The urologist plays an important role in the multidisciplinary team of physicians who provide care for patients with spina bifida. We review common strategies for managing the urinary tract in these patients. The primary objective in all phases of life is protecting kidney function by minimizing bladder hostility and establishing a good capacity, low-pressure urinary reservoir. Ensuring adequate bladder and bowel continence is also paramount for enhancing self-esteem and independence. Medical therapy incorporating clean intermittent catheterization and antimuscarinic medication is the cornerstone of neurogenic bladder management and often the only intervention required to achieve the above goals. Others may require formal lower urinary tract reconstruction to prevent urinary tract deterioration. As will be shown, current management, while effective, is not supported by strong evidence-based protocols; and the impact of any intervention upon quality of life, while subjectively seen as positive, does not have objective validation. These limitations are recognized and currently the subject of urologic investigation.

PRENATAL INTERVENTION

With improvements in neurosurgical management, the neonatal mortality of SB has declined dramatically, and most patients can be expected to live well into adulthood [Bowman et al., 2001]. Over the last decade, fetal intervention for a number of congenital anomalies has garnered increased enthusiasm, including SB [Kunisaki and Jennings, 2008]. Subsequently, in the late 1990’s, a number of US centers began performing fetal closure of neural tube defects, specifically the myelomeningocele (MMC). Two of these centers, Vanderbilt University and the Children’s Hospital of Philadelphia, separately reported the short-term neurological outcomes of prenatal MMC closure [Adzick et al., 1998; Tulipan and Bruner, 1998]. In these reports, the effect of prenatal closure upon neurological function was inconclusive. However, lower rates of hindbrain herniation and ventriculoperitoneal shunt dependence appeared to be evident. This initial data prompted the National Institutes of Health in 2003 to begin a non-blinded, randomized controlled trial of prenatal MMC closure.
at three US centers titled the Management of Myelomeningocele (MOM’s) Trial. The primary endpoint of the MOM’s Trial is comparing the neurosurgical outcomes of prenatal versus postnatal MMC closure [2009].

Before the inception of the MOM’s trial, urologists at several of the centers performing prenatal MMC closure reported the short-term postnatal urologic outcomes of the procedure. The urodynamic (UDS) bladder evaluation of six patients following prenatal closure at the University of California at San Francisco revealed evidence of abnormal bladder function in all patients, dilatation of the upper urinary tract in five, and the presence of vesicoureteral reflux in three [Holzheimer et al., 2000]. A report from Vanderbilt University also found a similar level of bladder dysfunction during urodynamic testing in 23 patients including elevated bladder storage pressures in 82% of patients [Holzheimer et al., 2000]. Finally, Koh et al. [2006] assessed bladder function using UDS in five patients presenting to their practice after undergoing prenatal MMC closure at outside institutions. The authors found evidence of abnormal external urinary sphincter function and evidence of bladder denervation in all five patients.

The short-term nature of the retrospective data presented in these studies is inherently limited but nonetheless appears to demonstrate minimal urologic improvement following prenatal MMC closure. Because of that, a supplement to the neurosurgical focus of the MOM’s Trial was established to allow study participants to be followed by urologists at each center evaluating the impact of prenatal MMC closure upon bladder function assessing three specific outcomes: (1) the ultimate need for clean intermittent catheterization (CIC), (2) the incidence of urinary tract infection, and (3) the risk of death. The urologic community must await these results before making firm statements about the value of prenatal intervention for SB and its implications for urinary tract function.

NEWBORN AND CHILDHOOD MANAGEMENT

Initial Evaluation and Treatment

The management of the urinary tract in children born with SB begins with prompt evaluation during the neonatal period. Typically, a renal and bladder ultrasound is obtained during the first week of life, preferably after 48 h from birth allowing for time to resolve any neonatal dehydration that may be associated with the trauma of labor and delivery. This initial sonogram provides a baseline for later comparison and can identify early upper tract changes, specifically hydronephrosis that could be due to neurogenic bladder hostility. Prophylactic antibiotics can be initiated at that time and continued until the first lower tract assessment is made. This assessment, typically comprised of a voiding cystourethrogram, serves to identify the presence of vesicoureteral reflux, which has been reported in 20% of newborns with SB [Noyes and Joseph, 2009]. Additionally, it is appreciated that “wet diapers” do not equate with normal bladder activity or synergistic voiding. Because of that, many programs begin proactive CIC, which is typically implemented before closure of the spinal cord defect and continued into the postoperative period. This early use of CIC ensures the maintenance of a low-pressure urinary bladder. The frequency of catheterizations is then adjusted based upon the residual urine volume obtained at each CIC [Stoneking et al., 2001].

