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CONTINENCE CARE

Urological Care of the Spinal Cord–Injured Patient

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Spinal cord injury (SCI) is a catastrophic occurrence affecting the lives of 11,000 people in the United States every year. Urologic complications account for much of the morbidity associated with SCI and as much as 15% of the associated mortality. Spinal cord–injured patients are required to digest a plethora of self-management information during the emotionally and psychologically distressing period immediately following their injury. As a vital resource in the SCI patients' recovery process, it is crucial for the WOC nurse to have knowledge of the specialized needs of this population. This article reviews the effects of SCI on bladder function, discusses potential complications of the neurogenic bladder, and provides an overview of management options to assist the patient in adaptation and restoration of quality of life.

Introduction

Spinal cord injury (SCI) affects approximately 11,000 people in the United States each year.[1] The level and extent of spinal cord damage determines the extent and severity of sensory and motor deficits, as well as the impact on respiratory, lower urinary tract, sexual, and bowel function. Since only 1% of persons with an SCI experience complete neurological recovery, the goal of care is rehabilitation to maximal functional independence and preservation of quality of life within the context of their SCI-related impairments.[2] Even with an aggressive rehabilitation program, persons with SCI are at considerable risk for complications such as pressure ulcers and urinary tract complications associated with neurogenic bladder. Urologic complications account for the majority of morbidity rates and 10% to 15% of deaths in this population.[1] Managing urinary elimination is one of the many adaptation challenges the spinal cord–injured person must master. How well they are assisted through the process will help achieve the restoration of their quality of life. The WOC nurse has specialized knowledge in urological complications and acts as an essential health care team member during and after the rehabilitation process.

Causes

The Spinal Cord Injury Information Network reports that motor vehicle accidents are the most frequent cause of SCI (47.5%). Falls are the second most frequent cause of SCI (22%), and violence, primarily from gunshot wounds, account for 13% of all these injuries. Recently, the proportion of sports-related injuries has declined to 8.9%. The majority of all those injured are men (79%), and the average age at the time of injury is 37.6 years.[2]

Continence Physiology

The term *continence* denotes the ability to store urine until an acceptable opportunity for urination occurs. Normal bladder function involves a cycle of filling, storage, and a conscious desire and decision to void.[3] This entire cycle relies on control of the detrusor (bladder) muscle and competence of the sphincter mechanism. The initial desire to void occurs when the bladder is filled with an amount of urine ranging approximately from 250 to 450 mL.[4] As the bladder distends, afferent nerves in the lamina propria (submucosal layer) of the bladder wall transmit messages to multiple modulatory area within the brain. These areas, in turn, inhibit micturition until the individual makes a conscious decision to urinate.[5] The pons contains a specialized group of neurons known as the *pontine micturition center*, which coordinates the micturition reflex.[6] During bladder filling, the detrusor muscle remains relaxed and the smooth and striated muscles of the urethral sphincter mechanism maintain tone, ensuring a closed bladder outlet. With voiding, the detrusor muscle contracts and the urethral sphincter muscles relax, ensuring nonobstructed urinary outflow.[7] Efferent signals from the central brain and brainstem are transmitted to the bladder via the autonomic nervous system. The autonomic nervous system regulates autonomic body functions, such as the heartbeat, bowel, and urinary tract contraction; it is divided into the sympathetic and the parasympathetic

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nerves.[8] Sympathetic outflow regulating lower urinary tract function originates from neurons in the 10th thoracic to the 2nd lumbar vertebrae. Efferent signals are transmitted via the hypogastric nerve; sympathetic signals promote urinary storage via detrusor relaxation and contraction of smooth muscle within the proximal urethra. The primary neurotransmitter responsible for these effects is norepinephrine. Parasympathetic signals regulating lower urinary tract function originate from neurons in the second, third, and fourth sacral segments. Activation of the parasympathetic nerves results in micturition (bladder evacuation) via direct stimulation of the detrusor muscle and indirectly via opening of the urethral sphincter mechanism.[9] Acetylcholine is the primary neurotransmitter mediating parasympathetic activity in the lower urinary tract. The somatic nervous system innervates the skeletal muscles of the body. Efferent nerves originating from neurons in sacral spinal segments 2 through 4 travel via the pudendal nerve to innervate the striated muscle of the urethral sphincter mechanism (rhabdosphincter), the periurethral striated muscle, and the pelvic floor muscles.[8]

