

Urinary Tract Infections and Spinal Cord Injury

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Overview

Urinary tract infections (UTIs) are considered to be the most prevalent bacterial infections with a significant economic burden on society (Grabe et al., 2012). UTIs are classified according to the localization of the infection, which includes the bladder (cystitis), kidney (pyelonephritis), or urine (bacteriuria), and can be asymptomatic or symptomatic (Foxman, 2002). Aguilar-Duran et al. (2012) report the classification of infections is according to the place of acquisition; hospital acquired (HA) infections that are detected 48 hours after hospital admissions and community acquired (CA) infections are those that do not meet the criteria to be in the first group as characteristically these infections are acquired from antibiotic-sensitive organisms that are uncomplicated to treat. According to the 1997 National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey, UTI within the United States results in approximately seven million medical office visits each year along with 1 million medical emergency visits, subsequently resulting in 100,000 hospitalizations (Schappert, 1997). In a study by Mazzulli (2002), nearly 15% of all prescribed antibiotics in the USA are distributed for UTIs at an estimated annual cost of over \$1 billion. Additionally, the annual cost associated with community acquired UTIs in the United States exceeds an estimated \$1.6 billion; this includes \$474 million in medical expenses, \$158 million in non-medical expenses and \$936 million in indirect cost or lost productivity (Foxman, 2000).

While examining the incidence rate of UTIs, Grabe et al. (2012) found the incidence of UTI varies depending on age and gender. In the first year of life (predominately first 3 months), UTI is more common in boys (3.7%) than in girls (2%), but then reverses percentages gender-wise during the school years. However, a slight decrease in UTIs appears in girls 11 to 15 years of age, after which the rate increases again throughout their mid-20s (Shortliffe & McCue, 2002). In a similar study conducted by Foxman (2010), the estimated incidence for UTIs in women 18 years and older was 12.6%, whereas in men it remained at 3%. Females are considerably more susceptible to experience a UTI than males, and one out of three women develops at least one UTI episode needing antimicrobial therapy by the age of 24. Additionally, when examining the number of office visits, Foxman (2002) reported women were twice as likely (1.2%) than men (0.6%) to require medical attention. Other specific subpopulations at greater risk of UTI include infants, pregnant women, the elderly, persons with spinal cord injuries who catheterize, individuals with diabetes or multiple sclerosis, and persons with acquired immunodeficiency disease syndrome/human immunodeficiency virus (Foxman, 2002).

Synopsis of Functioning Bladder Anatomy

The bladder is a muscular organ with a mucosal lining (urothelium) in which urine is stored. Internal and external sphincter muscles to the bladder and pelvic floor muscles help to

preserve continence (Wang et al., 2009). The urinary tract consists of: the urethra, bladder, ureters, kidneys, and sphincter (which are considered sterile areas and work to balance the excretion of urine and maintain substances and water in the body). Bacteria can enter any of these anatomical locations and produce an active infection (Lindsey, 2008). Microorganisms can reach the urinary tract by haematogenous or lymphatic spread, but experimental evidence indicates that the ascent of microorganisms from the urethra is the most common path that leads to UTI (Grabe et al., 2012). Foxman (2002) notes that in most cases, bacteria travels to the urethra and multiplies, causing a urethra infection (urethritis). If bacterium travels to the bladder and reproduces, a bladder infection (cystitis) can follow. If the infection is not treated, bacteria may then travel further up the ureters causing a kidney infection (pyelonephritis) (Foxman, 2002).

