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European Association of Urology

Review – Neuro-urology – Editor's choice

Summary of the 2024 Update of the European Association of Urology Guidelines on Neurourology

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Abstract

Background and objective: Most patients with neurourological disorders require lifelong medical care. The European Association of Urology (EAU) regularly updates guidelines for diagnosis and treatment of these patients. The objective of this review is to provide a summary of the 2024 updated EAU guidelines on neurourology.
Methods: A structured literature review covering the timeframe 2021–2023 was conducted for the guideline update. A level of evidence and a strength rating were assigned for each recommendation on the basis of the literature data.
Key findings and limitations: Neurological conditions significantly affect urinary, sexual, and bowel function, and lifelong management is required for neurourological patients to maintain their quality of life and prevent urinary tract deterioration. Early diagnosis and effective treatment are key, and comprehensive clinical assessments, including urodynamics, are crucial. Management should be customised to individual needs and should involve a multidisciplinary approach and address sexuality and fertility. Lifelong monitoring and follow-up highlight the importance of continuous care for neurourological patients.
Conclusions and clinical implications: The 2024 EAU guidelines on neurourology provide an up-to-date overview of available evidence on diagnosis, treatment, and follow-up for neurourological patients.
Patient summary: Neurological disorders very frequently affect the lower urinary tract and sexual and bowel function and patients need lifelong management. We summarise

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the updated European Association of Urology guidelines on neurourology to provide patients and caregivers with the latest insights for optimal health care support.

1. Introduction

Disturbances to the nervous system that regulates the lower urinary tract (LUT) can cause neurourological symptoms that significantly impact urinary storage and voiding function and may lead to various complications, of which renal damage is the most severe, alongside other issues such as urinary incontinence (UI). The risk and severity of these complications mainly depend on the type of neurological disorder present [1]. Thus, the treatment approach and the monitoring intensity are adjusted according to the specific neurourological disorder and its underlying cause, emphasising the need for tailored patient care. This paper is an update of an earlier guideline summary [2] and synthesises the 2024 European Association of Urology (EAU) guidelines on neurourology. The purpose of the current work is to provide an up-to-date overview of the management of neurourological patients.

2. Methods

For the 2024 EAU guidelines on neurourology, new evidence was identified, collated, and appraised via a structured assessment of the literature. Databases searched included Medline, EMBASE, and the Cochrane Libraries. Detailed search strategies are available on the EAU website (www.uroweb.org/guidelines). Recommendations were developed by the panel to prioritise clinically important care decisions. The strength of each recommendation is determined by the balance between desirable and undesirable consequences of alternative management strategies, the quality of the evidence (including certainty of estimates), and the nature and variability of patient values and preferences. A recommendation is rated as strong when the evidence quality is high and/or there is a favourable balance of benefits to harms and patient preferences. A recommendation is rated as weak when the evidence is of lower quality and/or the benefits and patient preferences are less clear [3].

3. Results

3.1. Epidemiology

Disorders of the central and peripheral nervous system significantly increase the risk of functional disturbances in the LUT, with symptoms depending on the location and extent of any lesions. For instance, 95% of individuals with a suprasacral spinal cord injury (SCI) exhibit symptoms of detrusor overactivity (DO) and detrusor sphincter dyssynergia (DSD) [4]. In multiple sclerosis (MS), approximately 75% of patients develop neurourological symptoms after disease progression for more than 10 yr [5].

3.2. Classification systems

The EAU guidelines use definitions and classifications reported by the International Continence Society (ICS) [6,7]. The pattern of LUT dysfunction due to neurological disorders is determined by the site and characteristics of any lesions. A practical classification system is provided in Figure 1.

3.3. Diagnostic evaluation

3.3.1. Timing of diagnosis and treatment

Early diagnosis and intervention in neurourological disorders are crucial to prevent urinary system complications and/or permanent damage [8], even when neurological reflexes are normal. Prompt treatment and ongoing monitoring are essential to reduce the risk of upper urinary tract (UUT) deterioration and renal failure [9].

3.3.2. Patient history

A thorough history is essential in neurourological care, with a focus on urinary, sexual, and bowel symptoms and identification of warning signs such as pain and infection (Table 1). This approach aids in diagnosing and choosing treatments, especially as symptoms can hint at underlying neurological conditions. Evaluation of the patient's lifestyle, mobility, autonomy, spasticity, medication, and other specific risks associated with the underlying neurological disorder (eg, autonomic dysreflexia [AD]) is also crucial.

3.3.2.1. Bladder diaries. Bladder diaries, ideally completed for 3 consecutive days, are essential when evaluating neurogenic LUT dysfunction. Key findings from these diaries can include urinary incontinence, voided volumes, diurnal and nocturnal urinary frequency, and urinary urgency, which offer critical insights for initial assessment and interpretation of urodynamics.

