Review Article

Follow-up urodynamics in patients with neurogenic bladder

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ABSTRACT

Introduction: Neurogenic bladder patients are at long-term risk of secondary upper urinary tract damage. Symptoms are unreliable and follow-up urodynamics is the only method of ascertaining safety of bladder pressures. This review examines the recommendations, shortcomings and utilization of existing guidelines. The evidence with regard to follow-up urodynamics in different settings relevant to neurogenic bladder is evaluated and an algorithm is proposed.
Methods: A pubmed search was conducted for studies on follow-up urodynamics in patients with neurogenic bladder. Additional search was made of secondary sources including reviews and guidelines.
Results: The need for follow-up urodynamics should be considered in all patients undergoing an initial assessment and weighed against the risks. Existing guidelines, while unanimous in their recommendation of its utilization, give scant details regarding its incorporation in clinical management. Follow-up urodynamics can document efficacy and identify the need for escalation of therapy in patients on intermittent catheterization and antimuscarinics. Patients with spinal injury, spinal dysraphism and anorectal malformations are at higher risk for upper tract damage. Follow-up urodynamics can help identify patients suitable for intravesical botulinum and mark those destined for failure. Patients undergoing augmentation cystoplasty may be candidates for less aggressive urodynamic follow-up.
Conclusions: Neurogenic bladder is managed by a broad cross-section of physicians. Clear recommendations and a management algorithm are important for improving patient care. Follow-up urodynamics can identify patients at risk, prevent renal dysfunction and improve the quality of life. There is an urgent need for more evidence on this important subject.

INTRODUCTION

Patients with neurogenic bladder are at risk of long-term upper tract damage. This is despite the normal functional and anatomical state of the kidneys early in the course of disease. Not just those with spinal injury who obviously have normal upper tracts at inception, up to 90% of children with spinal dysraphism also have normal upper tract function when assessed in infancy.[1] However, a significant proportion of these patients may develop renal dysfunction with time.[2,3] Damage to the upper tracts has been shown to be secondary to an abnormal lower urinary tract.[3,4] Symptoms are a poor guide to lower urinary tract dysfunction, especially in a setting of neurogenic dysfunction.[5-7]

Given these facts, urodynamics remains underutilized in the management of patients with neurogenic bladder. In two recent series, a large proportion of patients did not receive even a single urodynamics in the course of their management.[8,9] The initial urodynamics is important in planning therapy.[7] However, it is clear that many patients with neurogenic bladder continue to deteriorate in follow-up. Despite clean intermittent catheterization (CIC), children with spinal dysraphism may show progressive renal dysfunction and develop new renal scars triggered by poor bladder function.[10,11] Achieving and maintaining safe

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storage pressures are critical in ensuring long-term safety of the upper tracts.[12] While existing guidelines recommend follow-up evaluation, there are scant details regarding the incorporation of these recommendations into actual clinical practice [Table 1]. This review examines the evidence for follow-up urodynamics in patients with neurogenic bladder and provides an algorithm for incorporating it into clinical decision-making.

METHODS AND THEIR LIMITATIONS

Literature search was performed by cross-referencing "urodynamics," "cystometry," or "pressure-flow study" with forty different terms related to "neurogenic bladder." Landmark reviews and clinical practice guidelines on neurogenic bladder were also used as secondary source documents. Of note, none of the articles referenced in recent reviews on follow-up dealt directly with the value of follow-up urodynamics in the management of neurogenic bladder patients.[18,19] A search of the evidence quoted in major clinical practice guidelines with regard to value of follow-up urodynamics in patients with neurogenic bladder showed little evidence on the subject.[6,13-17,20] Hence, conclusions need to be drawn from studies carried out with a different objective thus limiting the strength of conclusions.

ADHERENCE TO CLINICAL GUIDELINES

Adherence to guidelines in clinical practice shows considerable variation but often falls short of recommendations. A large Canadian study examined the utilization of urodynamics in 1551 patients with spinal cord injury over a 10-year period and found that only 10% patients received the recommended follow-up with one-third not receiving even a single follow-up study.[9] Studies from UK showed improving compliance with guidelines in recent years, but most institutions were still not performing regular follow-up urodynamics.[21,22] A survey from France showed that routine follow-up urodynamics was performed by 56% of urologists and 83% of physiatrists, most often on an annual basis.[23] However, only 12% urologists in the Netherlands performed routine follow-up urodynamics despite European Association of Urology (EAU) guidelines recommendations.[24]

LITERATURE ON FOLLOW-UP URODYNAMICS

Early and appropriate urodynamics-based management of spinal cord injury patients can prevent the long-term development of poor compliance requiring augmentation cystoplasty surgery. None of the 246 patients with spinal cord injury from a Switzerland center needed augmentation cystoplasty during a mean follow-up of 17 years. Of note, therapy was initiated early and patients were followed carefully by a protocol that included urodynamics.[25] In contrast, children with meningomyelocele often show poor compliance, and thus, this group needs a different and more aggressive follow-up approach.[26]

Follow-up urodynamics in patients on clean intermittent catheterization and antimuscarinics

Antimuscarinics and CIC remain the mainstay of therapy in patients with florid neurogenic bladder such as spina bifida or spinal cord injury.[8,27-29] In contrast, patients with demyelinating conditions such as multiple sclerosis are more likely to be voiding spontaneously.[30]

