Neurogenic bladder dysfunction occurs in individuals with spinal cord injury (SCI) and other neurologic disease, affecting the ability of the urologic system to appropriately store and empty urine. This dysfunction is best evaluated with urodynamic studies (Madersbacher, 1999). Urodynamics are invasive studies that involve placement of a urethral catheter and retrograde filling of the bladder, which has the potential of causing a urinary tract infection (Esclarin, Garcia, & Herruzo, 2000) or inducing an episode of autonomic dysreflexia (Linsenmyer, Campagnolo, & Chou, 1996).

Purpose
The purpose of this study was to examine the incidence of symptomatic urinary tract infections (UTI) and autonomic dysreflexia (A/D) associated with urodynamics in a large population of neurogenic patients.

Introduction
Neurogenic bladder occurs in individuals with spinal cord injury and other neurologic diseases. The ability of the urologic system to appropriately store and empty urine is affected and best evaluated with urodynamics.

Objective
A descriptive study of a large neurogenic population studied the incidence of urinary tract infections (UTI) and autonomic dysreflexia (A/D) associated with urodynamics.

Method
A urinary tract infection protocol required collection of a urine culture and sensitivity pre-urodynamics, pre-medication with an antibiotic prior to study, and self-report of signs and symptoms of a UTI within 5 days post-procedure. The A/D protocol required continuous monitoring of blood pressure (B/P) and immediate intervention if B/P >30 mmHg over baseline, sweats, and headache occurred.

Results
626 patients were studied. The incidence of UTI post-urodynamics was <1%. The incidence of A/D during urodynamics was 6% and resolved with immediate intervention.

Conclusion
Using a standardized protocol for urodynamic studies results in a low incidence of UTIs and A/D in a large neurogenic population.

Literature Review
Protection of kidney function is the ultimate treatment goal of urologic management in the SCI population. High bladder storage pressures negatively affect kidney function (McGuire, Woodside, Borden, & Weiss, 1981; McGuire, Noll, & Maynard, 1991). Madersbacher (1999) strongly recommended urodynamics as the most effective means of evaluating individuals with neurogenic bladders in order to plan management strategies that protect kidney function. Urodynamics are invasive tests requiring catheterization and thus carry the risks of iatrogenic UTI and A/D. Theoretically, any stimulation of the lower urinary tract may result in A/D including placement of a urinary catheter, filling the bladder, detrusor contraction, and detrusor sphincter dyssynergia. Linsenmeyer et al. (1996) found patients to have...
symptomatic as well as asymptomatic A/D during urodynamics. Guidelines have been established to guide health care providers in treating A/D (Linsenmeyer et al., 2001). Usually, the simple act of pausing the study and allowing the bladder to accommodate or emptying the bladder will result in A/D subsiding immediately.

Current literature reports varying incidence of UTI associated with urodynamics. Almallah, Rennie, Stone, and Lancashire (2000) concluded that prophylactic antibiotics prior to cystoscopy and urodynamics in the non-SCI population were not necessary unless an individual had an artificial prosthesis. In a study from Canada, women who underwent urodynamic studies were randomized to receive a prophylactic antibiotic treatment or not. No difference in post UTI was seen (Baker, Drutz, & Barnes, 1991). Conversely, Esclarin et al. (2000) found a three-fold increase in UTIs in cervical-level acute SCI patients as opposed to other level of injuries who underwent invasive procedures. They concluded that patients with cervical injuries should receive prophylactic antibiotics. Prophylactic use of antibiotics varies depending on the patient population.

The authors queried institutions within the United States by telephone about what measures they took to prevent UTIs and to control A/D during urodynamics. This revealed a variety of protocols for UTI prophylaxis, most of which included an antibiotic directed towards gram-negative organisms. The dose and frequency varied between institutions and ranged from one dose pre-procedure to 5 days post-procedure. All agreed that if an individual had a symptomatic UTI, antibiotic therapy prior to the urodynamic study was required. Patients with implanted devices at some institutions received a broad-spectrum antibiotic that covered both gram-negative and gram-positive organisms.