3.3.3. Patient quality of life

Management of quality of life (QoL) in neurourological care involves addressing LUT management and treatment effects. Evaluation of treatment impacts on QoL for patients, particularly those with SCI and MS [10,11], is crucial, for which validated condition-specific and generic questionnaires should be used. These tools help in assessing the presence and impact of LUT, sexual, and bowel dysfunction, as well as neurourological management on health-related QoL, allowing for a comprehensive understanding of treatment outcomes on patient well-being. Questionnaires such as Qualiveen [12,13], which is available in both full and short versions and is translated into multiple languages, the Neurogenic Bladder Symptom Score (long and short forms) [14], and the Quality of Life-Bowel Management scoring tool [15] are specifically designed for adult neurourological patients. The Multiple Sclerosis Intimacy and

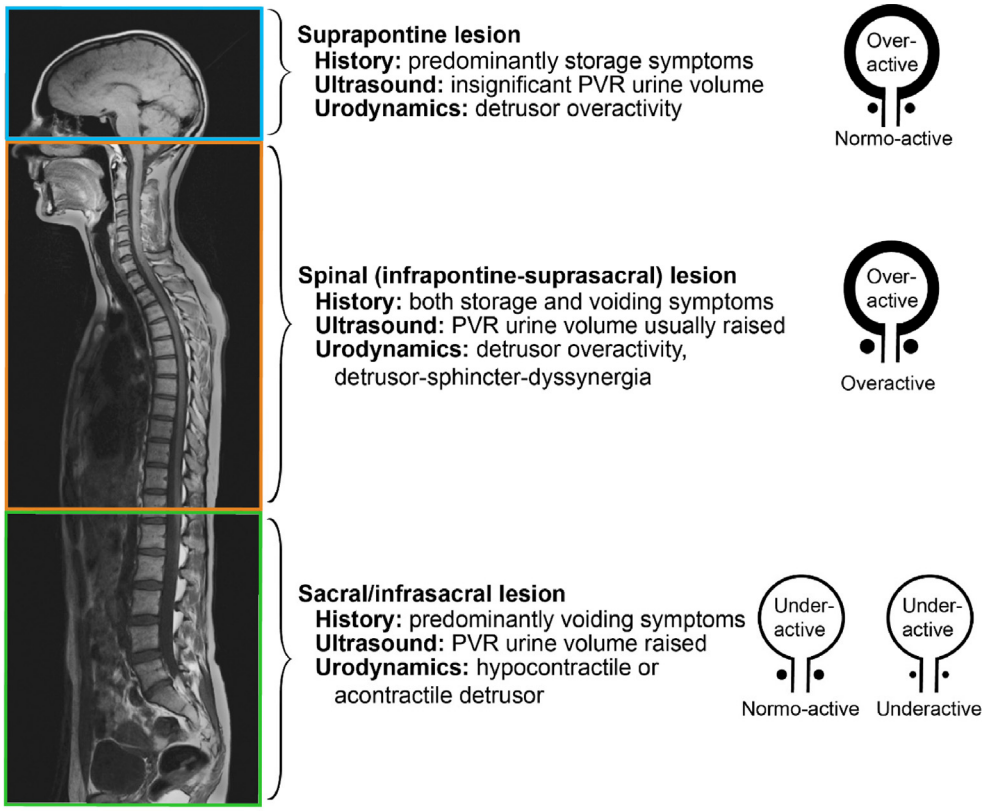

Fig. 1 – Patterns of lower urinary tract dysfunction in neurological disorders. Reproduced with permission from Panicker et al [1].

Table 1 – Recommendations for history-taking and physical examination

Recommendation	Strengthrating
Take an extensive general history, concentrating on past and present symptoms.	Strong
Take a specific history for urinary, sexual, bowel, and neurological function.	Strong
Pay special attention to the possible existence of alarm symptoms/signs (eg, pain, infection, haematuria, fever) that warrant a further specific diagnosis.	Strong
Assess quality of life when evaluating and treating neurourological patients.	Strong
Use available validated tools for urinary and bowel symptoms in neurourological patients.	Strong
Use MSISQ-15 or MSISQ-19 to evaluate sexual function in multiple sclerosis patients.	Strong
Acknowledge individual patient disabilities when planning further investigations.	Strong
Describe the neurological status as completely as possible; sensations and reflexes in the urogenital area must all be tested.	Strong
Test the anal sphincter and pelvic floor function.	Strong
Perform urinalysis, blood chemistry, bladder diary, postvoid residual volume, incontinence quantification, and urinary tract imaging as initial and routine evaluations.	Strong

MSISQ = Multiple Sclerosis Intimacy and Sexuality Questionnaire.

Sexuality Questionnaire (MSISQ)-15 and MSISQ-19 [16] also offer insights into sexual function, while generic health-related QoL questionnaires such as the I-QOL, King's Health Questionnaire, and Short Form Health Survey (SF-36, SF-12) have a broader assessment scope [17,18]. The quality-adjusted life year metric can be used to quantify treatment outcomes [19]. Selection of the most appropriate questionnaire depends on specific patient conditions and needs, again highlighting the tailored approach required in neurourological patient care.