The management of the urinary tract in children born with SB begins with prompt evaluation during the neonatal period.

Following repair of the spinal defect, baseline assessment of the lower urinary tract is undertaken and includes either a voiding cystourethrogram and/or lower urinary tract urodynamic evaluation with or without video fluoroscopic views of the bladder. The choice of the modality is based on available resources and institutional philosophy of a proactive approach. The reasoning behind a proactive approach is to identify risk factors based on the UDS findings that identify bladder hostility and/or external urinary sphincter dysfunction and are presumed to adversely influence renal function [Bauer et al., 1984]. Early intervention prevents upper tract changes and may prevent irreversible smooth muscle hypertrophy and fibrosis of the bladder regardless of voiding efficiency. However, although reasonable, there is no scientific evidence to show that a proactive protocol is any more effective than closely following the upper tract for changes and initiating treatment once changes are encountered. The downside to a proactive protocol is the potential for over treating and any inherent risks of that treatment. The downside to a reactive protocol is the potential for patients to develop irreversible renal changes as a result of late intervention. A multi-institutional prospective, randomized study is required to determine the true effectiveness of a proactive approach.

The timing for the initial UDS is also variable; many urologists wait until the infant is several weeks old [Bauer et al., 1984; Edelstein et al., 1995; Kaef er et al., 1999] to diminish lower tract changes due to spinal shock. Retrospective data have shown that children evaluated early in the newborn period are more likely to receive appropriate treatment for hostile bladder function [Kaef er et al., 1999; Kessler et al., 2006]. Such treatment includes the institution of CIC to limit residual urine volumes and anticholinergic therapy to reduce involuntary bladder contractions, both of which over time may lead to bladder and upper urinary tract deterioration.

This type of aggressive management approach has been shown to reduce the need for future bladder surgery in SB patients [Kaef er et al., 1999; Kessler et al., 2006]. Specifically, Kaef er et al. [1999] examined the need for future bladder augmentation surgery in SB patients treated with two different protocols. In patients whom CIC and antimuscarinic were instituted early, bladder augmentation was ultimately necessary in 17%. In patients who were treated after upper urinary tract deterioration developed, augmentation was necessary in 41%. Others have shown similar results when proactive therapy is initiated [Kessler et al., 2006]. Unfortunately, most of the reports supporting proactive treatment are of low-scientific quality and derived almost entirely from retrospective, uncontrolled series.

Tethered Cord

As the infant with SB progresses into childhood, meticulous surveillance of the urinary tract for signs of bladder hostility or upper tract deterioration is required. An important cause for deterioration at this age is the development of secondary spinal cord tethering caused by adhesions between the spinal
the importance of close follow-up and the benefits of serial UDS testing. This holds true for the newborn with apparent normal UDS findings.

A study from Children's Hospital Boston found over 30% of children with initially normal bladder function during newborn UDS assessment will subsequently develop neurourological changes necessitating spinal cord untethering. Postoperatively, 25% showed improvements in bladder function while 75% remained stable [Tarcan et al., 2001]. The need for careful followup of the SB patient cannot be overemphasized. Longitudinal care is best accomplished through multidisciplinary clinics comprised of a variety of resources including rehabilitation specialists, orthopedists, neurosurgeons, and urologists [Hudgins and Gilreath, 2004].

As children progress into late childhood and early adolescence, ensuring social bowel and bladder continence is paramount.

Bowel and Bladder Continence

As children progress into late childhood and early adolescence, ensuring social bowel and bladder continence is paramount. The management of neurogenic bladder was revolutionized in the 1970s when Lapides introduced the concept of CIC [Lapides et al., 1972]. Subsequently, CIC has become a vital tool in the urologist's armamentarium for the nonsurgical management all types of bladder problems. It also provides opportunities for continent urinary reconstruction not previously available. When CIC is combined with antimuscarinic medication, urinary continence has been reported in up to 90% of SB patients [Dik et al., 2006; Lemelle et al., 2006a; Verpooten and Buyse, 2008]. The overwhelming majority of pediatric patients tolerate CIC well with few complications [Campbell et al., 2004; Lindehall et al., 2004, 2007]. CIC is a task that can be performed independently and most children learn to do so between the ages of 8 and 12 years. Children who have been exposed to CIC during infancy tend to gain independence at a younger age. Girls commonly master this task sooner than boys [Campbell et al., 2004; Lindehall et al., 2004, 2007].