Neurogenic Bladder and SCI

Spinal cord injury adversely affects detrusor muscle function and urethral sphincter, resulting in neurogenic bladder dysfunction.[6] Within minutes after initial injury, the spinal cord swells to fill the spinal canal at the injury level. This swelling inhibits blood flow and oxygenation to the spinal cord tissue. Axons and neural cells are damaged. Bleeding may occur in the central gray matter, possibly spreading to other areas of the spinal cord. These events cause a condition known as spinal shock, lasting from several hours to several weeks. During spinal shock, even undamaged areas of the spinal cord become temporarily disabled, causing inhibition of all reflexes and function below the level of injury and creating an acontractile detrusor.[10] The return of reflex activity, such as the bulbocavernosus reflex, marks the end of spinal shock and may be followed by hyperreflexia, hypertonicity clonus, and neurogenic detrusor overactivity.[11] The extent and the type of damage to the voiding cycle are determined by the location, completeness, and vascular extension of the lesion. Vascular extension refers to ischemic damage to the spinal cord beyond the orthopedic level of injury. A complete injury produces both sensory and motor loss; with an incomplete injury, the person may retain sensation.[5]

Wein[12] classified voiding dysfunction into 4 board categories: (1) failure to store because of the outlet, (2) failure to store because of the detrusor, (3) failure to empty because of the outlet, and (4) failure to empty because of the detrusor.[12] Within the context of SCI, failure to store is typically caused by neurogenic detrusor overactivity, defined as *detrusor contractions* occurring during bladder filling; it typically occurs in injuries that affect spinal segments C2 to S1. Failure to store because of the outlet usually occurs with lower injuries affecting the lumbosacral vertebrae, spinal segments S2–4. Failure to empty because of the outlet may be caused by detrusor-sphincter dyssynergia (DSD) in SCI. *Detrusor-sphincter dyssynergia* is defined as impaired coordination between detrusor muscle contraction and relaxation of the striated sphincter during micturition. As a result, the detrusor muscle and striated sphincter contract at the same time, functionally obstructing the bladder outlet. These problems may present at different points following SCI. Therefore, ongoing assessment and changes in bladder management extends well beyond the initial rehabilitation period.[9]

Complications of the Neurogenic Bladder

Multiple complications can occur when normal innervation to the bladder and urinary sphincter is impaired. Common complications include urinary incontinence, urinary tract infection (UTI), upper urinary tract distress, urinary calculi, autonomic dysreflexia, and bladder cancer.

Urinary Tract Infection

Urinary tract infection is the most common urological complication for the SCI patient. Sepsis, frequently caused by UTIs, is a leading cause of mortality among patients with SCI.[2] Urinary tract infections increase the number of hospital admissions and length of a hospital stay and lead to loss of therapy time.[13] The SCI-related factors that contribute to UTI risk in persons with SCI include (1) incomplete bladder emptying, (2) low bladder wall compliance, and (3) insertion of an indwelling catheter.

Incomplete bladder emptying with micturition allows urine to remain in the bladder and act as a medium for bacterial growth. In patients with DSD, contraction of the striated muscles of the sphincter mechanism creates turbulence during micturition allowing urine to move from the more bacteria-laden distal urethra to the usually sterile proximal urethra, increasing the risk of colonization and UTI.[5]

Low bladder wall compliance also predisposes to upper UTI (pyelonephritis) and urosepsis by creating stasis affecting the entire urinary tract. It is caused by chronic bladder outlet obstruction with deposition of excess collagen in the bladder wall (seen on x-ray as trabeculations), fibrosis of the bladder wall owing to recurring UTI or chronic inflammation, or hypertonicity of the detrusor during bladder filling. Low bladder wall compliance results in sustained elevations of detrusor pressure during bladder filling. This leads to stasis of urinary reflux, dilation of the ureters and (ultimately) the renal pelvis, commonly called ureterohydronephrosis, and vesicoureteral reflux. As a result, bacteria present in the

lower urinary tract are afforded an excellent opportunity to ascend into the upper tracts, predisposing the person to pyelonephritis or even urosepsis. If this situation persists, renal function is compromised, which can cause distension and ischemia of the bladder wall and reflux into the ureters, leading to increased susceptibility to bacterial invasion.

