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The AUA/SUFU Guideline on Adult Neurogenic Lower Urinary Tract Dysfunction: Treatment and Follow-up

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Abbreviations and Acronyms

AC = Augmentation cystoplasty
AE = Adverse events
AUAER = American Urological Association
AUS = Artificial urinary sphincter
BNC = Bladder neck closure
CCC = Continent catheterizable channels
CIC = Clean intermittent catherization
CVA = Cerebrovascular accident
LUTS = Lower urinary tract symptoms
MCC = Maximum cystometric capacity
MS = Multiple sclerosis
NLUTD = Neurogenic lower urinary tract dysfunction
OAB = Overactive bladder
PD = Parkinson's disease
PICO = Populations, Interventions, Comparisons, Outcomes
QoL = Quality of life
RCT = Randomized controlled trial
SB = Spina bifida
SCI = Spinal cord injury
SNM = Sacral nerve modulation therapy
SUFU = Society of Urodynamics, Female Pelvic Medicine & Urogenital Reconstruction
SUI = Stress urinary incontinence
UDS = Urodynamic studies
UTI = Urinary tract infection

Purpose: The clinician treating patients with neurogenic lower urinary tract dysfunction (NLUTD) needs to balance a variety of factors when making treatment decisions. In addition to the patient's urologic symptoms and urodynamic findings, other issues that may influence management options of the lower urinary tract include cognition, hand function, type of neurologic disease, mobility, bowel function/management, and social and caregiver support. This Guideline allows the clinician to understand the options available to treat patients, understand the findings that can be seen in NLUTD, and appreciate which options are best for each individual patient. This allows for decisions to be made with the patient, in a shared decision-making manner, such that the patient's quality of life can be optimized with respect to their bladder management.

Materials and Methods: A comprehensive search for studies assessing patients undergoing evaluation, surveillance, management, or follow-up for NLUTD was conducted from January 2001 through October 2017 and was rerun in February 2021 to capture newer literature. The primary search returned 20,496 unique citations. Following a title and abstract screen, full texts were obtained for 3,036 studies. During full-text review, studies were primarily excluded for not meeting the PICO criteria. One hundred eight-four primary literature studies met the inclusion criteria and were included in the evidence base.

Results: This guideline was developed to inform clinicians on the proper evaluation, diagnosis, and risk stratification of adult patients with NLUTD and the non-surgical and surgical treatment options available. Additional statements on urinary tract infection and autonomic dysreflexia were developed to guide the clinician.

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Conclusions: NLUTD patients may undergo non-surgical and surgical treatment options depending on their level of risk, symptoms, and urodynamic findings. Appropriate follow-up, primarily based on their risk stratification, must be maintained after treatment.

Key Words: neurogenic bladder (or neurogenic lower urinary tract dysfunction), intermittent catheterization, indwelling catheter, botulinum toxin, anticholinergic, beta-3 agonist, urinary diversion, bladder augmentation

INTRODUCTION

The term neurogenic lower urinary tract dysfunction (NLUTD) refers to abnormal function of either the bladder, bladder neck, and/or its sphincters related to a neurologic disorder. Prior terminology commonly used "neurogenic bladder" to describe this condition. With the understanding this is not just an issue confined to the bladder, NLUTD is the preferred way to describe the various voiding issues seen in patients with a neurologic disorder. In addition to lower urinary tract symptoms (LUTS), such as urinary incontinence and retention, patients with NLUTD may experience recurrent urinary tract infection (UTI) and autonomic dysreflexia, which this Guideline will address. Non-urinary conditions such as sexual dysfunction, infertility, and bowel dysfunction are also common in patients with NLUTD but are not within this Guideline's scope. Lastly, this is a Guideline for adult patients with NLUTD; pediatric NLUTD will not be discussed.

GUIDELINE STATEMENTS

Non-Surgical Treatment

STATEMENT THIRTY-TWO: Clinicians may recommend pelvic floor muscle training for appropriately selected patients with NLUTD, particularly those with multiple sclerosis or cerebrovascular accident, to improve urinary symptoms and quality of life measures. (*Conditional Recommendation; Evidence Level: Grade C*)

Pelvic floor exercise reliably enhances strength and endurance of pelvic floor muscles across diverse patient groups. Improvements in the pelvic floor musculature were associated with reduction of LUTS and may be correlated with improvements on various quality of life (QoL) questionnaires. Due to the minimal associated risks, the Panel recommends engaging appropriate patients with pelvic floor physiotherapy as they may demonstrate benefit for their LUTS.