Several recent retrospective series have shown long-term pediatric CIC to be safe and effective. Two Swedish studies described the outcomes of patients performing CIC for more than 10 years [Lindehall et al., 2004, 2007]. Of 31 female patients performing over 370 patient-years of CIC, only 20 episodes of difficult catheterization occurred and four patients reported episodes of gross hematuria. In the companion study of 28 males performing over 430 patient-years of CIC, difficult catheterization episodes were reported only 42 times. Notably, the onset of puberty in the males did not lead to any appreciable increase in catheterization complications.

In the natural progression of bladder management with CIC, the initial party performing the task is the parent or caregiver, and with time, the primary responsibility of CIC is transferred to the child. This transition may be accepted by the child in a variety of ways. Lindehall et al. [2008] interviewed 22 adolescent SB patients (median age of 17) who had performed CIC for more than 5 years. They noted universally positive attitudes toward the use of CIC. However, as participants moved into adolescence, they expressed a reluctance to inform peers of their need to perform CIC. Edwards et al. [2004] reviewed 42 children and adolescents aged 7–19 in which more than one-third of subjects found CIC to be an inconvenience in their daily life and expressed difficulty performing CIC while in school.

An under-reported aspect of the natural progression of bladder management is the number of daily CIC on families (see Holmbeck and Devine [2010]). Borzyskowski et al. [2004] evaluated the impact of CIC in 40 patients with a neurogenic bladder, their parents, and siblings. CIC was not a source of emotional trauma for patients or their families. However, many parents reported a dislike for CIC but remained compliant with the procedure. Not surprisingly, one-third of mothers felt that caring for their child with SB diverted attention away from their other children. Of the siblings old enough to “worry,” two-thirds reported worrying about the health of their sibling with SB. In our experience, the institution of CIC at an early age introduces the family to the task and gives them confidence that they can perform it successfully. This prior experience becomes...
beneficial if families need to resume CIC after the neonatal period or following urinary tract reconstruction. Future research in assessing the global family impact of neurogenic bladder management, including CIC, is warranted.

Bladder Reconstruction

In spite of the successes achieved with medical management for neurogenic bladder, a substantial number of SB patients will ultimately require surgical reconstruction of the lower urinary tract to create a less hostile, more effective urinary reservoir [Lemelle et al., 2006a]. Parents and patients must understand the risk associated with reconstruction. Surgical indications for bladder reconstruction vary and include deterioration of the upper tract or persistent incontinence from poor bladder compliance with elevated resting pressures, bladder overactivity, incomplete bladder emptying, and diminished bladder outlet resistance [Scales and Wiener, 2008]. Bladder reconstruction is typically delayed until patients are older than 5 years of age when social continence is more important, and the family and child are willing to accept the responsibility of CIC. Bladder reconstruction may occur at an earlier age in those few children who do not respond to medical management. Under the age of three, this typically results in a temporary vesicostomy. On average, the age for bladder reconstruction has been reported to be between 8 and 12 years [Lendvay et al., 2006; Metcalfe et al., 2006; Snodgrass et al., 2009].

The primary goal for bladder reconstruction is the creation of capacious, low-pressure reservoir. A variety of techniques have been advanced, including augmentation, enterocystoplasty, and autologous augmentation. Augmentation, popularized by Cartwright and Snow, was based on the creation of a “pseudo” bladder diverticulum that would allow for increased capacity and compliance [Cartwright and Snow, 1989a,b]. Although conceptually appealing, long-term results have not supported consistent success [Snow and Cartwright, 1992]. Current reconstructive measures require the use of alternative tissue to improve the urinary reservoir. All tissue has been explored and includes the use of the dilated ureter, small bowel, colon, and stomach [Metcalfe et al., 2006; Husmann and Rathbun, 2008; Pereira et al., 2008]. Studies evaluating the long-term benefits of bladder reconstruction have confirmed the efficacy in reversing upper urinary tract deterioration and improving urinary continence. Pereira et al. [2008] reported 11-year followup in 29 patients following bladder augmentation. Preoperatively, nearly three-fourths of the patients had dilatation of the upper urinary tract due to vesicoureteral reflux and/or hydrourephrosis. Following augmentation, hydrourephrosis resolved in all patients and vesicoureteral reflux resolved in 76% without the need for further surgical intervention. Medel et al. [2002] reported the outcome of 19 incontinent SB patients undergoing bladder augmentation and found 80% of patients free of urinary incontinence episodes at 4-year follow-up.

