361-70.
  10. Luo DY, Ding MF, He CQ, Zhang HC, Dai Y, Yang Y, Sun ZC, Zhu SJ, Zhang JL, Song H, Shen H. Bladder management of patients with spinal cord injuries sustained in the 2008 Wenchuan earthquake. *Kaohsiung J Med Sci.* 2012 Nov; 28(11): 613-8.
  11. J.W. Warren. Catheter-associated urinary tract infections. *Inf Dis Clin N Am.* 1987; pg. 24.
  12. Li L, Ye W, Ruan H, Yang B, Zhang S, Li L. Impact of hydrophilic catheters on urinary tract infections in people with spinal cord injury: systematic review and meta-analysis of randomized controlled trials. *Arch Phys Med Rehabil.* 2013 Apr; 94(4): 782-7.
  13. Rahimkhani M, Khavaridaneshvar H, Sharifian R. Asymptomatic bacteriuria and pyuria in pregnancy. *Acta Medical Iranica.* 2008; 46(5): 409-412.
  14. Welk B, McIntyre A, Teasell R, Potter P, Loh E. Bladder cancer in individuals with spinal cord injuries. *Spinal Cord.* 2013 Jul; 51(7): 516-21.
  15. Pannek J. Treatment of urinary tract infection in persons with spinal cord injury: guidelines, evidence, and clinical practice. A questionnaire-based survey and review of the literature. *J Spinal Cord Med.* 2011; 34(1): 11-5.
  16. Ploypetch T, Dajpratham P, Assanasen S, Thanakiatpinyo T, Tanvijit P, Karawek J. Epidemiology of urinary tract infection among spinal cord injured patients in rehabilitation ward at Siriraj Hospital. *J Med Assoc Thai.* 2013 Jan; 96(1): 99-106.
  17. Shah A, Parekh P, Azmi P, Rajendra V, Knoale A, Palshikar G. Stem Cell: A Review. *Asian J Pharm Clin Res* 2011; 4(2): 7-12.
  18. Mobaleghi J, Salimizand H, Beiranvand S, Membari SH, Kalantar E. Extended spectrum B-lactamases in urinary isolates of *Escherichia coli* in five Iranian hospitals. *Asian J Pharm Clin Res* 2012; 5(Suppl 2): 35-36.