STATEMENT THIRTY-THREE: Clinicians may recommend antimuscarinics, or beta-3 adrenergic receptor agonists, or a combination of both, to improve bladder storage parameters in NLUTD patients. (*Conditional Recommendation; Evidence Level: Grade C*)

STATEMENT THIRTY-FOUR: Clinicians may recommend alpha-blockers to improve voiding parameters in NLUTD patients who spontaneously void. (*Conditional Recommendation; Evidence Level: Grade C*)

Antimuscarinics reliably increase maximum cystometric capacity (MCC) and voided/catheterized volumes, decrease detrusor pressure, and may improve urgency and incontinence across diverse NLUTD pathologies. There is no evidence for the superiority of any particular medication.

The Panel advocates a shared decision-making process with the patient to discuss the benefits of therapy balanced with the data reflecting anticholinergic use and potential cognitive decline or development of dementia. In selected NLUTD patients, use of anticholinergic agents less likely to cross the blood-brain barrier may be appropriate. Emerging, and therefore less robust, evidence exists for use of the more recently approved beta-3 agonist in the NLUTD population. Additional evidence suggests that the use of alpha-blockers combined with antimuscarinics can ameliorate symptoms across several etiologies of NLUTD.

Many practitioners employ combination therapy with anticholinergic and beta-3 adrenergic receptor agonists based upon data from non-neurogenic overactive bladder (OAB) patients.[1] After shared decision-making with the patient regarding risks and benefits, concomitant therapy with beta-3 adrenergic receptor agonists and antimuscarinics presents a reasonable treatment option.

Available information suggests intravesical oxybutynin reliably provided functional improvements in urodynamic (UDS) parameters with associated decrease in incontinence episodes.

STATEMENT THIRTY-FIVE: Clinicians should recommend intermittent catheterization rather than indwelling catheters to facilitate bladder emptying in patients with NLUTD. (*Strong Recommendation; Evidence Level: Grade C*)

The risk profile and possible complications associated with an indwelling catheter favors recommendation for intermittent catheterization (CIC), acknowledging that CIC may not always be feasible but should be preferred when the capability exists.[2,3]

Hydrophilic catheters may be associated with lower rates of UTI and urethral trauma than other

catheter types, specifically among spinal cord injury (SCI) patients. Suprapubic catheters are associated with higher rates of bladder stones than CIC or urethral catheters. Poorer QoL is associated with indwelling catheters and the need to have CIC performed by a caregiver; the best QoL is associated with the ability to self-catheterize. For the three methods of catheter utilization (CIC, indwelling urethral, and suprapubic catheter) pooled data regarding the percent of patients who experienced UTI during the follow-up periods favors CIC.[4]

STATEMENT THIRTY-SIX: For appropriately selected NLUTD patients who require a chronic indwelling catheter, clinicians should recommend suprapubic catheterization over an indwelling urethral catheter. (*Strong Recommendation; Evidence Level: Grade C*)

Although existing literature was composed of observational studies limited by small sample sizes, variable reporting of follow-up duration, and contradictory rates of adverse events (AEs), the Panel interpreted these data, along with shared experience of catheter management. to favor suprapubic catheterization.[5,6] Although the Panel recognizes that progression to urinary diversion other than suprapubic catheter may be ideal, often such procedures may be unfeasible due to high morbidity from prior abdominal interventions or not desired by the patient.

STATEMENT THIRTY-SEVEN: In NLUTD patients who perform clean intermittent catheterization with recurrent urinary tract infection, clinicians may offer oral antimicrobial prophylaxis to reduce the rate of urinary tract infections following shared decision-making and discussion regarding increased risk of antibiotic resistance. (*Conditional Recommendation; Evidence Level: Grade C*)

Antibiotic prophylaxis has been shown to reduce the rate of UTI in NLUTD patients who perform CIC.[7–9] Concerns regarding the use of antimicrobial prophylaxis include the development of antimicrobial resistance and the potential side effects of the medication.[10] Shared decision-making and full discussion regarding the potential harms related to acquiring an antibiotic resistant infection should be factored into the decision for antibiotic prophylaxis for UTI prevention.

STATEMENT THIRTY-EIGHT: In NLUTD patients who perform clean intermittent catheterization with recurrent urinary tract infection, clinicians may offer bladder instillations to reduce the rate of urinary tract infections. (*Expert Opinion*)

The body of evidence regarding bladder instillations to reduce the rate of UTI is limited due to the quantity, quality, and design of the studies in addition to the heterogeneity of the population, type of bladder management, and instillation solution utilized. There were insufficient studies and inadequate evidence for any single strategy to reduce the rate of UTI in NLUTD patients. One observational, retrospective study demonstrated fewer symptomatic UTIs after gentamicin instillation in NLUTD patients who perform CIC.[11]

STATEMENT THIRTY-NINE: Clinicians may counsel NLUTD patients with recurrent urinary tract infection who use various forms of catheter management that cranberry extract has not been demonstrated to reduce the rate of urinary tract infections. (*Conditional Recommendation; Evidence Level: Grade B*)

Several randomized controlled trials (RCTs) evaluated the effectiveness of cranberry to reduce the rate of urinary tract infections.[12–15] Despite the heterogeneous patient population, bladder management method, cranberry dose, and outcome measures studied, the results were consistent across all but one trial demonstrating that cranberry does not reduce the rate of UTIs in NLUTD patients.