When making an anatomical comparison between males and females, there is an increased risk among women due to the shorter distance to the bladder, increasing the possibility for bacterial colonizers to reach the bladder more easily before they are removed by urination (Foxman, 2010). Foxman also indicated a female urethra is in close proximity to the rectum, allowing for fecal flora to travel to the urethra with easier accessibility (Foxman, 2010). Comparatively, males are less susceptible to developing a UTI due to their longer urethra, drier periurethral areas that may be less prone to microbial colonization, and prostatic fluid that contains antibacterial properties (Neria & Mintz, 2008). According to Hooton et al. (1996), sexual intercourse can also aid in the relocation of uropathogens to the urethra and bladder, resulting in an infection. Consequently, the use of diaphragms and spermicides has been linked with an increased risk of UTI. Additionally, the majority of acquired UTIs in the United States are caused by *Escherichia coli* both in upper and lower tract infections accounting for approximately 80% of all cases with *Staphylococcus saprophyticus*, accounting for approximately 10% to 15% of infections (Ronald, 2002). Urinary tract infection is diagnosed using a combination of urinary symptoms and urine cultures, indicating numbers of a known uropathogen exceeding an identified threshold which is usually defined as $>1,000\text{cfu/ml}$ of urine (Foxman, 2010).

Spinal Cord Injury and Urinary Tract Infections

Several variables are responsible for the high prevalence of UTIs among persons with SCI. Some of the predispositions of UTIs involve urinary stasis and bladder catheterization as a major contributor of urinary infections (Darouiche, 2003). Others include “invasive procedures without antibiotic prophylaxis, cervical injury, neurogenic bladder, stagnant residual urine, incomplete voiding, catheter use, and elevated intravesical pressure” (Opperman, 2010, p. 451). Most individuals (approximately 80%) with SCI have bacteria within the urinary system from contamination from the skin and urethra which can then be brought to the bladder from an intermittent catheter (most common for those with a spastic reflex bladder), indwelling Foley or a Suprapubic catheter method of bladder management. For individuals with SCI, the inability to empty their bladder becomes a medical concern as bacteria are left in the remaining urine increases the likelihood of a UTI. Shah, Cannon, Sullivan, Nemchausky, and Pachucki (2005), report that at any given time, 85% of persons who require long-term catheter use have significant bacteriuria, increasing the risk of a urinary infection. Although proper and precise catheterization care can aid in lowering the frequency of UTIs, there is still no artificial drainage that can prevent or guarantee sterile urine (Barboi & Peruzzi, 2003). Unusual manifestations of urinary infections in people with SCI are nonspecific and can be caused by other conditions such as “ingrown toe nails, heterotopic bone ossification, osteomyelitis, and

pressure ulcers” (Darouiche, 2003, p. 201).

Medical Aspects of UTI. Once an individual has sustained a SCI, three parts of the urinary tract remain properly functioning (Lindsey, 2008). The functions of the urinary system such as the kidneys creating urine, urine flowing through the ureters and through the urethra, are involuntary responses, meaning the messages from the brain are unnecessary for these functions to process accordingly (Lindsey, 2008). Although the three urinary system functions are involuntary, bladder management following spinal cord injury can still disrupt the urinary process, as the messages from the nervous system to the bladder are lost. For some, depending on the severity of the injury, some bladders are unable to store urine due to the bladder's inability to stretch, and some experience intense pressure as a result from bladder spasms (resulting in spontaneous and accidental urination) (Linsenmeyer & Maddox, 2010). In addition to the previous complications of bladder management among those with SCI, pressured bladders with an excessively tight sphincter can back up urine into the ureters (reflux), and must be controlled with medications, surgery, or a bladder medication program since damage to the kidneys can result (Linsenmeyer & Maddox, 2010). The critical function of the bladder is to eliminate urine, and inability to do so increases chances of UTI.