3.3.4. *Physical examination and additional tests*

For neurourological patients, thorough neurological and physical examinations, especially of the urogenital and pelvic areas (Fig. 2), are crucial for accurate diagnosis, which should also take into consideration disabilities, history (eg, previous pelvic surgery or polytrauma), comorbidities (eg, prostate enlargement or pelvic prolapse), and potential changes in blood pressure. Key diagnostic tests such as urinalysis, blood tests, ultrasonography, and urodynamic evaluations are vital for comprehensive management.

3.3.4.1. Autonomic dysreflexia. AD is a critical condition primarily affecting individuals with SCI at or above the T6 level. AD is characterised by a rapid increase in systolic blood pressure (>20 mm Hg from baseline) and bradycardia, accompanied by symptoms such as severe headache, blurred vision, anxiety, and heart-rate fluctuations. Patients with AD experience sweating, piloerection, and flushing above the injury, and pallor and cold skin below it [20]. Triggered by various stimuli, including bladder or bowel distension and external noxious stimuli such as infections and pressure sores [21], AD requires immediate management to prevent life-threatening complications.

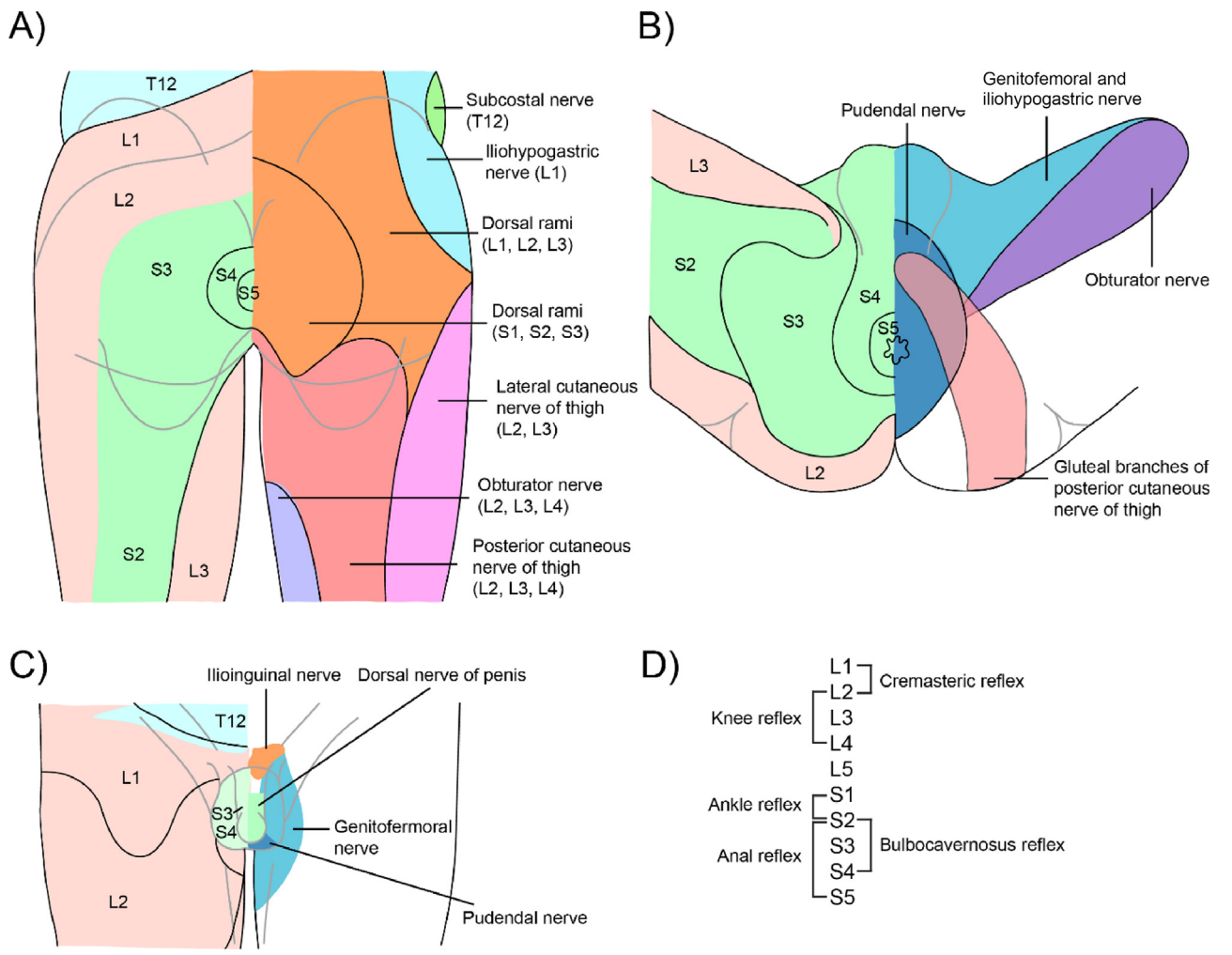

Fig. 2 – Lumbosacral dermatomes, cutaneous nerves, and reflexes. Reproduced with permission from Panicker et al [1].