STATEMENT FORTY: In NLUTD patients with spinal cord injury or multiple sclerosis refractory to oral medications, clinicians should recommend onabotulinumtoxinA to improve bladder storage parameters, decrease episodes of incontinence, and improve quality of life measures. (*Strong Recommendation; Evidence Level: Grade A*)

In NLUTD patients with SCI or multiple sclerosis (MS), intradetrusor injections of onabotulinumtoxinA reduces incontinence episodes, increases MCC, and decreases maximum detrusor pressure compared to placebo groups. UDS parameters as well as QoL outcomes also generally demonstrated improvement. There are no differences in efficacy between the 200 U and 300 U dose; however, there is an increasing dose-dependent relationship regarding risk of retention and need for CIC. In patients with SCI or MS, repeated intradetrusor injections of onabotulinumtoxinA restore the improvements experienced with the first set of injections and efficacy does not appear to diminish with repeat treatment in most patients.[16,17]

STATEMENT FORTY-ONE: In NLUTD patients, other than those with spinal cord injury and multiple sclerosis, who are refractory to oral medications, clinicians may offer onabotulinumtoxinA to improve bladder storage parameters, decrease episodes of incontinence, and improve quality of life measures. (*Conditional Recommendation; Evidence Level: Grade C*)

The evidence level regarding onabotulinumtoxinA in NLUTD patients who are refractory to oral medications is Grade A for SCI and MS patients. There are insufficient high-quality, adequately

powered trials available to make the same recommendation for patients with non-MS and non-SCI conditions of NLUTD such as Parkinson's Disease (PD), cerebrovascular accident (CVA), spina bifida (SB), and others.[18] Based upon the small sample sizes of RCTs evaluating the use of onabotulinumtoxinA with other conditions (non-MS and non-SCI) and the limitations of the observational studies reviewed (small sample size, bias, and lack of long-term follow-up), the body of evidence strength for onabotulinumtoxinA in NLUTD with non-SCI or non-MS conditions is Grade C. The balance between clinical benefits of onabotulinumtoxinA and risk of treatment in this population is unclear; clinicians may offer onabotulinumtoxinA to NLUTD patients refractory to oral medications to improve bladder storage parameters, decrease episodes of incontinence, and improve QoL measures.

STATEMENT FORTY-TWO: In NLUTD patients who spontaneously void, clinicians must discuss the specific risks of urinary retention and the potential need for intermittent catheterization prior to selecting botulinum toxin therapy. (*Clinical Principle*)

One of the most common AEs after onabotulinumtoxinA injections is incomplete bladder emptying or urinary retention, which may require a period of bladder catheterization. Reports from single injection RCTs involving NLUTD patients revealed a urinary retention rate range of 2.6 − 54% for the onabotulinumtoxinA treatment groups, and 1.9 − 5.0% for the placebo treatment groups. A meta-analysis by Yuan et al.[17] reviewed six placebo-controlled RCTs and indicated that onabotulinumtoxinA is significantly associated with the likelihood of having urinary retention (OR = 6.80; 95% CI: 3.46 to 13.35; $p<0.05$).[17] The meta-analysis by Li et al. reviewed 17 studies and noted a urinary retention rate of 20.49% (n=150) for onabotulinumtoxinA and 3.67% (n=15; $p<0.00000$) for placebo.[16] Clinicians must discuss the specific risks of urinary retention and the potential need for intermittent catheterization prior to selecting botulinum toxin therapy, consistent with Statement 18 in the *Diagnosis and Treatment of Non-Neurogenic Overactive Bladder (OAB) in Adults: an AUA/SUFU Guideline*.[19]

Surgical Treatment

STATEMENT FORTY-THREE: Clinicians may offer sphincterotomy to facilitate emptying in appropriately selected male patients with NLUTD but must counsel them of the high-risk of failure or potential need for additional treatment or surgery. (*Conditional Recommendation; Evidence Level: Grade C*)

Although detrusor relaxation with oral anticholinergic treatment in combination with CIC is the primary way to treat NLUTD patients with detrusor sphincter dyssynergia due to SCI,20 external urethral sphincterotomy may be performed in patients who are unwilling or unable to perform CIC. While sphincterotomy is irreversible, patients who experience reflex voiding, can maintain urinary drainage and containment with a condom catheter, and have poor hand function or an unwillingness to perform CIC are appropriate candidates for the procedure. Sphincterotomy can increase the effectiveness of bladder emptying, decrease UTIs, and preserve upper urinary tract function.[20] However, patients must be counseled that this procedure requires regular follow-up and repeat procedures may be required.[21]