Placement of a long-term indwelling urinary catheter ultimately results in colonization of the lower urinary tract. Patients managed by an indwelling catheter will show significant levels of bacteria in their urine within 72 hours of insertion, and levels of bacteria increase 5% to 8% per day.[14] Within 28 days of catheterization, virtually all patients will have evidence of bacteriuria and form a biofilm that adheres to both intraluminal and extraluminal surfaces of the catheter.[15] Patients who have bacteriuria have a fatality rate of 3 times higher than nonbacteriuric patients.[1] Chronic bacteriuria and inflammation associated with long-term catheterization also increases the risk for low bladder wall compliance.[14,16] Clean intermittent catheterization also increases the likelihood of chronic bacteriuria, but this risk is offset by the benefits gained from regular and complete bladder evacuation without the continued presence of a foreign object in the lower urinary tract created by the presence of an indwelling catheter.

The vast majority of UTIs are caused by organisms common to the bowel and the perineal skin, including gram-negative bacilli and enterococci.[1] As noted above, most people with neurogenic bladders have bacteriuria but they remain free from the symptoms associated with a UTI. Once bacteria invade the bladder wall and trigger an immune response causing symptoms, a UTI is diagnosed.[16] Although asymptomatic bacteriuria is associated with an increased risk of infection, antibiotic treatment is not indicated unless a symptomatic UTI occurs. Morton[17] found that antimicrobial prophylaxis did not significantly decrease symptomatic infections and resulted in twice the amount of antimicrobial-resistant bacteria. Routine urine cultures in healthy asymptomatic patients are also not recommended because this practice may lead to unnecessary treatment of bacteriuria.[18]

Clinicians must be alert in assessing symptoms of UTI in SCI patients since loss of sensation causes symptoms to be atypical. A symptomatic UTI is strongly suspected when 2 or more of the following occur: fever, increased spasticity, autonomic hyperreflexia (sometimes called autonomic dysreflexia), cloudy urine with increased odor, malaise, or lethargy or a sense of unease.[1] One study found that 39% of SCI patients were not able to accurately report a UTI based on their symptoms.[19] Therefore, thorough assessments are always warranted, and urine culture is prudent when vague symptoms are present. Treatment is based on culture and sensitivity results, although a broad-spectrum antibiotic may be initiated pending culture results.[5]

Modifiable UTI risk factors must be addressed when managing the patient with SCI and a neurogenic bladder. Teaching the patient and care providers to use good hygienic measures such as frequent replacement of condom catheters, consistent cleansing of intermittent catheters between uses, and regular changes of urinary containment devices. Waites and Canupp[20] found that men with SCI who have bacteriuria are significantly prone to be colonized in the distal urethra and perineum with the same pathogens present in the urine. Levendoglu[21] found that urethral flora was a significant source for the development of UTI in SCI patients. Overdistension of the bladder should be avoided. Some authors contend that bladder volume should not exceed more than approximately 400 mL.[22] Urine acidifiers such as cranberry juice are sometimes used in an attempt to decrease bacterial colonization of the urine, but studies by Waites[23] and Linsenmeyer[19] found that ingestion of cranberry juice or cranberry products did not significantly diminish bacterial counts. No advantage is noted for patients managed by intermittent catheterization, and insufficient research was found to determine if cranberry ingestion benefits patients with indwelling catheters.[24] Adequate fluid intake is important to maintain urine flow; 1,500 to 2,000 mL per day is a generally recommended amount of fluids. Excessive fluid intake may produce bladder distension and an inadequate intake may increase urine concentration and irritate the bladder wall.[22]

Guidelines for preventing complications of indwelling catheters include avoiding unnecessary catheterization.[25] If an indwelling catheter is deemed necessary, creation of a suprapubic cystostomy site is preferred because it avoids placement of a catheter in the more bacterial urethra.[26] Hampton[15] advises that catheter bags should be kept off of the floor. Indwelling catheters are generally changed every month, but Neuman[27] recommends that changing schedules should be individualized, and that catheter sized 14F to 16F size, with 5 mL retention balloons inflated with 10 mL of sterile water are placed. A larger balloon size is avoided because it tends to irritate the bladder outlet and paradoxically increases, rather than diminishes, the volume of urine retained in the bladder base. Larger catheter sizes are also avoided because they occlude periurethral glands and increase the risk of infection and predispose the person to urethral sphincter incompetence or even urethral erosion. When symptoms occur that raise the suspicion of a UTI, treatment should be based on results of a urine culture. The culture should be obtained after a catheter change since specimens from the old catheter may be misleading.[27]