3.3.5. *Urodynamics*

3.3.5.1. Introduction. For clinical decision-making, same-session repeat urodynamics are crucial [22]. Monitoring blood pressure and heart rate is critical for patients at risk of AD during these tests [23]. For SCI patients, a first urodynamic assessment within 3 mo after injury is fundamental for early diagnosis and treatment [24].

3.3.5.2. Urodynamic tests. Urodynamic testing is essential for neurourological patients, starting with free uroflowmetry and residual urine assessments to identify issues such as low flow rate, voided volume, micturition patterns, hesitancy, and postvoid residual volume (PVR), which provide a snapshot of the efficiency of bladder emptying [25]. Repetition of these noninvasive tests ensures that accurate baseline data are obtained. Filling cystometry, a standardised test to evaluate bladder storage function, assesses parameters such as compliance, cystometric capacity, and sensation, and can reveal conditions such as neurogenic detrusor overactivity (NDO) and UI.

Voiding cystometry, also known as a pressure-flow study, is critical for understanding the interaction between bladder contraction strength and outlet resistance during micturition, and can identify detrusor underactivity, acontractility, bladder outlet obstruction (BOO), DSD, and the presence of PVR via analysis of the mechanical and anatomical properties of the LUT. The diagnostic value is significantly enhanced by integration of videourodynamics, which adds a visual dimension to dynamic assessment of the bladder and urethra during filling and voiding.

Perineal electromyography is a method for measuring control over the external urethral sphincter and pelvic floor muscles, indicating coordination and dysfunction such as inadequate recruitment or DSD [26]. Videourodynamics is the most comprehensive method and merges imaging with filling cystometry and pressure-flow studies for diagnosis of functional impairments and anatomic abnormalities such as morphological changes in the LUT and reflux to the UUT [27].

Ambulatory urodynamics for evaluation of LUT function during the patient's normal activities, using diuresis for physiological filling, may be considered when conventional methods do not replicate symptoms. Triggered tests, such as the ice water test, may help in differentiating neural lesion levels [28].

3.3.5.3. Specialist uroneurophysiological tests. Neurological assessment for pelvic floor dysfunction involves

electromyography of striated sphincter muscles, pudendal nerve conduction, reflex latency, genital evoked responses, and sensory tests on the bladder and urethra. These tests evaluate motor and sensory functions.

3.3.6. Renal function

Patients with neurourological disorders, particularly those with SCI or spina bifida (SB) [29], are at higher risk of UUT complications because of high detrusor pressure during the storage and/or voiding phase. This risk is higher than in individuals with progressive conditions such as MS and Parkinson's disease (PD) [30].

Table 2 provides a summary of recommendations for urodynamics and uroneurophysiological tests.

3.4. Disease management

3.4.1. Introduction

Neurourological symptom treatment prioritises protection of the UUT, achievement or maintenance of urinary continence, restoration of LUT function, and improvement of QoL. Treatment considerations also include the patient's overall condition and support system, cost effectiveness, and potential complications. The primary treatment goal for high detrusor pressure is to lower the bladder pressure, despite the resulting PVR, enhance continence and QoL, and reduce the risk of urinary tract infection (UTI), although complete continence may not always be achievable.

3.4.2. Noninvasive conservative treatment

3.4.2.1. Assisted bladder emptying: Credé and Valsalva manoeuvres and triggered reflex voiding. Bladder expression techniques such as the Credé (suprapubic compression) and Valsalva (abdominal straining) manoeuvres can increase bladder pressure but may lead to inefficient emptying and high pressure harmful to the urinary tract, so their use is generally discouraged unless deemed safe according to urodynamics [31]. These methods may also worsen pelvic floor function and stress urinary incontinence (SUI).

Triggered reflex voiding, via stimulation of sacral or lumbar dermatomes in patients with upper motor-neuron lesions, can initiate involuntary detrusor contractions but risks high-pressure voiding and AD, especially in patients with high-level SCI. All assisted voiding requires low outlet resistance, careful patient education, and close monitoring.

External appliances such as pads and condom catheters offer social continence solutions, but devices such as penile clamps are contraindicated in cases of NDO or low bladder compliance owing to the risk of high pressures and complications in sensation-altered regions.

Table 2 – Recommendations for urodynamics and uroneurophysiological tests.