STATEMENT FORTY-FOUR: Clinicians may offer urethral bulking agents to NLUTD patients with stress urinary incontinence but must counsel them that efficacy is modest and cure is rare. (*Conditional Recommendation; Evidence Level: Grade C*)

Before considering treatment with a bulking agent for stress urinary incontinence (SUI) in patients with NLUTD, patients must be counseled that while bulking agents are a minimally invasive treatment option with low-risk for AEs, there is a paucity of literature that has evaluated this treatment in this particular patient population, success rates are not high, and long-term outcomes are poor.[22]

STATEMENT FORTY-FIVE: Clinicians should offer slings to select NLUTD patients with stress urinary incontinence and acceptable bladder storage parameters. (*Moderate Recommendation; Evidence Level: Grade C)*

Slings should be considered for NLUTD patients with SUI who can spontaneously void.[23] Assessment of bladder storage parameters with UDS should be performed prior to any SUI procedure in patients with relevant NLUTD where bladder compliance could be worsened by an outlet procedure, resulting in elevated storage pressures and risk to the upper urinary tracts. If there is concern for the future need for CIC, then consideration should be given to autologous fascia or other biologic grafts.

STATEMENT FORTY-SIX: Clinicians may offer artificial urinary sphincter to select NLUTD patients with stress urinary incontinence and acceptable bladder storage parameters. (*Conditional Recommendation; Evidence Level: Grade C)*

Artificial urinary sphincter (AUS) demonstrates significant improvements in SUI in select male and female patients with NLUTD.[24–26] While AUS has been demonstrated to be successful in managing SUI, the risk of voiding dysfunction and the possibility of requiring CIC after AUS placement should

be considered and discussed. Assessment of bladder storage parameters with UDS should be performed prior to any AUS placement in patients with relevant NLUTD where bladder compliance could be worsened by an outlet procedure, resulting in elevated storage pressures and risk to the upper urinary tracts. This is particularly applicable to patients with moderate- or high-risk NLUTD. In addition, adequate upper extremity function to allow for AUS manipulation needs to be confirmed prior to proceeding with implantation.

STATEMENT FORTY-SEVEN: After a thorough discussion of risks, benefits, and alternatives, clinicians may offer bladder neck closure and concomitant bladder drainage methods to select patients with NLUTD and refractory stress urinary incontinence. (*Expert Opinion*)

Bladder neck closure (BNC) for bladder outlet incontinence is an irreversible procedure and is an option for patients who are refractory to any other form of urethral reconstruction due to prior interventions that may have injured the bladder neck or external sphincter, or who have severe urethral pathologies, such as strictures or urethrocutaneous fistula.[27] Although BNC is associated with continence rates of 75 − 100%, fistulization with recurrent incontinence can occur in up to 25% of cases.[28,29] Assessment of bladder storage parameters with UDS should be performed in patients with relevant NLUTD where bladder compliance could be worsened by an outlet procedure such as BNC, resulting in elevated storage pressures and risk to the upper urinary tracts.

STATEMENT FORTY-EIGHT: Clinicians may offer posterior tibial nerve stimulation to select spontaneous voiding NLUTD patients with urgency, frequency, and/or urgency incontinence. (*Conditional Recommendation; Evidence Level: Grade C)*

Posterior tibial nerve stimulation is approved for patients with non-neurogenic OAB; however, it has been shown to offer benefit to select patients with NLUTD where bladder problems are mainly isolated to storage symptoms. This benefit has primarily been demonstrated in patients with neurologic diagnoses such as MS, PD, and CVA who have OAB symptoms and continue to volitionally void.[30,31]

STATEMENT FORTY-NINE: Clinicians may offer sacral neuromodulation to select NLUTD patients with urgency, frequency, and/or urgency incontinence. (*Conditional Recommendation; Evidence Level: Grade C)*

While the data is limited, several studies have reported on the success of sacral neuromodulation (SNM) in pools of mixed NLUTD, including MS, CVA, PD, cerebral palsy, acquired brain injuries, viral and vascular myelitis, encephalitis, central nervous system tumors, Friedreich ataxia, dysautonomia, incomplete SCI, multiple system atrophy, and spinocerebellar atrophy. Observational studies demonstrate improvements in urinary incontinence, urgency episodes, MCC, voided volumes, and urinary frequency. AEs included mainly infections and device malfunction, some of which required explanation.[32]

STATEMENT FIFTY: Clinicians should not offer sacral neuromodulation to NLUTD patients with spinal cord injury or spina bifida. (*Moderate Recommendation; Evidence Level: Grade C)*