Deterioration of Renal Function

The most significant urological complication in patients with SCI is renal insufficiency. Hostile neurogenic bladder dysfunction refers to the potential of the bladder to create upper urinary tract distress.[5] Upper urinary tract distress is

defined as *ureterohydronephrosis, vesicoureteral reflux*, and *recurring febrile UTI*, with or without renal insufficiency. Hostile neurogenic bladder dysfunction is diagnosed via urodynamic testing; low bladder wall compliance, combined with obstruction and an elevated detrusor leak point pressure, indicates a high risk for upper urinary tract distress and deterioration of renal function. Other factors that predispose to progressive renal insufficiency include recurring febrile UTI and renal calculi.[28] The treatment of progressive upper urinary tract distress focuses on reversing elevated and sustained intravesical pressures during bladder filling. For many persons with SCI, regular and effective bladder evacuation may be promoted by intermittent catheterization, and elevated intravesical pressures may be further alleviated by administration of antimuscarinic drugs. Quadriplegic men, who are unable to perform intermittent catheterization managed by condom catheterization, may be treated by α-adrenergic blocking agents in an effort to reduce bladder outlet obstruction caused by vesicosphincter dyssynergia. Alternatively, a transurethral sphincterotomy may be performed or a urethral stent placed within the membranous urethra. Patients with severe trabeculation or fibrosis of the bladder wall may be managed by augmentation enterocystoplasty or urinary diversion. A suprapubic catheter may also be placed in selected cases when other options are not feasible or tolerable for the person with an SCI.

Urinary Calculi

Neurogenic bladder dysfunction increases the risk of urinary calculi.[5] Immobility contributes to supersaturation of the urine, and urinary stasis predisposes the person with precipitation of crystals from the urine that can act as the nidus of a urinary calculus. Infectious stones frequently occur in patients with SCI. Bacterial pathogens such as *Proteus, Klebsiella*, and *Pseudomonas* species split urea and predispose the person to triple phosphate (struvite) urinary stones. Urinary calculi act as a safe harbor for bacteria and frequently obstruct the urinary tract, exacerbating stasis and renal pelvic or ureteral dilation, further compromising renal function.

Autonomic Hyperreflexia

Autonomic hyperreflexia is a potentially life-threatening response to an irritating stimulus seen in persons with SCI.[29] The noxious stimulus occurs below the level of injury, resulting in firing of afferent nerves that ascend through tracts in the spinal cord but are blocked by the SCI lesion. The risk of autonomic hyperreflexia is greatest when lesions affect spinal segments T6 or higher. Since the impulse cannot reach the brain, a pathologic response may be activated, which results in global stimulation of the sympathetic nervous system, resulting in contraction of peripheral arterioles resulting in tachycardia and dangerously high blood pressures. The most common irritating stimulus is bladder distension; however, distension of the bowel and sexual activity may also trigger autonomic hyperreflexia. Symptoms include pounding headaches, sweating, chest tightness, and trouble breathing. The treatment is to remain sitting, immediately loosen any tight clothing, and to promptly relieve the source of irritant. Performing a catheterization, unblocking an indwelling catheter, or emptying an overfilled drainage bag are likely to relieve autonomic hyperreflexia associated with bladder distension.[29] If relief is not achieved, immediate care should be sought. People with dysreflexia should be taught to identify potential triggers and prevent their occurrence whenever possible. For the person with an SCI and neurogenic bladder, preventive behaviors may include adherence to a self-catheterization schedule or regular drainage of a leg bag if an indwelling catheter is in place.[30]

Bladder Cancer

The incidence of bladder cancer in SCI patients is 16 to 28 times higher than in the general population, and persons with SCI are at especially high risk for squamous cell carcinomas. Modifiable risk factors include smoking.[31] Marijuana smoking may be more cancer promoting then tobacco, because it has a longer half life (up to 60 hours), it is smoked without a filter, and it reduces bladder contractility, thus increasing exposure of the bladder to potential carcinogens produced when marijuana is smoked.[32] In one study of transitional cell carcinoma, Pannek[33] did not find an overall higher incidence when compared to an able-bodied population, but 60% of the SCI patients presented with advanced stage (muscle infiltrating) tumors. The most prevalent risk factor for bladder cancer that is directly related to the neurogenic bladder of SCI is prolonged use of an indwelling catheter. Groah and colleagues[34] completed a cohort study of 3,670 people with SCI and found that those managed by an indwelling catheter for 12 or more years experienced a 25-fold greater risk of bladder cancer than the general population. This information is essential when WOC nurses and other care providers counsel SCI patients about long-term bladder management options and the importance of routine urologic follow-up. Similar to the general population, any person with SCI who experiences an episode of gross hematuria should undergo evaluation for bladder cancer, unless an alternative cause is identified.[31]