Recommendation	Strengthrating
Perform a urodynamic investigation to detect and specify lower urinary tract (dys)function; use same-session repeat measurement, as these results are crucial in clinical decision-making.	Strong
Noninvasive testing is mandatory before invasive urodynamics is planned.	Strong
Use videourodynamics for invasive urodynamics in neurourological patients. If this is not available, then perform filling cystometry continuing into a pressure-flow study.	Strong
Use a physiological filling rate and body-warm saline.	Strong
Perform blood pressure and heart-rate monitoring during urodynamic investigations and other invasive procedures in patients at risk of autonomic dysreflexia.	Strong

3.4.2.2. Neurourological rehabilitation.

3.4.2.2.1. Bladder rehabilitation including electrical stimulation. The aim of bladder rehabilitation is to restore bladder function in patients with neurourological symptoms. Treatments include electrical stimulation, behavioural therapy, pelvic-floor muscle training (PFMT), and different forms of electrostimulation. Behavioural therapy and PFMT show promise in PD, MS, and stroke patients by improving urinary symptoms [32–34]. Peripheral electrostimulation, such as tibial nerve and transcutaneous electrical nerve stimulation (TENS), is safe and improves bladder function in MS and stroke patients [35,36]. Electrostimulation combined with PFMT and biofeedback significantly reduces symptoms in MS patients [37], although intravaginal electrostimulation with PFMT is not superior in reducing incontinence in women with SCI [38]. Intravesical electrostimulation increases bladder capacity and sensation in patients with SCI and myelomeningocele [39], and repetitive transcranial magnetic stimulation has shown promise in improving symptoms in PD, SCI, and MS [40].

3.4.2.3. Drug treatment. There is no single best treatment for neurourological symptoms; combinations such as catheterisation and antimuscarinics are often used to protect the urinary tract and improve outcomes. Medications target either storage or voiding symptoms according to their mechanism of action.

3.4.2.3.1. Drugs for storage symptoms. Antimuscarinic drugs are the first-line choice for NDO treatment [41]; they enhance bladder capacity and reduce urinary incontinence by inhibiting parasympathetic pathways. Antimuscarinic effectiveness varies, and selection of the right treatment for individual patients is challenging owing to the lack of personalised clinical evaluation tools. Higher doses or combinations may enhance efficacy [42], but side effects such as dry mouth, constipation, and cognitive impairment can affect adherence [43,44]. Various antimuscarinics such as oxybutynin, trospium chloride, tolterodine, propiverine, darifenacin, and solifenacin are effective and tolerated during long-term use. Fesoterodine and imidafenacin have also shown promising results in reducing AD episodes and improving urodynamic variables [45].

β3-Adrenergic receptor agonists such as mirabegron and vibegron can improve symptoms and QoL in NDO patients [46–48], although further research is needed to identify their exact role and optimal dosages.

Other treatments include desmopressin for nocturnal polyuria in MS patients [49] and combination therapies, which have shown promising results, but clinical experience is limited. Cannabinoids and tadalafil have shown potential benefits for incontinence and NDO symptoms [50,51], respectively.

3.4.2.3.2. Drugs for voiding symptoms. Cholinergic drugs such as bethanechol that improve bladder contractility for detrusor underactivity are rarely used, with only preclinical evidence supporting the intravesical effectiveness of cannabinoid agonists. Alpha-blockers such as tamsulosin effectively reduce bladder outlet resistance, PVR, and AD [52]. However, there is a lack of substantial evidence on the efficacy of drugs that increase bladder outlet resistance for mild SUI in neurourological patients.

3.4.2.4. Minimally invasive treatment.

3.4.2.4.1. Catheterisation. Intermittent catheterisation (IC) is recommended for neurourological patients unable to empty their bladders effectively. Hand and cognitive functions are significant factors in IC continuation. The impact of the catheterisation technique (sterile, aseptic, clean) and catheter type (coated, uncoated) on UTI incidence, complications, and user satisfaction remains unclear [53]. Sterile IC is not routine, and patients, especially those with MS or SCI, may experience an increase in UTIs and dissatisfaction, impacting their QoL and treatment adherence [54,55]. Inconvenience, leakage, and infections contribute to a high IC discontinuation rate within the first year [56]. Proper training in self-catheterisation and maintenance of an ideal bladder capacity can reduce the UTI risk [57]. Indwelling catheters, including suprapubic cystostomy, should be avoided when possible because of a higher rate of complications, including UTI [58].

3.4.2.4.2. Intravesical drug treatment. Antimuscarinics such as oxybutynin hydrochloride can be administered intravesically to reduce NDO, and have shown efficacy and tolerability, with fewer side effects because of different metabolism and greater bladder retention [43]. Vanilloids such as capsaicin and resiniferatoxin, which desensitise C-fibres temporarily, have shown limited efficacy and an unfavourable safety profile in comparison to botulinum toxin A injections [59].

3.4.2.4.3. Botulinum toxin injections in the bladder. Botulinum toxin A provides reversible chemical denervation that lasts for approximately 9 mo; the dosage and injection sites over the detrusor vary by preparation. Multiple randomised controlled trials and meta-analyses have shown the effectiveness of botulinum toxin A in managing neurourological disorders in MS, SCI, and PD patients, with 50-70% of patients continuing treatment over the mid to long term [60–62]. The dosage and application vary, but repeated injections can sustain efficacy, even in patients with initially low response rates or failure after augmentation enterocystoplasty [63]. Common side effects include symptomatic UTIs, haematuria, and urinary retention requiring IC.