SNM should not be used in patients with NLTUD due to SCI or SB due to the high variability in the bladder dysfunction and the disease processes themselves. Studies have shown SNM may improve various outcomes in patient with SCI and SB including incontinence, chronic urinary infections, and upper tract protection; however, these were heterogenous clinical situations and subsequent revisions and other procedures were also required.[33,34]

STATEMENT FIFTY-ONE: Clinicians may offer augmentation cystoplasty to select NLUTD patients who are refractory to, or intolerant of, less invasive therapies for detrusor overactivity and/or poor bladder compliance. (*Conditional Recommendation; Evidence Level: Grade C*)

Augmentation cystoplasty (AC) is the most common reconstructive procedure for managing NLUTD when bladder capacity, bladder compliance, or destrusor overactivity is refractory to medications or botulinum toxin. AC is associated with high rates of continence and upper urinary tract protection.[35] Prior to proceeding with AC, patients with NLUTD must be made aware of the potential long-term risks (eg, stones, perforation, bowel dysfunction, mucus production) and the need for life-long follow-up after lower urinary reconstruction. In addition, the hand and cognitive function necessary to perform regular CIC must be assessed and be present by either the patient or a family member/caregiver that would conceivably be able to perform this on a regular basis.

STATEMENT FIFTY-TWO: Clinicians may offer continent catheterizable channels, with or without augmentation, to select NLUTD patients to facilitate catheterization. (*Conditional Recommendation; Evidence Level: Grade C*)

Continent catheterizable channels (CCC) may be offered to NLUTD patients who are able to perform self-catheterization but have a devastated urethra

that cannot be catheterized (eg, urethral stricture, perineal pressure ulcer eroding into the urethra) or require BNC closure (ie, complete loss of the urethra due to a chronic indwelling urethral catheter).[36,37] An additional indication would be patients with normal hand dexterity and urethral function who prefer a CCC due to ease of catheterization. Preoperative counseling is required before any CCC surgery to advise the patient on potential complications, expectations, and outcomes. This is especially important for patients with cognitive and/or upper extremity limitations.

STATEMENT FIFTY-THREE: Clinicians may offer ileovesicostomy to select patients with NLUTD and must counsel them on the risks, benefits, alternatives, and the high-risk of needing additional treatment or surgery. (*Conditional Recommendation; Evidence Level: Grade C)*

Ileovesicostomy is an option for patients unable to perform self-catheterization secondary to poor hand function, immobility, challenging body habitus, or condom catheter-induced skin breakdown. The goal of ileovesicostomy is to allow for low pressure storage via a urostomy while avoiding the need for a ureteroenteric anastomoses. However, there is a concern that with longer follow-up, patients have increased risk for requiring revision or alternate surgery to facilitate urinary drainage.[38–40]

STATEMENT FIFTY-FOUR: Clinicians should offer urinary diversion to NLUTD patients in whom other options have failed, or are inappropriate, in order to improve long-term quality of life. (*Moderate Recommendation; Evidence Level: Grade C*)

Incontinent or continent urinary diversion for end-stage bladder or urethral dysfunction, intractable fistula, or non-healing decubitus ulceration is indicated when all other options fail to provide safe and adequate storage of urine. Careful counseling is required for both types of urinary diversion and consideration of upper extremity and hand function, along with assessment of the patient's social and home environment for support, is imperative. Given the delayed complication rate of 21-50% for patients undergoing supravesical diversion, cystectomy should be considered at the time of reconstruction.[41,42]

STATEMENT FIFTY-FIVE: Other potential treatments for NLUTD should be considered investigational and patients should be counseled accordingly. (*Expert Opinion*)

Use of non-standardized options for the treatment of NLUTD should be limited due to their infancy in development or lack of adequate outcomes data supporting their use and should only be performed in the context of a well-designed clinical trial.

Follow-up and post treatment

STATEMENT FIFTY-SIX: In NLUTD patients with impaired storage parameters and/or voiding that place their upper tracts at risk, clinicians should repeat urodynamic studies at an appropriate interval following treatment. (*Expert Opinion*)

Subgroups of patients with neurological disorders affecting bladder function are at risk for upper tract damage, particularly if elevated bladder storage pressures remain untreated. Efforts aimed at reducing intravesical pressures should be assessed for their effectiveness, which is most readily done by repeat multichannel UDS. An interval of two years or less in those at risk is reasonable once pressures have been normalized; however, decreased frequency of testing is possible if the patient remains clinically stable. Providers following NLUTD patients with impaired storage pressures must be aware of concerning UDS findings and other high-risk parameters (i.e., neurologic etiology, hydronephrosis, loss of renal function) and re-evaluate the patient at appropriate intervals.