Psychosocial Consequences of Neurogenic Bladder

Scelza and Shatzer[35] report that the suicide rate for SCI patients is 2 to 6 times greater than in the general population. SCI patients with neurogenic bladders are at greater risk for depression than the normal population, and women are at a higher risk than men.[36] Depression in the person with SCI further diminishes quality of life. It may hinder initial recovery and impede adherence to self-care

measures such as self-catheterization. Regular screening for depression scales should be incorporated into ongoing assessment and treatment with antidepressants, coupled with referral to a mental health care provider when indicated.

Sexual function following SCI is a significant concern. The spinal cord-injured population is comparatively young, and 51.8% are single when injured.[2] Fear or embarrassment associated with bladder and bowel accidents may impair sexual activity.[9] A study based in Korea found that men who were able to self-catheterize were twice as sexually active as those who where not.[37] Although adaptation to sexual activities may require time, the WOC nurse can facilitate this process by assisting the patient to master a bladder management program that maximizes independence and continence.

Assessment

The purpose of the urologic evaluation is to assess lower urinary tract function after SCI and its impact on renal function. Once this evaluation is completed, the patient is informed of available management options and the advantages, risks, and anticipated costs of each option. The formulation of a care plan is a collaborative process based on urological concerns related to preservation of renal function and continence, functional assessment including ability to perform self-catheterization, empty a leg bag or manipulate a condom catheter, personal preferences, availability of care providers to assist with bladder management, and economic considerations.

The urologic evaluation of the SCI patient begins with a review of lower urinary tract symptoms and their effect on quality of life. A functional assessment is completed that focuses on dexterity, mobility, and toilet accessibility. Identification of support systems, including care provider during waking and sleeping hours, is completed and consideration of any cultural or religious practices that may influence bladder management.[7] A urinalysis or urine culture is completed when indicated based on knowledge that, unlike community-dwelling persons, asymptomatic bacteriuria is expected for persons with SCI and a neurogenic bladder managed by intermittent or indwelling catheterization. Renal function may be assessed by a serum creatinine. However, creatinine, which is a breakdown product from muscle metabolism, may be decreased in serum levels of SCI patients due to diffuse muscle atrophy. Macdiarmid and colleagues[28] have found that a properly collected 24-hour urine specimen for creatinine clearance is a simple and accurate alternative for assessing renal function.

A urodynamic evaluation, which evaluates bladder filling and micturition, is typically completed after spinal shock has resolved. Renal function may also be evaluated by a radionuclide scan of the kidneys or a renal ultrasound. An intravenous pyelogram is no longer considered a part of a routine urologic evaluation. It is recommended that a renal ultrasound be done yearly on SCI patients because it is accurate, available, noninvasive, and costs less than the renal nuclear scan.[38]

Managing the Neurogenic Bladder Following SCI

Bladder management is an essential element of self-care following SCI and it is based on dual goals of preservation of renal function and social continence. Ineffective strategies for bladder management in the past resulted in high incidence of morbidity and mortality.[39] For example, prior to 1973, renal failure was the leading cause of death in spinal cord–injured patients.[2] In addition to specialized knowledge in continence and complications, the WOC nurse is an advocate who is familiar with industry products and reimbursement issues. The WOC nurse is an educator skilled in incorporating both the patient and care providers into the multiple aspects of rehabilitation. The WOC nurse also acts a resource who can connect the patient and caregivers to community resources, such as local support groups.[40] Most importantly, throughout the recovery process, the WOC nurse possesses knowledge and sensitivity to the physical, cognitive, emotional, cultural, sexual, and economic impact that an SCI has on an individual.[41]

The WOCN Society position statement outlines urinary management to include (1) dietary and fluid management, (2) bowel training or defecation program, (3) scheduled voiding program, (4) indwelling catheter management, (5) intermittent catheterization program management, (6) recommendations regarding containment and absorptive devices and skin care, and (7) education and counseling for patient caregivers.[42] The following discussion is a summary of the urological management options for persons with an SCI. Management options include intermittent catheterization, reflex or trigger voiding, condom catheters, indwelling catheters, and suprapubic catheters. The discussion also reviews common medications and surgical procedures used in the management of neurogenic bladder dysfunction following SCI.