None of the institutions recommended routine prophylaxis for A/D (nifedipine). Many, however, monitored B/P during the procedure. At some institutions, individuals who had a history of A/D or a documented hypertensive response during invasive procedures were started on long-acting alpha-adrenergic agents (doxazosin or terazosin) before the study. Current literature and best practice guidelines recommend treatment interventions directed toward the characteristics of the specific patient population. However, additional objective rates and outcomes were unavailable.

Methodology: Procedure

Urinary Tract Infection Protocol. All patients, both SCI and non-SCI, referred for urodynamics were given a prophylactic dose of gentamicin prior to the procedure following collection of a urine specimen. There were three exceptions: (a) patients who were already receiving antibiotics, (b) patients who had recent urine cultures showing organisms resistant to gentamicin, or (c) patients who were allergic to gentamicin. The last two groups were given a single dose of a fluoroquinolone instead of gentamicin. Finally, patients who were clinically symptomatic for a UTI at the time of the procedure were treated with an antibiotic and rescheduled.

Patients and health care providers were instructed verbally and in writing to report any UTI symptoms that occurred after the procedure. Any patients reporting a UTI were clinically evaluated with an examination and repeat urine culture to verify the occurrence. A post-procedure urodynamic infection was defined as clinical symptoms and a urine culture with greater than 100,000 cfu occurring within 5 days post-procedure (Agency for Health Care Policy and Research [AHCPR], 1999). Symptoms included abdominal pain, fever, increased spasms, increased urine leakage, increased autonomic dysreflexia, and change in urine (cloudy, foul smelling, bloody, or milky).

The Autonomic Dysreflexia Protocol. When patients arrived for urodynamics, continuous blood pressure (B/P) monitoring was initiated and maintained throughout the study. If the patient’s blood pressure was elevated (>140/90) prior to the start of the procedure, the procedure was postponed and the patient was referred to the primary care provider. Urodynamics were rescheduled once better control of blood pressure was obtained. For this study, A/D was defined as a B/P >30 mmHg over baseline (Consortium for Spinal Cord Medicine, 2001) and symptoms such as sweats, headache, piloerection, and diaphoresis above the level of the lesion. Symptoms of A/D during the procedure were identified and recorded. If B/P rose to 30 mmHg over baseline, the procedure was stopped and bladder drained.

Results

Sample. From 2000 through 2002, 626 patients (605 males, 21 females; age range 18 to 90 years) with neurogenic bladder underwent urodynamic evaluation. Neurologic diagnoses included 530 spinal cord injured (249 cervical, 225 thoracic, 54 lumbar, 2 sacral), 50 multiple sclerosis, 32 Cauda Equina, 3 Brown Sequard, and 2 Parkinsons. Of the 530 SCI patients, 296 were incomplete injuries, 219 were complete, 63% were outpatient, and 37% were inpatient.

Bladder management for these individuals consisted of self-emptying, clean intermittent catheterization (CIC), external condom catheter with or without sphincterotomy, endourethral stents, bladder augmentation, or sacral nerve stimulation with the Brindley bladder stimulator. Of the 626 patients, pre-urodynamic culture results were available for 568 (90%) (200 positive and 368 negative). Pre-study urine cultures were not processed in 58 patients (10%). Reasons included an empty bladder or laboratory error.

Urinary tract infections. Of the 626 patients, only two developed a post-study UTI, as defined by our criteria, that
resulted in an incidence of <1%. Although symptoms of a UTI were reported in four patients, only two had a positive culture as noted previously. The third patient was treated empirically without a urine culture and the fourth patient had a negative culture and symptoms resolved without antibiotic therapy. The first patient managed his bladder with an external condom catheter and occasional CIC. He had just completed a course of levofloxacin from his primary care provider for a positive urine culture and did not receive a prophylactic dose of gentamicin. A pre-urodynamic culture was not available. He developed a fever 8 hours post-urodynamics and had a positive urine culture at that time. The second patient managed his bladder with CIC and was initially rescheduled due to symptoms and cloudy urine. He was treated with a course of levofloxacin and rescheduled a week later for urodynamics. Pre-study culture was negative and he did not receive gentamicin since he had just completed antibiotics. Two days post-procedure, he developed pain and fever. Diagnostic workup revealed a positive urine culture and a ureteral stone. The third and fourth patients were outpatients and reported symptoms of a UTI to their health care providers and our department. Patient number three reported having symptoms 6 days post-urodynamics, refused to come into the clinic for documentation with urine culture, and was treated empirically with antibiotics by the primary care provider. Patient number four reported to the urgent care center and was examined by a physician. Urine culture collected at that time was negative and the patient was followed without antibiotic treatment. His symptoms of lower abdominal discomfort resolved a few days later.