STATEMENT FIFTY-SEVEN: In NLUTD patients with impaired storage parameters that place their upper tracts at risk and are refractory to therapy, clinicians should offer additional treatment. (*Expert Opinion*)

The goal of therapy directed at elevated storage pressures is to improve upper tract drainage which should serve several goals, the most important of which are to preserve renal function and reduce the risk of recurrent symptomatic UTIs. When that is not accomplished by initial efforts, additional interventions should be offered. Stepwise therapy based on invasiveness is reasonable, as long as repeated UDS are conducted to assess effectiveness at appropriate intervals. For patients refractory to all therapies, constant urinary drainage should be strongly considered.[40,43,44]

STATEMENT FIFTY-EIGHT: In NLUTD patients who have undergone lower urinary tract reconstruction incorporating a bowel segment(s), the clinician should assess the patient annually with:

a. focused history, physical exam, and symptom assessment.
b. basic metabolic panel.
c. urinary tract imaging.
(*Expert Opinion*)

As with any patient undergoing lower urinary tract reconstruction, those with NLUTD require lifelong surveillance as complications are not uncommon. Many of these patients may have some

degree of pre-existing renal dysfunction or have a prior history of recurrent UTIs. Patients who previously underwent bladder augmentation using bowel, or those with history of either continent or incontinent diversion, may be at risk for metabolic disturbances depending on the degree of pre-existing renal dysfunction, the presence of co-morbidities, the length and type of bowel segment utilized, and the type of diversion created.[45,46] At a minimum, the Panel recommends lifelong surveillance with annual history and assessment of any symptoms potentially related to the urinary tract reconstruction (i.e., incontinence, infections, hematuria), physical examination, basic metabolic panel and urinary tract imaging.

STATEMENT FIFTY-NINE: Clinicians may perform urodynamics following sphincterotomy to assess outcome. (*Conditional Recommendation; Evidence Level: Grade C)*

Sphincterotomy has been found to be an effective treatment for patients with detrusor sphincter dyssynergia and elevated storage pressures, particularly in the setting of SCI.[47] In particular, sphincterotomy has been shown to lower the risk of renal damage[48] and recurrent bladder infections, presumably by decreasing detrusor leak point pressures. To assess the efficacy of sphincterotomy and document the reduction in intravesical storage pressures, multichannel UDS is recommended in the postoperative period.[49] Since the long-term data for sphincterotomy indicates that impaired bladder emptying and elevated intravesical pressures can recur following treatment, sometimes insidiously, ongoing monitoring of both upper and lower urinary tract emptying and bladder storage pressures is appropriate.

STATEMENT SIXTY: In NLUTD patients who have undergone lower urinary tract reconstruction utilizing bowel, and who also develop gross hematuria or symptomatic recurrent urinary tract infection, clinicians should perform cystoscopy. (*Moderate Recommendation; Evidence Level: Grade C*)

The role of routine surveillance cystoscopy in the asymptomatic, stable NLUTD patient is not supported by current literature. However, the role of endoscopic evaluation in NLUTD patients who have undergone lower urinary tract reconstruction utilizing a bowel segment, such as AC, remains controversial.[50] It is now recognized that lower urinary tract malignancy in NLUTD patients with lower urinary tract reconstruction utilizing bowel almost always present with signs and symptoms such as gross hematuria, unexplained recurrent UTI or suprapubic pain. In NLUTD patients who present with these signs and/or symptoms, a full evaluation including cystoscopy, urine cytology, and computerized tomography scan of the abdomen and pelvis is warranted.