3.4.2.4.4. Bladder-neck and urethral procedures. Reducing bladder outlet resistance is important for UUT protection and can be achieved via chemical denervation or surgical interventions such as sphincterotomy, although these often lead to complications and a risk of incontinence [64]. Sphincter injections of botulinum toxin A offer a temporary solution for DSD and improve outcomes in SCI patients, but repeated applications are needed because of the limited duration; side effects are mild [65]. Techniques to increase bladder outlet resistance and treat SUI, such as urethral bulking agents, show early promise but their effectiveness decreases over time [66].

3.4.3. Surgical treatment

There is inconsistent reporting of outcomes for SUI surgeries in neurourological patients, which hinders comparisons. A core outcome set is needed for standardisation. Until then, a combination of subjective and objective measures, including validated QoL questionnaires, is recommended for assessment of treatment success.

3.4.3.1. Bladder-neck and urethral procedures for SUI. Urethral slings, particularly for self-catheterising women, provide lasting benefits, with synthetic slings offering good medium- to long-term outcomes and minimal morbidity [67,68]. Autologous slings are favoured alongside bladder augmentation. However, complications such as new-onset LUT symptoms and mesh issues can arise. Artificial urinary sphincters are durable and successful, particularly in men with neurogenic SUI, but are associated with higher complication and reoperation rates [67,69]. More research is needed for evolving techniques, including artificial urinary sphincters in women. The efficacy of adjustable continence devices is comparable to that observed for non-neurological patients, but complication rates are high.

3.4.3.2. Endoscopic techniques for treatment of anatomic BOO. Transurethral resection of the prostate is recommended for men with benign prostatic obstruction, with sphincter function and neurological disease impacts taken into consideration. Urethrotomy is used to treat urethral strictures, while urethroplasty tailored to specific lesions often fails in neurological patients [70]. Sphincterotomy helps in reducing AD, hydronephrosis, and UTIs, but is irreversible; it is suitable for men using condom catheters and may need repetition. Urethral stents show similar results to sphincterotomy, with faster recovery but higher costs and risks [71].

3.4.3.3. Denervation, deafferentation, and sacral neuromodulation. Sacral anterior root stimulation (SARS) induces detrusor contraction in patients with complete lesions above the implant, which facilitates successful "post-stimulus voiding", although it may lead to Charcot spinal arthropathy as a long-term complication [72,73]. Sacral dorsal rhizotomy, which is effective in reducing NDO, is now mainly used together with SARS [74]. Sacral neuromodulation is effective and safe for the treatment of neurogenic LUT dysfunction in selected neurourological patients [75].

3.4.3.4. Bladder augmentation. Intestinal bladder augmentation enhances compliance and reduces NDO, benefiting long-term renal function and QoL in SCI and SB patients [76,77]. However, potential complications include perforation and metabolic issues, so cautious use and lifelong follow-up are required. Patients on IC after augmentation report better urinary function and satisfaction than those using botulinum toxin or catheterisation alone [78].

3.4.3.5. Urinary diversion. Urinary diversion protects the UUT when other treatments are ineffective. Continent

diversion is favoured for enhancing QoL but has a significant complication rate [79]. Incontinent diversion improves QoL in patients not able to self-catheterise but requires support for stoma management [80]. Surgical techniques vary, and diversions may be reversible with new advances.

Table 3 summarises the treatment recommendations for neurourology patients.

3.5. Urinary tract infection

3.5.1. Epidemiology, aetiology, and pathophysiology

UTIs in neurourological patients are identified via symptoms and laboratory findings such as bacteriuria and leukocyturia, with no standardised cutoff values [81]. Factors contributing to UTIs include gender, catheterisation, bowel management, and comorbidities such as poor glycaemic control in diabetes [82–84]. Asymptomatic bacteriuria is more prevalent among SCI patients and varies by bladder management method; routine screening is not advised. UTI symptoms in this group can include fever, changes in incontinence, malaise, cloudy urine, and AD, with cloudy urine highly indicative of UTI [85].

