



URINARY TRACT INFECTION IN CLIENTS WITH SPINAL CORD INJURY WHO USE INTERMITTENT CLEAN SELF CATHETERISATION

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ABSTRACT

Urinary tract infection (UTI) was identified as a significant issue for people with spinal cord injury (SCI) performing intermittent clean self-catheterisation (ICSC) in the community.

A review of the literature was undertaken to establish the major risk factors of UTI and how these risks could be reduced in practice. The majority of authors recommended the use of a clean catheterisation technique in the community. The maintenance of appropriate bladder volumes, low residuals and regular emptying intervals appear to be of paramount importance for minimising risk of UTI for this client group.

INTRODUCTION

People with SCI can experience both neurogenic bladder and sphincter dysfunction resulting in an inability to effectively store and excrete urine. The management of the neurogenic bladder by ICSC is one of the preferred methods as it allows for regular emptying at manageable intervals therefore maintaining a low-pressure environment (Giannantoni et al 1998; Prieto-Fingerhut et al 1997). It is also often more socially acceptable for the client than visually obvious continence management systems. Clean intermittent catheterisation gained prominence through the work of Lapedes et al (1972). Since that time ICSC has become the method of choice for bladder management for clients with paraplegia and low-level tetraplegia, provided they have sufficient hand function to perform the technique (Gallien et al 1998; Selzman and Hampel 1993). The technique of ICSC and catheter management is initially taught during primary rehabilitation and may be reviewed by many different health workers in the community, subsequent to discharge.

The Spinal Outreach Team, Queensland Spinal Cord Injury Service, Princess Alexandra Hospital, Queensland, Australia, provides a consultancy service that assists clients, their carers and other health care services in the delivery of effective and appropriate care for people with SCI across Queensland. A review of service statistics revealed that bladder management problems made up 25% of the referrals to the team's clinical nurse - with UTI being the major presenting problem. This prompted a review of the literature to establish the causes of infection, so that interventions provided by the Spinal Outreach Team, would be evidence based towards the reduction of UTI.

Scope of the Problem

Any loss of normal bladder function will result in an increased risk of UTI (Stover et al 1989). UTI is typically defined as bacteriuria of 10^5 colonies, which may or may not be accompanied by microbial invasion of the tissues (NIDRR 1992). Stover et al (1989) reported that two thirds of patients using ICSC have some form of chronic bacteriuria. Cardenas and Hooton (1995) reported, from the Model Spinal Cord Injury Care System, that UTI was the most frequent medical complication following spinal cord injury. Whilst ICSC is widely accepted as reducing the incidence of UTI when compared to methods such as indwelling catheterisation (Cardenas and Hooton 1995; De Ruz et al 2000; Furuhashi et al 1988; Gallien et al 1998; Nygaard and Kreder 1996; Selzman and Hampel 1993; National Institute of Disability and Rehabilitation Research 1992; Stover et al 1989); the rate of UTI is clearly indicated throughout the literature as still significantly high. The incidence of UTI has been reported as between 20-53% in people with spinal cord injury using ICSC (Whiteneck et al 1992; Cardenas and Mayo 1987). Recurrent UTI can lead to complications such as bladder and renal calculi, pyelonephritis, vesicoureteral reflux and renal failure (Shekelle et al 1999).

Risk factors associated with UTI can be defined as modifiable or non-modifiable. There is limited evidence in the literature to support a link between the non-modifiable factors such as gender, level of injury and time since injury (Shekelle et al 1999). It is those risk factors amenable to intervention, which are the focus of this paper. These factors include bladder distension, timing of emptying, bladder residuals and technique of catheterisation.

Bladder distension as a source of infection

In 1953, Mehrotra observed the slowing of blood flow in the bladder walls of rats following the distension of the bladder. In 1968 Schwartz, through his study of dogs, proved that bacteria was able to invade the urinary system from the gastrointestinal system when he introduced labelled *E.coli* into the rectum. Lapidus et al (1965) acknowledged the studies by both Mehrotra (1953) and Schwartz (1968) and applied them to their own clinical observations. They presented a theory of bladder distension contributing to UTI at the Second International Symposium on Pyelonephritis in 1964.