Indwelling Catheters

Indwelling urethral catheters are used in the acute post-trauma phase of recovery but they are not recommended for long-term use due to the high risk for UTI, calculi, urethral erosion, or damage to urethral sphincter incompetence, bladder cancer, and impaired renal function. Despite these risks, there are times when their use is necessary. For example, an indwelling catheter may be placed transiently to promote wound healing and prevent contamination of the wound in patients with stage III or stage IV pressure ulcers in the perineal area.[6] Long-term indwelling catheterization may be used for a quadriplegic woman who lacks sufficient upper limb function in addition to inadequate assistance of a caregiver.[43] In comparison

to urethral catheters, suprapubic catheters are typically preferred because they are associated with a reduced risk of infection and avoid urethral damage.[7] Another potential advantage of the suprapubic catheter is the increased ability to engage in sexual relations.[44] With either insertion site, patients who are dependent on indwelling catheters and their caregivers must be alerted to potential risks, preventive measures, and identification of complications to report in order to preserve renal function and avoid or promptly manage urologic complications.[25]

Intermittent Catheterization

Intermittent catheterization (IC) provides regular, complete bladder evacuation and is one of the safest bladder management programs for SCI patients with neurogenic bladder dysfunction. Weld and associates[44] retrospectively reviewed the medical records of 316 posttraumatic spinal cord–injured patients and concluded that IC greatly reduces the rate of all urological complications when compared to indwelling catheters. In addition, patients benefit from reduced effect on body image and enhanced sexual adjustment, as there are no obvious external drainage systems and the appearance of the genitalia remains unaltered.[5]

Although IC has proved a safe and effective technique for neurogenic bladder management, not all persons with SCI are able to perform self-intermittent catheterization or have the resources of a care provider who can perform the procedure throughout the day. Qualifications for intermittent catheterization education include adequate dexterity of the upper extremities needed to insert a catheter, as well as motivation to regularly perform catheterization.[6] Hindrances to learning self-catheterization include embarrassment, fear of putting a tube inside the body, discomfort associated with catheter insertion for patients with incomplete injuries and preserved urethral sensation, and fear of failure.[13] Teaching begins with providing the patient with a basic understanding of their anatomy and physiology.[45] Women are particularly challenged to adapt to the procedure because it may be difficult to access the urethra while seated in a wheelchair. This challenge is exacerbated by weight gain. Menstruation presents further situational challenges; therefore, the use of tampons is recommended to reduce any hygienic or motivational concerns that may arise.[13]

Important components of instructing intermittent catheterization are product selection, clean technique including cleansing the genital area and hands, insertion of the catheter without urethral trauma, techniques to ensure complete bladder evacuation, catheter removal, cleansing, storage, and reuse. Since persons with SCI have variable impairments affecting upper and lower extremity mobility and dexterity, the plan of care and instruction must be individualized. Physical and occupational therapies are valuable resources to assist the patient achieve success with the procedure.[46] Although intermittent catheterization is associated with a lower risk of serious urologic complications than indwelling catheters, infection and urethral damage are still possible.[45] Sterile technique is not considered necessary, clean intermittent catheterization is adequate provided that good technique is used, and proper care is taken of reusable equipment.[47] Simple soap and water washing and drying and storing in a clean zip lock–type bag are sufficient.[16] For those who are impoverished, Kovindha[48] of Chiang Mai University in Thailand found that silicone catheters may be used for a range of 1 to 7 years with similar outcomes to the use of disposable catheters. Frequency of catheterization should be 4 to 6 times per day.[22]

The ability to maintain clean intermittent catheterization as a bladder management method may change with a patient's circumstance. One study noted that after 15 years, 67% of patients remained indwelling catheterization free, although at each 5-year interval there was an increase in patients who converted to indwelling catheter use.[49] Another study done in Turkey had less success with 52% of patients using IC on discharge reverting to indwelling catheter use by follow-up. Compliance among patients managed by IC was lower for women, for persons with severe spasticity, and for patients who must rely on a caregiver to insert the catheter.[50] Even though IC is associated with fewer urologic complications than other techniques and avoids drainage devices and collection bags, Oh and colleagues[51] found that persons with SCI who manage their bladder with IC report poorer health-related quality of life than able-bodied individuals.