Establishing a Diagnosis. A major concern and obstacle for persons with SCI involves the inability to detect urinary tract infection symptoms as a result of sensory deficits (Darouiche, 2003). Another concern is the high incidence of bacteriuria within this population making diagnosis difficult. Although difficulties do exist in establishing a diagnosis and that there is no universally accepted identification of a symptomatic UTI in people with SCI, Darouiche (2003) provides a useful guide in identifying this persistent secondary complication within this population. The characterizing factors include: the presence of significant bacteriuria in the urine ($\geq 10^5$ CFU/ml); pyuria; and fever (>100 °F), along with at least one of the following signs and symptoms: Suprapubic discomfort, bladder spasms, increased spasticity, worsening of dysreflexia, and a change in voiding habits (Darouiche et al., 1993). As asymptomatic bacteriuria progresses to symptomatic infection, in theory, it is possible to prevent and eradicate asymptomatic bacteriuria resulting in a decrease in symptomatic UTIs in patients with SCI despite various studies yielding conflicting results. One preventative measure includes the daily administration of antibiotics, although this is discouraged by many Urologists due to antibiotic resistance. Morton et al. (2002) found the use of prophylactic antibiotics to prevent UTIs is still unsupported and debated.

Approximately 57% of persons with a SCI will experience a UTI and/or bacteriuria post-injury making UTIs the most frequent medical complication for those with SCI during acute care (Morton et al., 2002; Barboi & Peruzzi, 2003). Additionally, UTIs are among the most common medical complications and the most problematic for this population during hospitalization. They are the main cause for re-hospitalization. Individuals will experience a UTI after sustaining their SCI injury and will struggle with a UTI between 1.82 and 2.6 per year (Opperman, 2010). As a result, UTIs can intensify the symptoms of the disability, affect quality of life, and negatively impact health, mobility, and independence.

Bladder Management and Complications

To improve quality of life and reduce medical complications among people with SCI, preferred bladder management methods should be considered to best suit the patient's individual needs (Sekar et al., 1997). Singh et al. (2011) notes the most common types of bladder management for SCI patients include intermittent catheterization, indwelling catheterization, condom drainage, and Crede maneuver. Respectively, each one of these

methods has advantages and disadvantages in terms of accessibility, cost, and risks of secondary medical complications.

With improved medical re: UTI now available for persons with SCI and overall life expectancy reaching 70% to 92% (depending in-part on severity of injury), the choice of bladder management has become increasingly important as it directly impacts long-term medical care and quality of life (Cameron et al., 2011). In a study conducted by Cameron et al. (2011) comparing various forms of bladder management among 24,762 participants, indwelling catheters was associated with more pressure ulcers. Increased odds of obtaining a pressure ulcer increased from the first year of obtaining a SCI to year 20, and the results are as follows: voiding (.09 to .26), condom catheterization (.26 to .78), intermittent catheterization (.34 to .62) and indwelling catheterization (95% for all) (Cameron et al., 2011). In addition to the pressure ulcers reported by patients using indwelling catheters, patients were at greater risk for incurring kidney stones in comparison to those who voided by condom drainage in years 1, 5 and 15, and intermittent bladder management in years 5, 10, and 15, with an increased risk for total hospital stays with patients using indwelling catheters (Cameron et al., 2011). Other studies have reported similar findings involving long-term use of indwelling catheters, indicating squamous metaplasia (non-cancerous changes in the lining of the bladder), thickening of the bladder, diverticula (small pouch developed outside the wall of the intestines), calculi (mineral deposits that form into a stone), and presence of multiple organisms from use of indwelling catheters (Montgomerie, 1997).

Although many with SCI utilize indwelling catheters as a bladder management technique, other options include intermittent catheterization typically 4 to 6 times per day, and especially for those individuals with paraplegia, who can self-catheterize (Newman & Wilson, 2011). The utilization of intermittent catheterization within this population has reduces many of the complications associated with indwelling catheters (Weld & Dmochowski, 2000). Weld and Dmochowski's (2000) found that of their 314 SCI patient medical record review for UTIs, 398 UTI infections were recorded with 53.5% from using indwelling catheters, 27.2% from intermittent catheterization, 32.4% who voided via condom drainage, and 44.4% with Suprapubic catheter usage.