Lapidus et al (1968) studied 112 women with recurrent UTI and found 60% to have a history of large voiding volumes (500-1100ml) and infrequent voiding patterns (5-10 hours). No other abnormalities were detected. After instilling regular voiding regimes, only nine returned with a UTI and these had not adhered to the regime. Lapidus et al (1972) maintained that ischemic bladder tissue caused by an over distension of the bladder could allow bacterial invasion from the client's own gastrointestinal tract, thereby contributing to UTI. This is a theme subsequently repeated in the literature (Bennett et al 1997; Diokno et al 1983; Giannantoni et al 1998; Nygaard and Kreder 1996;

Rainville 1994; Selzman and Hampel 1993; Shekelle et al 1999; Wyndaele and Maes 1990). Chua et al (1996) reinforced that maintaining a low-pressure bladder should be one of the aims of effective bladder management in people with SCI. The study by Bakke and Vollset (1993) into risk factors of bacteriuria showed a relationship between high mean catheterisation volumes and UTI in 302 women using ICSC. A subsequent study indicated that the mean volume of 170 patients with UTI was 432ml, compared to mean volumes of 353ml in a second group of patients who were not seen to have associated infections (Bakke et al 1997).

In 1992, at the Urinary Tract Infection Consensus Conference held by the National Institute on Disability and Rehabilitation Research (NIDRR), professionals within fields of disability and rehabilitation, including researchers, clinicians and consumers, came together to form a consensus on the best practises for prevention and treatment of UTI. From this conference it was concluded that the risk factors for UTI included, over-distension of the bladder, vesicoureteral reflux, high-pressure voiding, large post-void residuals, presence of stones in the urinary tract and outlet obstruction. These conclusions further emphasise the importance of maintaining low bladder volumes and preventing high-pressure voiding (NIDRR 1992).

Some authors also discussed fluid intake as a way to manage appropriate bladder volumes. The recommendation of a fluid intake of 1500-2000mls a day is well supported for the prevention of over distension of the bladder (Chua et al 1996; Perrouin-Verbe et al 1995; Wyndaele et al 1980). Chua et al (1996) indicated that bladder volumes should not exceed 400mls.

Bladder residuals as a source of infection

Hinman (1977) endeavoured to find a mathematical relationship between the frequency of catheterisation and residual volumes. Through the use of the modified phenolsulfonphthalein test it was found that an unattainable volume of urine was left behind after catheterisation which was higher than the volume left after normal voiding. Hinman (1977) wrote of a permissible residual volume, which is the amount of urine left behind after catheterisation that maintains a constant bacteriuria level. He proposed that the higher the residual left after catheterisation the greater the frequency of catheterisation required during the day to reduce the risk of UTI.

High residual volumes are noted anecdotally throughout the literature as a significant risk factor for UTI (Chua et al 1996; Giannantoni et al 1998; Nygaard and Kreder 1996; Selzman and Hampel 1993; Shekelle et al 1999; NIDRR 1992; Stover et al 1989; Wu and Nanninga 1990). Merritt (1981) conducted a study of people with SCI to compare residual urine volumes and the incidence of UTI. This study showed a positive association between higher residuals and UTI rate.

Safe emptying intervals

A safe emptying interval is defined as the time it takes for bacterial concentrations to return to original levels after the bladder has been emptied. Failure to catheterise once the safe emptying interval has been reached will result in increasing bacterial concentrations and an increased chance of invasion of the bladder tissue (Wu and Nanninga 1990; Hinman 1977).

The consensus by NIDRR also outlined the importance of catheterisation frequency. The issue was raised that people who are unable to perform self-catheterisation and rely on others to perform this task are at a greater risk of developing UTI, primarily due to the inability to adhere to catheterisation schedules (NIDRR 1992). Cardenas and Mayo (1987) found this to be the case, whereby subjects who were catheterised by others had the highest rate of infection at one year post discharge. Bakke and Vollset (1993; 1997) showed an association between low frequency of catheterisation and UTI.

Several authors have recommended catheterisation schedules ranging between four and seven times per day (Chua et al 1996; Perrouin-Verbe et al 1995; Wyndaele and Maes 1990). Other authors have recommended more precise catheterisation schedules of every four to six hours (Prieto-Fingerhut et al 1997; Wu and Nanninga 1990).