Table 3 – Recommendations for treatment of neurourology patients

Recommendation	Strengthrating
Use antimuscarinic therapy as the first-line medical treatment for neurogenic detrusor overactivity.	Strong
Do not use mirabegron with the intention of reducing urodynamically proven neurogenic detrusor overactivity.	Strong
Prescribe α-blockers to decrease bladder outlet resistance.	Strong
Do not prescribe parasympathomimetics for an underactive detrusor.	Strong
Use intermittent catheterisation as a standard treatment for patients who are unable to empty their bladder.	Strong
Thoroughly instruct patients in the technique for and risks associated with intermittent catheterisation.	Strong
Avoid indwelling transurethral and suprapubic catheters whenever possible.	Strong
Offer intravesical oxybutynin to patients with neurogenic detrusor overactivity with poor tolerance to the oral route.	Strong
Use botulinum toxin injection in the detrusor to reduce neurogenic detrusor overactivity in patients with multiple sclerosis or spinal cord injury if antimuscarinic therapy is ineffective.	Strong
Offer bladder augmentation in cases of low bladder compliance and/or refractory neurogenic detrusor overactivity.	Strong
Place an autologous urethral sling as first-line treatment in female patients with neurogenic SUI who are able to self-catheterise.	Strong
Place a synthetic urethral sling as an alternative to an autologous urethral sling in selected female patients with neurogenic SUI who are able to self-catheterise.	Weak
Insert an artificial urinary sphincter in selected female patients with neurogenic SUI; however, patients should be referred to an experienced centre for the procedure.	Weak
Insert an artificial urinary sphincter in male patients with neurogenic SUI.	Strong
Consider sacral neuromodulation in selected neurourological patients.	Strong

SUI = stress urinary incontinence.

3.5.2. Diagnostic evaluation

For UTI diagnosis in neurourological patients with symptoms, a urine culture and urinalysis are preferred. A dipstick test is more useful to exclude rather than prove UTI and is not recommended [86]. Given the unique bacterial strains and resistance patterns among these patients, microbiological testing is crucial [87].

3.5.3. Disease management

Neurourological patients should not be screened and treated for asymptomatic bacteriuria owing to the risk of the development of resistant bacteria, with no benefit to the patient (Table 4). UTIs in these individuals are complex and require tailored antibiotic courses of 5-14 d according to the infection severity and microbiological testing [88]. Decisions on immediate treatment for severe symptoms or signs such as fever should consider resistance profiles and past cultures [89]. For afebrile UTIs, non-antibiotic strategies may initially be justified [90].

3.5.3.1. Recurrent UTI. Recurrent UTIs in neurourological patients suggest inadequate management of underlying issues such as high bladder pressure, incomplete voiding, and urinary stones [87].

3.5.3.2. Prevention. If an improvement in bladder function or removal of foreign bodies/stones fails to prevent UTIs in neurourological patients, alternative methods should be explored. Hydrophilic catheters have been associated with lower UTI rates [91]. However, cranberry juice, probiotics, methenamine hippurate, and L-methionine lack effectiveness in UTI prevention for neurological patients [92–94]. Oral immunotherapy and low-dose antibiotic prophylaxis are not recommended because of insufficient evidence or the risk of an increase in bacterial resistance [95–97]. Promising but unvalidated approaches include weekly antibiotic cycling and bladder inoculation with non-pathogenic *Escherichia coli* [98,99]. Intravesical iodine washouts and gentamicin have reduced UTI rates without causing drug resistance; benefits have also been seen with hyaluronic acid [100,101].

3.6. Sexual function and fertility

Sexual issues are classified into primary (neurological damage), secondary (physical disabilities), and tertiary (psy-

Table 4 – Recommendations for the treatment of UTI

Recommendation	Strengthrating
Do not use dipstick urinalysis to screen for UTI in neurourological patients.	Strong
Do not screen for or treat asymptomatic bacteriuria in patients with neurourological disorders.	Strong
Avoid the use of long-term antibiotics for recurrent UTIs.	Strong
In patients with recurrent UTIs, optimise treatment of neurourological symptoms and remove foreign bodies (eg, stones, indwelling catheters) from the urinary tract.	Strong
Individualise UTI prophylaxis in patients with neurourological disorders as there is no optimal prophylactic measure available.	Strong

UTI = urinary tract infection.

chosocial) categories. The PLISSIT model (permission, limited information, specific suggestion, intensive therapy) provides a structured approach for treatment [102]. Sexual dysfunction is often accompanied by neurogenic LUT and bowel dysfunction.

3.6.1. Erectile dysfunction

3.6.1.1. Phophodiesterase type 5 inhibitors). Phosphodiesterase type 5 inhibitors (PDE5Is) are the first-line treatment for neurogenic erectile dysfunction (ED), with effectiveness and safety demonstrated in SCI, MS, SB, and PD patients, who reported improvements in erectile function and satisfaction [103–108]. Treatment effectiveness varies, and potential side effects include headache, flushing, and hypotension in those with high-level spinal injuries [104,107]. PDE5Is are contraindicated for patients on nitrate medication.

3.6.1.2. Drug therapy other than PDE5Is. Fampridine improves ED in SCI and MS patients but has a high discontinuation rate because of side effects [109]. Sublingual apomorphine shows limited effectiveness and notable side effects in SCI patients [110]. Pergolide mesylate significantly boosts ED scores in PD patients for up to 1 yr [111].

3.6.1.3. Mechanical devices. Mechanical devices (vacuum tumescence devices and penile rings) may be effective but are less popular [112].