Tambyah and Maki (2000) similarly found condom drainage to have relatively fewer difficulties than those who catheterized intermittently throughout the day. Nevertheless, problems may still arise as incomplete bladder drainage, which can lead to persistently high bladder pressures, recurrent UTIs, and the likelihood of glomerular filtration rate deterioration (Newman & Price, 1985). Newman and Price (1985) indicated a high prevalence of bladder trabeculation noting this occurrence was secondary to high bladder pressure. In a similar study by Cardenas and Hooton (1995), bladder trabeculation was found in 26 of 34 patients, and diverticula in 14 of 34 patient records they reviewed.

The credé maneuver to induce urination is accomplished by gently pressing down on the bladder (Shen, Zheng, Zhang, Zeng, & Hou, 2012). A study by Shen et al. (2012), focused on identifying the variability between such management methods over the course of two years. Shen and colleagues evaluated 67 patients, 26 (38.8%) of whom utilized the credé maneuver coupled with reflex voiding. This study suggested a higher rate of urinary tract infections and a higher residual urine volume associated with patients utilizing the credé maneuver when compared to those using clean intermittent catheterization (Shen et al., 2012). Similarly, in a study conducted by Chang, Hou, Dong, and Zhang (2000), 74 persons with spinal cord injury that used the credé maneuver for over 20 years were compared based on gender and complications. Gender comparisons resulted in an overall high prevalence of residual urine at

100ml in both genders (93.2%); and 50% of those tested demonstrated a 300ml residual urine volume. Additionally, it was reported that males generated a higher rate of vulnerability for upper urinary tract deterioration than women ($P=0.05$) (Chang et al., 2000). An epidemiological follow-up study was conducted to determine the efficiency of bladder management methods in relation to long-term effectiveness (Hansen, Biering-Sørensen, & Kristensen, 2004). It was determined that although the credé maneuver is discouraged by professionals due to its higher residual urine volume and UTI probabilities, the frequency of usage by participants rose from 5% to 19% between the time of discharge and follow up. Although individuals with SCI may continue to use the credé maneuver as a bladder management method, education may be the key to informing patients of best practices (Hansen et al., 2004).

The use of intermittent catheterization, indwelling catheterization, condom, and the credé maneuver as bladder management methods for persons with SCI come with certain unique beneficial components that may enhance well-being dependent on the characteristics of the person's condition. Furthermore, such methodologies also comprise a variety of health concerns (i.e., prevalence of UTIs) that must be thoroughly evaluated by the rehabilitation team to deter such complications and improve quality of life.

Implications for Life Care Planners

When individuals acquire a spinal cord injury, certain physiological changes place them at a greater risk for secondary complications such as the prevalence of UTIs. This risk may also affect the individual in other ways including: increased probability of depression, higher levels of anxiety, lower level of functioning and productivity, and perceived quality of life. The method of bladder management must be appropriately matched with the individual's functional ability and urologic needs to reduce the probability of attaining a UTI. Risk factor education on distinct bladder management methods and implementing a proper rehabilitation phase is a critical preventative step to improve overall health outcomes.

The implications for life care planners regarding UTI issues for those with SCI should be based on several factors when having the opportunity to consult with a treating urologist. First, the individual's severity of functioning becomes important regarding whether or not he or she retains the hand and finger dexterity to self-catheterize. If not, as is generally found with those with a C6 level of injury or higher, needing the assistance of a caregiver to catheterize every 4 to 6 hours can severely impact ability to work, quality of life, etc. As a result, if those with tetraplegia retain the ability to void by condom drainage and leg bag, this may be the desired methodology of choice. If, however, the patient is unable to sufficiently drain the majority of urine from the bladder using a combination of condom and/or credé technique, and indwelling or suprapubic catheter may be more advantageous without risking quality of life from having to be catheterized every several hours. This of course is a personal decision for the individual and his or her urologist to make, noting the epidemiological incidence of UTIs with each method of drainage.