**Autonomic dysreflexia.** Autonomic dysreflexia occurred in 42 patients for an incidence of 6%, all of which occurred in the high-risk cervical and thoracic SCI injuries. All symptoms resolved with cessation of bladder filling and immediate drainage of the bladder. One patient was given sublingual nifedipine 10 mg to answer a specific question of whether his bladder was causing his A/D. There were no secondary A/D complications noted. All studies were completed.

**Discussion**

The results demonstrate a low incidence in both post-urodynamic UTI and significant AD within a large neurogenic bladder population undergoing urodynamic studies. It is important to point out that the low incidence was obtained using a specific protocol that requires a prophylactic dose of gentamicin in all patients; whether prophylactic antibiotics are needed in asymptomatic patients remains to be answered.

Individuals who manage their bladders with CIC or condom catheters often have asymptomatic bacterial colonization and long-term prophylaxis does not reduce the incidence of symptomatic infections in the populations studied. The need to eradicate these bacteria is not supported in the literature with firm conclusions regarding other risk factors such as instrumentation (AHCPR, 1999). Baker and colleagues (1991), and Almallah et al. (2000) found that use of antibiotics prior to urodynamics did not make a difference in the incidence of UTI in their female non-SCI patient populations. However, Esclarin and colleagues (2000) found an increased risk of UTIs after instrumentation in patients with high-level injuries and recommended antibiotic treatment. The difference between these findings probably lies in the different patient populations: SCI versus non-SCI. A randomized study comparing the utilization of antibiotics versus no antibiotics would address the question of whether antibiotics are needed prior to urodynamics in the SCI population.

Autonomic dysreflexia is known to occur in patients who have a T6 and above spinal cord injury. Catheterization and filling of the bladder during urodynamics may be catalysts for A/D. Results of this study suggest that although 10% of patients do develop AD symptoms, they are readily managed and do not prevent completion of the study. In the authors’ patient population, A/D was easily reversed with simple maneuvers, and with the exception of one patient, all tests were completed safely without need for pretreatment. This allowed for the safe urodynamic study of difficult-to-diagnose cases, directly relating A/D symptoms to bladder filling, and providing a measure of lower urinary tract function. This incidence is consistent with the literature (Linsenmeyer et al., 1996). It is important to be aware of this risk and have a plan on how to treat it when it does occur.

Treatment risks regarding the increasing use of sildenafil and other oral agents for erectile dysfunction by patients with SCI are also significant. Agents such as nitroglycerine, isosorbide dinitrate, or sodium nitroprusside are currently used to treat A/D. If sildenafil has been taken within the previous 24 hours, an alternative short-acting, rapid-onset antihypertensive agent should be used. Longer-acting drugs in the same family may require a longer waiting period (Consortium for Spinal Cord Medicine, 2001).

In this complex, neurogenic patient population, understanding the risks and exploring the clinical symptoms are essential for a clearer explanation of the causative factors.

**Conclusion**

Individuals with neurogenic bladders present added challenges for health care providers. Little research has been done in these areas, and best practice has been the basis for present care. Using a standardized protocol for the urodynamic studies resulted in a low incidence of UTIs and A/D in our neurogenic patient population.
Clinical Implications

To assist with safely performing video-urodynamics in patients with neurogenic bladders, the following are recommended.

- Continuously monitor B/P during urodynamics.
- Develop a standard A/D protocol to follow in the event a patient develops A/D during a procedure.
- Assess patient pre-urodynamics for signs and symptoms of UTI.
- Treat symptomatic UTIs prior to urodynamics.
- Administer a course of prophylactic gram-negative antibiotics to colonized patients according to culture results.
- Use a sterile urodynamic system and aseptic technique for each patient.
- Investigate origin of post-procedure UTIs with an examination and repeat culture.

Individuals will be more willing to undergo video-urodynamics if they know the risks are limited. Attention to practice and outcomes improves care provided to this challenging patient population.

References