Hinman (1977), through his mathematical relationship between residuals and frequency of catheterisation showed that increasing the frequency of catheterisation was more effective in the reduction of bacteriuria than increasing urinary output. This further reinforces the importance of frequent catheterisation not only in reducing the risk of UTI, but also in the treatment of acute incidents of infection.

Clean versus sterile technique

Lapides et al (1972), asserted that a clean technique rather than a sterile technique was sufficient to minimise the risk of UTI. They also suggested that organisms introduced by the catheter, would be eliminated by the patient through their normal defence mechanisms. Sterile intermittent catheterisation can be awkward and impractical outside the hospital environment. A clean technique is more practical for routine life at home. Moore et al (1993) in a randomised crossover trial showed no significant difference between sterile and clean catheterisation techniques. Clean catheterisation is advocated for use in the community by the majority of authors, but the method of cleaning has not been reported as significantly impacting on UTI (Giannantoni et al 1998; Perrouin-Verbe et al 1995; Rainville 1994; Sutton et al 1991; Webb et al 1990; Wyndaele and Maes 1990; Lapides et al 1972, 1974, 1976). If the catheter and the catheterisation technique are clean, how this is achieved may be irrelevant.

In the statement produced by NIDRR it was concluded that infection was reduced with intermittent catheterisation compared to indwelling catheterisation, and ICSC posed no greater risk than sterile catheterisation. Suggestions were made that care was required that the reused catheters be cleaned properly, but here too, no indication was given as to what cleansing agent or method should be used (NIDRR 1992).

In a study conducted by King et al (1992) comparing urinary infection rate for clean versus sterile technique of catheterisation (in a hospital setting), it was shown that the rates for both methods were similar. Prieto-Fingerhut et al (1997) compared sterile intermittent catheterisation to non-sterile catheterisation performed by nursing staff in a rehabilitation unit of people with SCI. It was found that patients who received a non-sterile technique had a 13% higher incidence of UTIs. This result was not statistically significant, possibly due to the small sample size of 29. This study also indicated that the total cost of the sterile method was 277% higher than the non-sterile method. Bennett et al (1997), found that a closed sterile catheterisation system did result in less UTI's in hospitalised SCI patients.

It could be argued from these results that sterile catheterisation would be the optimum technique for all ICSC but as these studies involved catheterisation performed by trained nursing staff in a hospital environment, the relevance of this result to community management must be questioned. In his paper outlining the urological treatment of the acute spinal cord injured person, O'Donnell (1987) states that a strict sterile technique should be performed whilst an in-patient but a clean technique is sufficient in the community.

The catheter as a source of infection

It has been assumed that contamination of the catheter, prior or during its use, is a primary source of UTI. Barnes et al (1992) explored the possibility that catheterisation was a source of infection in men with SCI. They postulated that urine samples were actually contaminated during insertion of the catheter into the urethra. Their study involved a comparison of urine bacteria to swabs from the urethra, perineum and fingers. It was found that there was no evidence of the introduction of new bacteria to the bladder during catheterisation. However, one in 10 cases showed an increased number of the strain of bacteria already present in the bladder, after catheterisation.

Wyndaele et al (1980) observed 30 patients with neurogenic bladders treated with ICSC. Eleven of these patients had persistent UTIs. The researchers attributed one case to small capacity bladder and chronic reflux, five patients were said to have careless and irregular catheterisation and five had no objective cause for chronic infection. It was then stated that these chronically infected patients must have been contributing to their infections by

improper and careless catheterisation. They do concede in a later paper that over distension of the bladder and irregular bladder emptying increases the risk for recurrent infections, although chronic persistent infections were still felt to be caused by improper catheterisation technique (Wyndaele and Maes 1990). Winder (1990) stated that UTIs were caused by 'bad habits' including poor catheter cleaning and technique of insertion. She recommended that the catheterisation technique be reviewed with particular emphasis placed on the amount of lubricant used by male clients. UTIs were attributed to excessive lubricant use, which was thought to be left inside the urethra and introduced into the bladder by consecutive catheterisation.

The statement by the NIDRR (1992) indicated that a poor level of hygiene is a possible contributor to infections. However, there is limited research to establish the effect of personal hygiene and other behavioural factors upon the rate of UTI (Shekelle et al 1999).