Reflex Voiding With Condom Catheter Containment

Reflex voiding consists of bladder emptying by means of overactive detrusor contractions and urine containment. Contractions can be triggered by various stimulation techniques including squeezing the penis or scrotum, tapping on the suprapubic area, but the majority occur spontaneously in response to a variety of stimuli including intravesical volume and the chemical composition of the urine.[7] Since there are no external containment devices for women, reflex voiding is optional only for men who are able to wear a condom catheter. A condom catheter is a tube-vented condom that depends on a watertight seal for successful use. Product selection is especially important; some condom catheters contain an adhesive applied to its inner surface, while others are by a band or balloon. Counseling patients and care providers about placement and care of a condom catheter includes advice about regular skin inspection and avoiding pressure injuries. Daily condom changes and meticulous skin care are recommended to avoid skin and urinary complications.[5]

Bladder outlet obstruction, usually caused by DSD, increases the risk of UTI, upper urinary tract distress, and autonomic dysreflexia.[7] Several interventions are designed to reduce urethral resistance; they include pharmacotherapy

(using alpha-adrenergic antagonists), transurethral sphincterotomy, or urethral stenting.[5] Intermittent catheterization remains the optimal choice for bladder management in SCI patients, but reflex voiding is a viable option for quadriplegic men who are unable to self-catheterize.

Crede Maneuver

Bladder expression using the Crede maneuver (pushing on the abdomen to forcefully express urine) was historically used in an attempt to promote continence and ensure adequate bladder evacuation. This maneuver is no longer recommended because it raises intravesical pressures against a closed bladder outlet, raising the risk of vesicoureteral reflux, hernia, rectogenital prolapse, and hemorrhoids.[7]

Pharmacotherapy

Antimuscarinics are a class of medications designed to relax the detrusor muscle by selectively blocking acetylcholine from binding to muscarinic receptors in the lower urinary tract. They block overactive detrusor contractions and improve bladder capacity, thus decreasing episodes of incontinence between episodes of IC.[52] They are also used to reduce the sustained high intravesical (detrusor) pressures associated with low bladder wall compliance and reduce the associated risk of upper urinary tract distress. Side effects include dry mouth, constipation, dilated pupils, blurred vision, and central nervous system effects including drowsiness and impaired short-term memory. Paradoxically, the side effect of dry mouth may increase the amount of water consumed, thereby increasing chance of incontinence. This class of medications includes tolterodine, solifenacin, darifenacin, trospium, and oxybutynin. Oxybutynin is available in 3 formulations, an immediate release tablet taken 2 to 3 times daily, an extended release pill taken once daily, and a transdermal patch applied twice weekly. Tolterodine is available as an immediate release tablet taken twice daily or an extended-release capsule taken once daily. Darifenacin and solifenacin are available as tablets taken once daily, and trospium is packaged as a capsule taken twice daily.[53] Tricyclic antidepressants also possess antimuscarinic effects and may also relax the bladder. An example of this type of medicine is imipramine.

Botulinum toxin has been found useful for the treatment of neurogenic detrusor overactivity. It works by inhibiting the release of acetylcholine at the neuromuscular junction and promotes muscle relaxation. Schurch and colleagues[54] found that injecting Botox into the bladder of persons with SCI found to be refractory to oral antimuscarinics partially or entirely alleviated overactive detrusor contractions for as long as 9 months. These patients were able to withdraw or markedly reduce oral or transdermal antimuscarinic drugs. Botulinum toxin is not approved for the treatment of neurogenic detrusor overactivity, but larger clinical trials are underway.

Alpha-adrenergic antagonists selectively block the neurotransmitter noradrenaline (norepinephrine) from binding to alpha-adrenergic receptors in the bladder neck and proximal urethra, reducing urethral resistance during micturition. They may be prescribed as first-line therapy for men with DSD managed by reflex voiding with condom catheter containment. Because alpha-adrenergic receptors are found in the smooth muscle of the arterioles, hypotension is a common side effect. Since many patients with SCI already have low base line blood pressures, they may not be able to tolerate these medications. Four medications in this class are administered most commonly: terazosin, doxazosin, tamsulosin, and alfuzosin.[35] All are administered once daily. Two of the drugs, terazosin and doxazosin, require dosage titration. Alfuzosin and tamsulosin have greater affinity for the alpha-adrenergic receptors found in the urethra rather than those found in arteriolar smooth muscle; they do not require titration but are more expensive.