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Despite these seemingly favorable reports and wide spread acceptance for bladder reconstruction by urologists, enterocystoplasty is supported by surprisingly little controlled data. Reports often compare augmentation studies with populations not limited to SB and are confounded by multiple uncontrolled variables and the lack of standardized terminology. Scales and Wiener [2008] reviewed the published literature on bladder augmentation and revealed that current knowledge is derived entirely from small, single-institution, retrospective series. Their review further observed the limited number of studies that accurately define both the surgical indications and appropriate outcome measures of bladder augmentation. Improved evidenced-based research is required to gain a true scientific perspective on the benefits of bladder augmentation. This need is tempered by the reality that randomized trials of any surgical intervention are difficult to establish, particularly in the pediatric population. Bladder augmentation surgery is not without associated risks, and parents and patients must clearly understand the ramifications of the procedure including the potential for complications and need for further surgery. It is of utmost importance that parents and patients recognize the need for strict compliance with CIC and follow-up before any operative reconstruction. A large, single-center review reported the outcomes of 500 bladder augmentations performed over a 25-year period in patients with SB and neurogenic bladder [Metcalfe et al., 2006]. After mean followup of 13 years, additional operative intervention was necessary in one-third of patients. Life-threatening complications included rupture of the augmented bladder in 8% and bowel obstruction in 3%. Development of bladder stones was noted in 15%, and the need for secondary bladder augmentation due to ineffective improvement in bladder hostility was reported in ~10% [Metcalfe et al., 2006]. This single-center experience has provided important benchmarks that should be used when obtaining informed consent with patients and families regarding potential complications of bladder augmentation.

The concern for the development of a malignancy within the augmented bladder has become a more recent concern in the pediatric population. Concrete data regarding tumor development are lacking, but available evidence suggests that invasive bladder cancer occurs in ~1–2% of patients following augmentation. Two studies support this finding with the median length of followup of 19 and 32 years from augment to tumor development [Soergel et al., 2004; Husmann and Rathbun, 2008]. The role of environmental carcinogens in this process is unclear, and the development of malignancy in the augmented bladder is likely multifactorial. The risk for tumor development can only be expected to increase as followup progresses. Present recommendations suggest that patients should undergo annual bladder cancer screening evaluations beginning 10 years after augmentation cystoplasty [Metcalfe et al., 2006].

Patients with augmentations are also at greater risk for metabolic abnormalities due to the greater permeability of gastrointestinal tissue when compared
with urothelium. A review of the consequences associated with various bowel segments found systemic metabolic acidosis to be the most commonly encountered metabolic derangement regardless of the intestinal tissue used. Various other abnormalities included vitamin B12 deficiency, steatorrhea, hyperammonemia, and osteomalacia have also been noted [Gilbert and Hendle, 2005]. Historically, one concerning aspect of these metabolic derangements has been the potential for growth impairment as a consequence of chronic systemic acidosis. However, recent studies have found that growth rates and bone mineral density in augmented patients are no different from that of controls, and therefore this fear may be overstated [Mingin et al., 2002].

Regenerative tissue engineering has been explored as a potential alternative to traditional bladder augmentation because of the limitations presented. Atala and associates [2006] provide the first results of using a seeded biodegradable construct for augmentation in the neurogenic population. Seven children underwent autologous augmentation. No major complications were reported. This pilot study has led to an industry supported multi-institutional phase II study evaluating the effectiveness of autologous tissue used for augmentation [Joseph et al., 2009]. The study enrolled 11 children, 10 underwent neobladder augmentation. All 10 patients have completed the primary 12-month end point. Results similar to Atala’s initial findings have been encountered. Subjective improvement has been reported by some families but that has not been correlated with objective urodynamic improvement [Joseph et al., 2009]. Although these results remain promising, to date, there is no objective clinical data that support the use of autologous regenerative tissue for bladder augmentation.