3.6.1.4. Intracavernous injections and intraurethral application. Intracavernous injections (alprostadil, papaverine, phentolamine) offer an effective treatment when oral drugs fail, but require careful dosing and precautions [113,114]. Complications can include pain, priapism, and fibrosis. These injections are a preferred option for patients on nitrates, patients with PDE5I drug interactions, or in cases in which PDE5Is are ineffective. Intraurethral alprostadil application represents a less effective alternative [114].

3.6.1.5. Penile prostheses. Penile prostheses are an option for neurogenic ED after other treatments fail; a high success rate has been observed for SCI patients, but there is a 10% risk of serious complications such as infection and perforation, which varies by implant type [104,115].

3.6.2. Male fertility

Fertility in male neurological patients may be impacted by ED, ejaculation disorders, and sperm quality issues related to conditions such as diabetes, SB, MS, and SCI [116]. Treatments include sympathomimetic agents for retrograde ejaculation, prostatic massage, vibrostimulation, and electroejaculation for semen retrieval, with precautions for AD in SCI [116–120]. Oral midodrine improves sperm retrieval in SCI cases [121]. Disease-modifying drugs in MS do not affect pregnancy outcomes [122]. Surgical sperm retrieval methods are options when others fail [123,124], with intracytoplasmic sperm injection enabling SCI patients to achieve fatherhood [125].

3.6.2.1. Sperm quality and motility. Semen quality in neurological patients is influenced by bladder management methods, with IC offering better results than alternatives [126]. Shortly after SCI, sperm shows decreased vitality and motility [123]. Vibrostimulation leads to better sperm motility in comparison to electrostimulation, and electroejaculation with an interrupted current enhances motility more than a continuous current. However, freezing of sperm does not notably increase fertility rates for men with SCI [127–130].

3.6.3. Female sexuality

A significant number of women with SCI continue sexual activities but report less satisfaction. Women with MS or SB experience widespread sexual dysfunction, which is often overlooked by health care providers [131,132]. Challenges such as UI and spasticity particularly affect sexual function. Treatment mainly addresses lubrication issues. Arousal and orgasm in women with SCI with complete sacral lesions can be achieved via stimulation of other erogenous zones above the lesion [133–135].

3.6.4. Female fertility

SCI may temporarily affect reproductive capacity [136]. Women with SCI experience more pregnancy and delivery complications, such as spasticity, pressure sores, anaemia, AD, and higher Caesarean section rates [137–139]. Women with MS considering pregnancy need to consult their physician to adjust their drug treatment plan to achieve optimal maternal and MS outcomes.

Table 5 summarises treatment recommendations for sexual dysfunction and fertility.

3.7. Follow-up

Neurourological disorders require regular follow-up, often every 1-2 yr, but more frequently for high-risk patients (Table 6). Follow-up should include semi-annual ultra-

Table 5 – Recommendations for the treatment of sexual (dys)function and fertility

Recommendation	Strengthrating
Prescribe oral phosphodiesterase type 5 inhibitors as first-line medical treatment in neurogenic ED.	Strong
Give intracavernous injections of vasoactive drugs (alone or in combination) as second-line medical treatment in neurogenic ED.	Strong
Offer mechanical devices such as vacuum devices and rings to patients with neurogenic ED.	Strong
Perform vibrostimulation and transrectal electroejaculation for sperm retrieval in men with spinal cord injury.	Strong
Perform microsurgical epididymal sperm aspiration, testicular sperm extraction, and intracytoplasmic sperm injection after failed vibrostimulation and/or transrectal electroejaculation in men with spinal cord injury.	Strong
Counsel men with spinal cord injury at or above Th 6 and fertility clinics about the potentially life-threatening condition of autonomic dysreflexia.	Strong
Do not offer medical therapy for the treatment of neurogenic sexual dysfunction in women.	Strong
Take a multidisciplinary approach, tailored to the individual patient's needs and preferences, for the management of fertility, pregnancy, and delivery in women with neurological diseases.	Strong

ED = erectile dysfunction.

Table 6 – Recommendations for follow-up

Recommendation	Strengthrating
Assess the upper urinary tract at regular intervals in high-risk patients.	Strong
Any significant clinical changes should instigate further specialised investigation.	Strong
Perform a urodynamic investigation as a mandatory baseline diagnostic intervention in high-risk patients at regular intervals.	Strong

sonography and yearly clinical exams [140]. Patients with high disability scores and significant clinical changes require closer monitoring, including frequent urodynamics [141]. Ongoing surveillance is crucial, especially given the heightened risk of bladder cancer in neurourological patients [142].

4. Discussion

Neurological disorders very often cause LUT, sexual, and bowel dysfunction, which require a detailed diagnosis and follow-up for tailored therapy that takes the patient's health, lifestyle, and expectations into consideration. Clinical assessment should be comprehensive and usually includes urodynamics. Conservative and noninvasive therapies are recommended before considering surgical procedures. Sexuality and fertility are topics that should not be ignored.

5. Conclusions

The 2024 update of the EAU guidelines on neurourology provides an up-to-date overview of evidence from the literature on diagnosis, treatment, and follow-up for patients with neurourological conditions.

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