REFERENCES

1. Kelleher C, Hakimi Z, Zur R et al: Efficacy and tolerability of mirabegron compared with antimuscarinic monotherapy or combination therapies for overactive bladder: A systematic review and network meta-analysis. Eur Urol 2018; **74:** 324.
2. Moore KN, Fader M and Getliffe K: Long-term bladder management by intermittent catheterisation in adults and children. Cochrane Database Syst Rev 2007: CD006008.
3. Rognoni C and Tarricone R: Intermittent catheterisation with hydrophilic and non-hydrophilic urinary catheters: Systematic literature review and meta-analyses. BMC Urol 2017; **17:** 4.
4. Krebs J, Wollner J and Pannek J: Risk factors for symptomatic urinary tract infections in individuals with chronic neurogenic lower urinary tract dysfunction. Spinal Cord 2016; **54:** 682.
5. Ahluwalia RS, Johal N, Kouriefs C et al: The surgical risk of suprapubic catheter insertion and long-term sequelae. Ann R Coll Surg Engl 2006; **88:** 210.
6. Cronin CG, Prakash P, Gervais DA et al: Imaging-guided suprapubic bladder tube insertion: Experience in the care of 549 patients. AJR Am J Roentgenol 2011; **196:** 182.
7. Fisher H, Oluboyede Y, Chadwick T et al: Continuous low-dose antibiotic prophylaxis for adults with repeated urinary tract infections (antic): A randomised, open-label trial. Lancet Infect Dis 2018; **18:** 957.
8. Poirier C, Dinh A, Salomon J et al: Prevention of urinary tract infections by antibiotic cycling in spinal cord injury patients and low emergence of multidrug resistant bacteria. Med Mal Infect 2016; **46:** 294.
9. Salomon J, Denys P, Merle C et al: Prevention of urinary tract infection in spinal cord-injured patients: Safety and efficacy of a weekly oral cyclic antibiotic (woca) programme with a 2 year follow-up–an observational prospective study. J Antimicrob Chemother 2006; **57:** 784.
10. Morton SC, Shekelle PG, Adams JL et al: Antimicrobial prophylaxis for urinary tract infection in persons with spinal cord dysfunction. Arch Phys Med Rehabil 2002; **83:** 129.
11. Cox L, He C, Bevins J et al: Gentamicin bladder instillations decrease symptomatic urinary tract infections in neurogenic bladder patients on intermittent catheterization. Can Urol Assoc J 2017; **11:** E350.
12. Waites KB, Canupp KC, Armstrong S et al: Effect of cranberry extract on bacteriuria and pyuria in persons with neurogenic bladder secondary to spinal cord injury. J Spinal Cord Med 2004; **27:** 35.
13. Gallien P, Amarenco G, Benoit N et al: Cranberry versus placebo in the prevention of urinary infections in multiple sclerosis: A multicenter, randomized, placebo-controlled, double-blind trial. Mult Scler 2014; **20:** 1252.
14. Hess MJ, Hess PE, Sullivan MR et al: Evaluation of cranberry tablets for the prevention of urinary tract infections in spinal cord injured patients with neurogenic bladder. Spinal Cord 2008; **46:** 622.
15. Linsenmeyer TA, Harrison B, Oakley A et al: Evaluation of cranberry supplement for reduction of urinary tract infections in individuals with neurogenic bladders secondary to spinal cord injury. A prospective, double-blinded, placebo-controlled, crossover study. J Spinal Cord Med 2004; **27:** 29.

16. Li GP, Wang XY and Zhang Y: Efficacy and safety of onabotulinumtoxina in patients with neurogenic detrusor overactivity caused by spinal cord injury: A systematic review and meta-analysis. Int Neurourol J 2018; **22:** 275.

17. Yuan H, Cui Y, Wu J et al: Efficacy and adverse events associated with use of onabotulinumtoxina for treatment of neurogenic detrusor overactivity: A meta-analysis. Int Neurourol J 2017; **21:** 53.

18. Ehren I, Volz D, Farrelly E et al: Efficacy and impact of botulinum toxin a on quality of life in patients with neurogenic detrusor overactivity: A randomised, placebo-controlled, double-blind study. Scand J Urol Nephrol 2007; **41:** 335.

19. Lightner DJ, Gomelsky A, Souter L et al: Diagnosis and treatment of overactive bladder (non-neurogenic) in adults: Aua/sufu guideline amendment 2019. J Urol 2019; **202:** 558.

20. Pannek J and Kullik B: Does optimizing bladder management equal optimizing quality of life? Correlation between health-related quality of life and urodynamic parameters in patients with spinal cord lesions. Urology 2009; **74:** 263.

21. Vainrib M, Reyblat P and Ginsberg DA: Long-term efficacy of repeat incisions of bladder neck/external sphincter in patients with spinal cord injury. Urology 2014; **84:** 940.

22. Tabibian L and Ginsberg DA: Transurethral collagen injection in neuropathic sphincter deficiency. Topics in Spinal Cord Injury Rehabilitation 2003; **8:** 54.

23. Farag F, Koens M, Sievert KD et al: Surgical treatment of neurogenic stress urinary incontinence: A systematic review of quality assessment and surgical outcomes. Neurourol Urodyn 2016; **35:** 21.

24. Kaiho YM, Takei H, Hirayama M et al: Surgical and patient reported outcomes of artificial urinary sphincter implantation: A multicenter, prospective, observational study. J Urol 2018; **199:** 245.

25. Bersch U, Göcking K and Pannek J: The artificial urinary sphincter in patients with spinal cord lesion: Description of a modified technique and clinical results. Eur Urol 2009; **55:** 687.

26. Chartier Kastler EG, Game S, Denys X et al: Treatment of neurogenic male urinary incontinence related to intrinsic sphincter insufficiency with an artificial urinary sphincter: A french retrospective multicentre study. BJU Int 2011; **107:** 426.

27. Shpall AI and Ginsberg DA: Bladder neck closure with lower urinary tract reconstruction: Technique and long-term followup. J Urol 2004; **172:** 2296.

28. Hulecki SJ and Hackler RH: Closure of the bladder neck in spinal cord injury patients with urethral sphincteric incompetence and irreparable urethral pathological conditions. J Urol 1984; **131:** 1119.