Facilitating Independent CIC

As CIC is a critical component of bladder management in many SB patients, the ability to independently perform CIC is important. Unfortunately, a number of patients have difficulty with catheterization of their native urethra due to a variety of factors including previous bladder surgery, manual dexterity, neurological deficit, body habitus, and confinement to a wheelchair. To better facilitate CIC, a continent, catheterizable channel may be created with access from an abdominal stoma. Using operative techniques pioneered by Mitrofanoff, a patient’s appendix can be excised from the cecum and interposed between the abdominal wall and the bladder to create a continent catheterizable bladder channel [Mitrofanoff, 1980]. For patients lacking a suitable appendix, alternative bowel segments have been substituted or a portion of the bladder may be configured into a tube for anastomosis with the skin [Harris et al., 2000; Clark et al., 2002; Casale et al., 2006].

Social continence in the SB patient is not limited to the bladder and urinary control. It is appreciated that attention only to urinary incontinence without addressing bowel continence has significant ramifications related to poor self-esteem, independence, and socialization. Successful management of chronic constipation due to the neurogenic bowel begins with addressing stool composition and constipation. Constipation is a significant source of morbidity for patients. Adherence to diets high in fiber, the use of stool softeners, and the performance of a consistent bowel program comprised various enemas, suppositories, and rectal stimulation are required to maintain normal bowel function and achieve continence.

With principles similar to that of catheterizable bladder channels, Malone and colleagues [1990] described the antegrade continence enema in 1990 to improve the daily management of neurogenic bowel. This allowed for effective clearance of stool from the large colon by providing catheter access to the cecum to be used for the antegrade administration of a tap water enema. Since that time, urologists have embraced this procedure and used a variety of bowel segments to create a continence channel between the abdominal wall and the colon [Clark et al., 2002; Casale et al., 2006; Bani-Hani et al., 2008]. The reported fecal continence rate following the creation of an antegrade continence enema channel ranges from 70 to 90% [Yerkes et al., 2001; Bani-Hani et al., 2008]. The surgical outcomes for catheterizable channels have been favorable, and patient acceptance of these procedures has been high [Yerkes et al., 2003; Bani-Hani et al., 2008]. Yerkes et al. [2001] used a five-point Likert scale to demonstrate that 88% of patients had much improved self-confidence and personal hygiene following creation of an antegrade continence enema. Likewise, a study with mean follow-up of 4.3 years in 50 patients undergoing catheterizable bladder channel surgery noted that 96% were continuing to catheterize their channel daily [Harris et al., 2000]. The most common complication of a bladder or bowel channel is skin-level stenosis of the orifice reported to occur in 5–18% of patients [Harris et al., 2000; Clark et al., 2002; Bani-Hani et al., 2008; Cain et al., 2008]. Stomal leakage from a bladder or bowel channel is rare and occurs in only 2–3% of patients [Harris et al., 2000; Clark et al., 2002; Bani-Hani et al., 2008; Cain et al., 2008]. Regardless of the channel created, or the type of tissue used, patients and their families must be thoroughly counseled before the procedure regarding the importance of diligent compliance with daily catheterizations. Long-term studies have shown that the incidence of infection, stomal stenosis, and surgical revision following creation of a catheterizable channel is significantly more likely to occur in patients who are not compliant with routine follow-up visits and daily catheterization [Clark et al., 2002]. Although these operative procedures are socially enhancing, patient selection and education regarding the principles of catheterization must be carried out wisely.

Social Interaction

As healthy children become young adults, positive social interaction with peers becomes critical for transition as does patient perception of sexual identity. These concerns are also present in the transitioning SB population (see Sawyer and Macnee [2010]). Few published studies have addressed sexuality in the SB patient. Verhoef et al. [2005] found that 70% of SB patients age 16+ SB desired sexual relationship but less than half considered this a satisfactory part of their life. A study of young adults, 15–35 years of age, demonstrated that women with SB were two times as likely to have intercourse as men, and patients with urinary incontinence were 23% less likely to engage in intercourse [Cardenas et al., 2008]. To that end, only a small number of studies have addressed the role of bladder continence upon sexual relationships and even fewer have addressed the role of bowel continence. Lassman et al. [2007] found that the degree of urinary continence mattered little in terms of sexual activity in adult SB patients. Yet, the investigators noted that those patients who were continuously wet were significantly less likely to be sexually active [Lassmann et al.,...
Quality of Life Outcomes

Quality of life (QOL) is intuitively considered to be improved in individuals who have gained social continence. And the outcome related to the impact of urinary reconstruction in the SB population has also garnered considerable attention. However, strong clinical evidence to support this is lacking, and the results of investigations into impact of urinary continence and QOL in SB have been conflicting [Moore et al., 2004; Lemelle et al., 2006b]. In light of these results (see also Sawin and Bellin [2010]), it is increasingly important for surgeons to evaluate and understand how surgical reconstruction of the urinary tract impacts both continence and QOL outcomes, yet only limited retrospective data have thus far shown improvements in QOL following lower urinary tract reconstruction [MacNeily et al., 2005].