The survey conducted by Rainville (1994), involving 175 rehabilitation facilities in the United States of America, covered areas such as equipment used, cleansing agents used, cleaning technique, catheter replacement times, and techniques taught for discharge. The majority of facilities taught clients to use non-sterile catheters in the community. Soap and water was the most commonly used cleaning agent (59.8%), but many of the facilities were advocating a variety of other agents including bleach, povidone-iodine, and boiling water, as well as 'others', which were not named.

A number of studies have been conducted comparing different catheter cleaning methods (Mervine and Temple 1997; Kurtz et al 1995; Lavellee et al 1995; Moore 1990). A study by Kurtz et al (1995) compared betadine solution, bleach, hydrogen peroxide, and tap water as mediums for cleaning catheters. The study showed the betadine, bleach, and hydrogen peroxide solutions were better than tap water in the eradication of *E.coli*, reducing the bacteria growth to zero. This state of zero bacteria growth may be hard to reproduce in a home environment. Many other variables would be introduced, such as, how well the client or carer washes their hands, where the catheter is stored in between cleaning and using, and the cleanliness of the environment in which the client is performing the catheterisation.

In a study conducted by Mervine and Temple (1997), microwave sterilisation was compared to soap and water washing. The results indicated that microwave was more effective in the eradication of organisms, but rubber catheters only could be used with this method of sterilisation. Lavellee et al (1995) also conducted a study into the best process of cleaning a catheter for reuse in intermittent catheterisation. It was found that the act of rinsing and drying the catheter after use reduced the *E.coli* count to near zero. On the strength of this result they questioned whether further cleaning was required.

Moore (1990) showed there was no significant difference between the ability of cetrimide, a recognised antiseptic agent, and Sunlight® soap, to clean colonised catheters. This would suggest that a cheap and easily obtained substance such as dishwashing liquid or Sunlight® soap could successfully be used to clean catheters.

In a study of 255 children who were using intermittent clean catheterisation it was shown there was no significant renal impairment even in the presence of bacteriuria introduced by the catheter (Kass et al 1981). There is, however, no doubt that good catheter technique is important in avoiding trauma to the urethra. Pubic hairs can infrequently be introduced during ICSC and can become a nidus for stone formation (Diokno et al 1983).

Patient education to reduce risk factors

Barber et al (1999) proposed that the risk of UTI in people with SCI could be reduced through the education of proper technique and hygiene. They targeted patients who had experienced two or more UTIs in a six-month period. The target group consisted of only 17, and at the end of the study 11 people (65%) had decreased their number of UTIs to less than two in a six month period.

Anderson et al (1983) conducted a study of patient education and the reduction of the incidence of UTI, where the focus of the education was recognition of the signs and symptoms of infection. This study showed that although the incidence of UTI was reported to be the same as a comparison group without education, the educated group lost less time from work and leisure activities as a result of infection. It was thought in this study, that the educated patients were taking earlier action with their UTIs leading to a reduced impact on their daily lives.

CONCLUSION AND RECOMMENDATIONS FOR PRACTICE

The majority of the literature supports the notion that over distension of the bladder, high residuals and prolonged emptying intervals are the key risk factors for UTIs in people using ICSC. Bladder management should aim to reduce these risk factors whilst recognising the need to develop a routine which can be adapted to the client's lifestyle. The NIDRR consensus has recommended that these findings be adopted by practitioners and consumers in the management of bladder dysfunction and spinal cord injury (NIDRR 1992).

There is far less evidence to implicate catheterisation technique and the introduction of bacteria from catheter insertion as primary sources of infection. In the studies that were concerned with catheterisation cleanliness, it appears that simple soap based mediums may well be as effective as the more recognised antibacterial and antiseptic mediums. Whilst technique and hygiene should form part of a comprehensive ICSC education program, these

elements should not be emphasised at the expense of bladder volumes, residuals and emptying intervals.

To implement a best practice approach to bladder management the following factors should be the primary areas of focus when educating patients on the principles of self-catheterisation:

1. The importance of maintaining low bladder volumes to reduce distension,
2. The importance of regular emptying schedules to allow for a safe emptying interval,
3. A clean technique that is easy to comply with in a community setting, and,
4. Encouragement of techniques that ensure the lowest possible residual volumes.

Similarly, when attempting to determine the cause of recurrent UTI in individual cases, adherence to a comprehensive assessment addressing these major risk factors is recommended.

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