29. Stoffel JT and McGuire EJ: Outcome of urethral closure in patients with neurologic impairment and complete urethral destruction. Neurourol Urodyn 2006; **25:** 19.

30. Zecca C, Panicari L, Disanto G et al: Posterior tibial nerve stimulation in the management of lower urinary tract symptoms in patients with multiple sclerosis. Int Urogynecol J 2016; **27:** 521.

31. Schneider MP, Gross T, Bachmann LM et al: Tibial nerve stimulation for treating neurogenic lower urinary tract dysfunction: A systematic review. Eur Urol 2015; **68:** 859.

32. Kessler TM, La Framboise D, Trelle S et al: Sacral neuromodulation for neurogenic lower urinary tract dysfunction: Systematic review and meta-analysis. Eur Urol 2010; **58:** 865.

33. Lombardi G, Musco S, Celso M et al: Sacral neuromodulation for neurogenic non-obstructive urinary retention in incomplete spinal cord patients: A ten-year follow-up single-centre experience. Spinal Cord 2014; **52:** 241.

34. Lombardi G, Nelli F, Mencarini M et al: Clinical concomitant benefits on pelvic floor dysfunctions after sacral neuromodulation in patients with incomplete spinal cord injury. Spinal Cord 2011; **49:** 629.

35. Hoen L, Ecclestone H, Blok BFM et al: Long-term effectiveness and complication rates of bladder augmentation in patients with neurogenic bladder dysfunction: A systematic review. Neurourol Urodyn 2017; **36:** 1685.

36. Phe V, Leon P, Granger B et al: Stress urinary incontinence in female neurological patients: Long-term functional outcomes after artificial urinary sphincter (ams 800(tm)) implantation. Neurourol Urodyn 2017; **36:** 764.

37. Cheng PJ, Keihani S, Roth JD et al: Contemporary multicenter outcomes of continent cutaneous ileocecocystoplasty in the adult population over a 10-year period: A neurogenic bladder research group study. Neurourol Urodyn 2020; **39:** 1771.

38. Hellenthal NJ, Short SS, O'Connor RC et al: Incontinent ileovesicostomy: Long-term outcomes and complications. Neurourol Urodyn 2009; **28:** 483.

39. Vanni AJ and Stoffel JT: Ileovesicostomy for the neurogenic bladder patient: Outcome and cost comparison of open and robotic assisted techniques. Urology 2011; **77:** 1375.

40. Tan HJ, Stoffel J, Daignault S et al: Ileovesicostomy for adults with neurogenic bladders: Complications and potential risk factors for adverse outcomes. Neurourol Urodyn 2008; **27:** 238.

41. Deboudt C, Perrouin-Verbe MA, Le Normand L et al: Comparison of the morbidity and mortality of cystectomy and ileal conduit urinary diversion for neurogenic lower urinary tract dysfunction according to the approach: Laparotomy, laparoscopy or robotic. Int J Urol 2016; **23:** 848.

42. Gobeaux N, Yates DR, Denys P et al: Supratrigonal cystectomy with hautmann pouch as treatment for neurogenic bladder in spinal cord injury patients: Long-term functional results. Neurourol Urodyn 2012; **31:** 672.

43. Colli J and Lloyd LK: Bladder neck closure and suprapubic catheter placement as definitive management of neurogenic bladder. J Spinal Cord Med 2011; **34:** 273.

44. Chartier-Kastler EJ, Mozer P, Denys P et al: Neurogenic bladder management and cutaneous non-continent ileal conduit. Spinal Cord 2002; **40:** 443.

45. Chen JL and Kuo HC: Long-term outcomes of augmentation enterocystoplasty with an ileal segment in patients with spinal cord injury. J Formos Med Assoc 2009; **108:** 475.

46. Cheng KC, Kan CF, Chu PS et al: Augmentation cystoplasty: Urodynamic and metabolic outcomes at 10-year follow-up. Int J Urol 2015; **22:** 1149.

47. Pan D, Troy A, Rogerson J et al: Long-term outcomes of external sphincterotomy in a spinal injured population. J Urol 2009; **181:** 705.

48. Chancellor MB, Bennett C, Simoneau AR et al: Sphincteric stent versus external sphincterotomy in spinal cord injured men: Prospective randomized multicenter trial. J Urol 1999; **161:** 1893.

49. Takahashi R, Kimoto Y and Eto M: Long-term urodynamic follow-up after external sphincterotomy in patients with spinal cord injury. Neurourol Urodyn 2018; **37:** 2625.

50. Hamid R, Greenwell TJ, Nethercliffe JM et al: Routine surveillance cystoscopy for patients with augmentation and substitution cystoplasty for benign urological conditions: Is it necessary? BJU Int 2009; **104:** 392.