Finally, the current paper addressed some of the statistical prevalence statistics regarding UTIs among those with a spinal cord injury. Whether or not a life care planner perceives one or more UTIs will occur requiring hospitalization, IV antibiotics, and/or oral antibiotics over one's lifetime remains a decision for the urologist or physician specialist to determine. Many factors may lead one to conclude that the occurrence of UTIs among those with incomplete versus complete tetraplegia versus paraplegia and other individual demographic characteristics such as age and gender come into play as to the possibility versus probability of occurrence and inclusion of costs in the life care plan.

References

- Aguilar-Duran, S., Horcajada, J., Sorlí, L., Montero, M., Salvadó, M., Grau, S., & ... Knobel, H. (2012). Community-onset healthcare-related urinary tract infections: Comparison with community and hospital-acquired urinary tract infections. *The Journal of Infection*, 64(5), 478-483. doi:10.1016/j.jinf.2012.01.010
- Barboi, C., & Peruzzi, T. W. (2003). Acute medical management of spinal cord injury. In V. W. Lin (Ed.), *Spinal cord medicine: Principles and practice* (pp. 113-123). New York, NY: Demos Medical Publishing.
- Cameron, A. P., Wallner, L. P., Forchheimer, M. B., Clemens, J., Dunn, R. L., Rodriguez, G., & ... Tate, D. G. (2011). Medical and psychosocial complications associated with method of bladder management after traumatic spinal cord injury. *Archives of Physical Medicine & Rehabilitation*, 92(3), 449-456. doi:10.1016/j.apmr.2010.06.028
- Cardenas, D., & Hooton, T. (1995). Urinary tract infection in persons with spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, 76(3), 272-280.
- Chang, S. M., Hou, C. L., Dong, D. Q., & Zhang, H. (2000). Urologic status of 74 spinal cord injury patients from the 1976 Tangshan earthquake, and managed for over 20 years using the crede maneuver. *Spinal Cord*, 38, 552-554.
- Shortliffe, L., & McCue, J. D. (2002). Urinary tract infection at the age extremes: Pediatrics and geriatrics. *American Journal of Medicine*, 113(Supplement 1A), 55S-66S.
- Darouiche, R. O. (2003). Infection and spinal cord injury. In V. W. Lin (Ed.), *Spinal cord medicine: Principles and practice* (pp. 201-207). New York, NY: Demos Medical Publishing.
- Darouiche, R., Cadle, R., Zenon, G., Markowski, J., Rodriguez, M., & Musher, D. (1993). Progression from asymptomatic to symptomatic urinary tract infection in patients with SCI: a preliminary study. *The Journal of The American Paraplegia Society*, 16(4), 219-224.
- Foxman, B. (2002). Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *The American Journal of Medicine*, 113 Suppl 1A5S-13S.
- Foxman, B. (2010). The epidemiology of urinary tract infection. *Nature Reviews Urology*, 7(12), 653-660.
- Foxman, B., Barlow, R., D'Arcy, H., Gillespie, B., & Sobel, J. (2000). Urinary tract infection: Self-reported incidence and associated costs. *Annals of Epidemiology*, 10(8), 509-515.
- Grabe, M., Bishop, M. C., Bjerklund-Johansen, T.E., Botto, H., Cek, M., Lobel, B., Naber, K.G., Palou, J., & Tenke, P. (2012). Guidelines on Urological Infections. *European Association of Urology*, 7-15.
- Hansen, R. B., Biering-Sorensen, F., & Kristensen, J. K. (2004). Bladder emptying over a period of 10-45 years after a traumatic spinal cord injury. *Spinal Cord*, 42, 631-637.
- Hooton, T., Scholes, D., Hughes, J., Winter, C., Roberts, P., Stapleton, A., & ... Stamm, W. (1996). A prospective study of risk factors for symptomatic urinary tract infection in young women. *The New England Journal of Medicine*, 335(7), 468-474.
- Linszenmeyer, L., & Maddox, S. (2010). Bladder management following spinal cord injury: What you should know. *Spinal Cord Medicine*. Retrieved from <http://www.themiamiproject.org/Document.Doc?id=210>
- Lindsey, L. (2001). Bladder care and management. Retrieved from <http://images.main.uab.edu/spinalcord/SCI%20Infosheets%20in%20PDF/Bladder%20Care%20and%20Management.pdf>
- Mazzulli, T. (2002). Resistance trends in urinary tract pathogens and impact on management.