Botulinum toxin can be injected into the striated muscle of the urethral sphincter mechanism as a treatment of DSD. It provides prolonged relaxation of the striated sphincter muscles without surgery.[55] Injection of botulinum toxin is indicated for men who are dependent on reflex voiding with condom catheter containment.[56]

Surgery

Surgical reconstruction of the lower urinary tract is usually contemplated only when more conservative measures fail to provide adequate continence or preserve upper urinary tract function. Continent or incontinent urinary diversions may be created. The most common incontinent urinary diversion is the ileal conduit. A segment of terminal ileum is isolated from the fecal stream, and one end is sutured closed. The other end is brought through the abdominal wall via a stoma. Ureters are implanted into the new ileal pouch in a refluxing manner. A segment of colon may be substituted for ileum, but this approach is infrequently used because of a higher risk of hyperchloremic acidosis.[57] Stomal complications, such as stenosis, necrosis, retraction, prolapse, or peristomal hernias, are the most common complications of urinary diversion. Other complications include UTI, pyelonephritis, and urinary calculi. Renal deterioration typically occurs over a period of 10 to 20 years.[40] Despite these complications, urinary diversions remain a viable option for highly selected patients with neurogenic bladder and SCI.[58]

Many patients dislike the idea of wearing a urinary pouch. Several surgical procedures have been developed over the last few decades that afford the patient continence and a small stoma that can be covered with a discrete dressing.[57] The individual must be capable of, and committed to, a lifelong IC.[59] Three notable procedures all create an internal urinary reservoir and a continent catheterizable stoma but achieve this in distinct ways. The Kock procedure uses approximately 100 cm of small bowel to form a pouch, with a proximal and distal nipple valve to create

continence. There is a 25% eventual nipple failure rate.[40] The Indiana pouch uses a segment of the small bowel and/or the colon to form the pouch; the ileocecal valve serves as a continence mechanism that prevents the outflow of urine.[59] The Mitrofanoff procedure uses the appendix or ureter to create a continent stoma. The advantages of these procedures include preservation of body image and improved access to a catheterizable stoma when compared to the native urethral meatus. This access is especially significant for women who are often obliged to catheterize while sitting in a wheelchair. Disadvantages of continent urinary diversion procedures are metabolic complications such as hypochloremic metabolic acidosis. Resection of the terminal ileum may cause vitamin B_{12} deficiency and require monthly supplement injections for life.[5] Additionally, the reoperation rate in continent diversions is about twice that of incontinent diversions.[40]

Augmentation cystoplasty preserves the native bladder vesicle but augments its size using a detubularized segment of bowel. It is indicated for patients with refractory neurogenic detrusor overactivity or those with low bladder wall compliance and upper urinary distress. The low-pressure reservoir created by an augmentation cystoplasty promotes continence by ablating or greatly reducing the force of overactive detrusor contractions, and it relieves the sustained elevated pressures present in a low compliant bladder. The dome of the bladder is split and a detubularized segment of bowel is anastomosed. As with other procedures using large segments of the bowel, metabolic acidosis and vitamin B_{12} deficiency are a risk.[60] Nevertheless, Quek[61] and Linder[62] found augmentation cystoplasty to offer long-term clinical and urodynamic improvement in patients with neurogenic bladder dysfunction. It is important to note that ongoing trials are being conducted in tissue engineering and tissue engineered replacement bladders. Engineered bladders are created by selecting autologous cells from the host, expanding the cells in vitro, attaching them to a matrix, and implanting the matrix into the same host.[63] Clinical trials to determine the efficacy of this procedure for the management of patients with SCI and neurogenic bladder are ongoing.

In other cases, transurethral sphincterotomy can relieve high intravesical pressures associated with DSD. A transurethral incision of the external urinary sphincter is completed under cystoscopic guidance. Vapnek and associates[64] found sphincterotomy to be initially effective in decreasing outlet obstruction but they also noted that ongoing term follow-up is necessary to monitor the patient's long-term response. Alternative techniques for transurethral sphincterotomy include laser incision and implantation of a urethral stent.

Conclusion

Persons with an SCI are required to digest a plethora of self-management information during the emotionally and psychologically distressful period immediately following injury. The WOC nurse plays an essential role in assisting the patient to manage neurogenic bladder dysfunction.

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