Using the PedsQL® 4.0 instrument prospectively administered to SB patients and their parents before and after lower urinary tract reconstruction surgery, Parekh et al. [2008] found significantly lower QOL scores among SB patients when compared with norms for healthy children. Interestingly, scores reported by patients before surgery were significantly higher than those reported by their parents, but this disparity lessened in the postoperative period. QOL was not impacted negatively following surgery, but the authors were unable to demonstrate a true QOL benefit from surgical reconstruction. These findings are similar to the findings of MacNeil et al. [2009]. In their report on 31 consecutive SB patients undergoing urinary tract reconstruction, the authors could not demonstrate any significant changes in health-related QOL. At face value, this limited evidence would suggest that urinary tract reconstruction does little to improve QOL. Urologists must continue to critically evaluate the manner in which operative intervention impacts QOL by using better research methodology and developing better instruments for assessing and capturing these important postoperative outcomes. For those interested in a more detailed review of QOL outcomes data in the SB population, see the article by Sawin and Bellin [2010].

Future Directions

The technological advances of the 20th century have led to an intense interest in the arena of tissue engineering as indicated earlier. Although tissue engineering techniques address the secondary and end organ consequences of SB, other investigators are developing techniques to combat the primary neural dysfunction associated with SB. Xiao et al. [2005] reported their experience with the microsurgical creation of a somatic-autonomic reflex pathway. Building upon their initial results in patients with spinal cord injury, 20 incontinent SB patients underwent the performance of a limited lumbar laminectomy followed by microsurgical anastomosis of lumbar nerve roots and sacral nerve roots. Postoperatively, 17 of the 20 patients were able to initiate volitional voiding by stimulating the L5 dermatome on the thigh. Included among the 17 responders to treatment were 14 patients who were unable to initiate volitional voiding before surgery. The authors additionally noted improvements in bladder sensation following surgery [Xiao et al., 2005]. This work has been followed by a pilot study showing mixed results [Gridler et al., 2009]. Recent NIH support has been received to continue this investigation as a multi-institutional study. A cooperative effort between neurosurgeons and urologists is ongoing to establish a universal protocol to enhance data acquisition and assessment.

As an alternative to chronic anticholinergic therapy for overactive bladder, an emerging body of literature exists for the use of botulinum toxin. When injected directly into the smooth muscle of the bladder, botulinum toxin, a potent neurotoxin, is thought to prevent bladder overactivity and improve bladder compliance by inhibiting acetylcholine release. A recent meta-analysis of six trials, comprised primarily of pediatric SB patients, suggested that botulinum toxin improved continence and lowered bladder pressures to safe levels (<40-cm H2O) [Game et al., 2009]. The promise of this therapy is the elimination of the need for daily medications but may be tempered by its transitory effectiveness. Further insight is needed before this modality is routinely incorporated into the treatment algorithm of neurogenic bladder.

Finally, as pediatric SB patients become adults, urologists must also address how we can improve the transition of care from pediatric specialists to adult specialists. This concern is of particular importance in those young adult patients who have undergone complex urinary tract reconstruction as a child. As we further refine the management of the urinary tract in SB, an adequate system for providing lifelong care into adulthood is critical.

CONCLUSIONS

SB is a multifaceted disease that requires coordinated lifelong care. The urologist should become involved early and remain a part of the patient’s care team for life. The paramount goal of managing the neurogenic bladder is the early establishment and maintenance of a low-pressure urinary reservoir followed by consistent, meticulous long-term care with appropriate intervention when required. Ensuring social continence and subsequent social independence can pose some of the greatest management challenges. In the subset of patients who fail medical therapy, surgeons, caregivers, and patients must understand the implications of urinary tract reconstruction including the need for strict compliance with CIC and the possibility of future surgery. Urologists must continue to critically evaluate the medical and surgical approaches to the
care of SB and move toward improved evidenced-based outcomes.

REFERENCES