- The Journal of Urology*, 168(4 Pt 2), 1720-1722.
- Morton, S., Shekelle, P., Adams, J., Bennett, C., Dobkin, B., Montgomerie, J., & Vickery, B. (2002). Antimicrobial prophylaxis for urinary tract infection in persons with spinal cord dysfunction. *Archives of Physical Medicine & Rehabilitation*, 83(1), 129-138.
- Montgomerie, J. Z. (1997). Infections in patients with spinal cord injuries. *Clinical Infectious Diseases*, 25(6), 1285-1290.
- Neria, J., & Mintz, M. (2008). Urinary tract Infections. In Skolnik, N. S., & Albert, R. H. (Eds.), *Essential Infectious Disease Topics for Primary Care* (pp.259-274). Totowa, NJ: Humana Press.
- Newman, E., & Price, M. (1985). External catheters: hazards and benefits of their use by men with spinal cord lesions. *Archives of Physical Medicine and Rehabilitation*, 66(5), 310-313.
- Newman, D. K., & Willson, M. M. (2011). Review of Intermittent Catheterization and Current Best Practices. *Urologic Nursing*, 31(1), 12-48.
- Opperman, E. (2010). Cranberry is not effective for the prevention or treatment of urinary tract infections in individuals with spinal cord injury. *Spinal Cord*, 48(6), 451-456. doi:10.1038/sc.2009.159
- Schappert, S. (1997). Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 1997. Vital and Health Statistics. Series 13, Data from The National Health Survey, (143), 1-39.
- Sekar, P., Wallace, D., Waites, K., DeVivo, M., Lloyd, L., Stover, S., & Dubovsky, E. (1997). Comparison of long-term renal function after spinal cord injury using different urinary management methods. *Archives of Physical Medicine & Rehabilitation*, 78(9), 992-997.
- Shah, P., Cannon, J., Sullivan, C., Nemchausky, B., & Pachucki, C. (2005). Controlling antimicrobial use and decreasing microbiological laboratory tests for urinary tract infections in spinal-cord-injury patients with chronic indwelling catheters. *Official Journal of the American Society of Health-System Pharmacists*, 62(1), 74-77.
- Shen, L., Zheng, X., Zhang, C., Zeng, B., & Hou, C. (2012). Influence of different urination methods on the urinary systems of patients with spinal cord injury. *Journal of International Medical Research*, 40(5), 1949-1957. doi:10.1177/030006051204000536
- Singh, R., Rohilla, R., Sangwan, K., Siwach, R., Magu, N., & Sangwan, S. (2011). Bladder management methods and urological complications in spinal cord injury patients. *Indian Journal of Orthopedics*, 45(2), 141-147. doi:10.4103/0019-5413.77134
- Tambyah, P., & Maki, D. (2000). Catheter-associated urinary tract infection is rarely symptomatic: A prospective study of 1,497 catheterized patients. *Archives of Internal Medicine*, 160(5), 678-682.
- Wang, Y., Tripathi, P., Guo, Q., Coussens, M., Ma, L., & Chen, F. (2009). Cre/Lox recombination in the lower urinary tract. *Genesis The Journal of Genetics And Development*, 47(6), 409-413.
- Weld, K. J., & Dmochowski, R. R. (2000). Effect of bladder management on urological complications in spinal cord injured patients. *Journal of Urology*, 163(3), 768-772.

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