Follow-up urodynamics demonstrates the efficiency of antimuscarinincs in improving capacity, volume at first involuntary contraction, and its strength. In a study of adults

Table 1: Position of various guidelines on follow-up urodynamics

Document or guideline	Agency, version	Recommendations	References
Management of bladder in adults with spinal cord injury (clinical practice guideline)	Consortium for Spinal Cord Medicine, USA, 2006	Recommends evaluation of upper and lower tract on regular (usually annual basis) Does not define what specific modalities to use for follow-up	[6]
Neurogenic lower urinary tract dysfunction: Clinical management recommendations	Fifth International Consultation on Incontinence 2013 (Published 2016)	Patients on CIC and antimuscarinics should undergo long term follow up urodynamics No separate section on follow up	[13]
Adult urodynamics	American Urological Association, 2012	Follow-up important in "relevant" neurological conditions including spinal cord injury, meningomyelocele, and "others thought to be at high risk" Decision on basis of initial findings and patient's response	[14]
Guidelines on neurourology	European Association of Urology, 2016	Urodynamics should be done at regular intervals in high-risk patients. Interval should not exceed 1–2 years	[15]
	European Association of Urology, 2009 (last published version)	Videourodynamics every 2 years in those with normal storage pressure and every year in those with poor compliance or detrusor overactivity	[16]
Urinary incontinence in neurological disease: Management of lower urinary tract dysfunction in neurological disease	National Institute for Health and Clinical Excellence, United Kingdom, 2012	Long-term surveillance for high-risk patients. Avoid routine urodynamics in low-risk patients High risk defined as spinal cord injury, spina bifida, anorectal malformation or patients with poor compliance, detrusor sphincter dyssynergia, and reflux	[17]

with spinal injury or multiple sclerosis, both solifenacin and oxybutynin showed dose-dependent efficacy.[31] However, not all patients responded to antimuscarinics.[28,32]

Improvement in urodynamic parameters was also noted in myelodysplasia children who underwent follow-up evaluation.[33] Oxybutynin eliminated or reduced the contraction pressure of phasic detrusor contractions and reduced storage pressures. However, 8% of patients developed upper tract changes indicating the importance of lower tract surveillance. These results were better than historical controls treated expectantly. The authors emphasized the need for proactive urodynamics-based management.

Follow-up urodynamics documenting failure to resolve storage pressure abnormalities in patients on antimuscarinics may guide the need for careful addition of mirabegron.[34]

Given that storage pressures are critical for the upper urinary tract, urodynamics can be used to objectively document the reduction in unsafe pressures in patients on antimuscarinics and can help identify patients who need more aggressive management. Alternatively, antimuscarinics may be tapered down or withdrawn under careful urodynamic monitoring in some patients.

Follow-up urodynamics in patients on intravesical botulinum toxin

Follow-up urodynamics has been used both to identify refractory patients suitable for intravesical botulinum injection and for assessing the response to that therapy. In a landmark, large multicentric randomized trial of 416 patients with multiple sclerosis ($n = 227$) and spinal cord injury ($n = 189$), Ginsberg *et al*. showed that botulinum toxin A injections reduced the contraction pressure of involuntary detrusor contractions by 33 cm H_2O and abolished the contractions in two-third patients for a median duration of 9 months.[35]

Urodynamics has been almost universally utilized to assess the efficacy of botulinum toxin in children with spina bifida. All 12 studies included in a recent review utilized urodynamics to follow the outcome of botulinum toxin injections.[36] Although detrusor pressures reduced following injection in all eight studies, pressures often remained unsafe. A compliance of 20 ml/cm H_2O was attained in only two of the studies.[36] Patients with neurogenic detrusor overactivity respond better than patients with poor compliance.[37] In a study of 37 children with neurogenic bladder, 17 children failed to respond to botulinum toxin A injection. The mean preinjection compliance of nonresponders was significantly lower than responders, 8.6 ml/cm of H_2O as compared with 25.1 ml/cm of H_2O ($P = 0.039$).[38] Not all initial responders continue to respond to injections in this setting and hence continued urodynamic surveillance of these patients remains important.[39]

It is clear that patients with poorly compliant bladder receiving botulinum toxin injection need follow-up urodynamics to identify nonresponders for alternate therapies.[26]

Follow-up urodynamics in patients undergoing augmentation cystoplasty

Follow-up urodynamics almost universally shows a marked reduction in storage pressures and adequate cystometric capacity following augmentation cystoplasty. In a series of 26 patients followed 8 years, the maximum detrusor pressure fell from 81 to 20 cm H_2O while the capacity increased from 201 to 615 ml.[40] Similar results were noted in a series of children with neurogenic bladder due to meningomyelocele with filling pressure reducing from 41 to 11 cm H_2O.[41] In contrast, Vainrib *et al*. showed that 11% of adult meningomyelocele patients had unsatisfactory compliance at a mean follow-up of 10.4 years. It is unclear whether these patients had symptoms or clinical markers of poor performance.[42]

The almost universal success of augmentation cystoplasty in achieving a good bladder capacity and reduction of storage pressures calls into question the need for routine use of long-term urodynamics following augmentation cystoplasty. It might be judicious to perform one follow-up study at 6 months and reserve long-term follow-up for the small subgroup having unsatisfactory findings on this study or other clinical clues to an unfavorable outcome.

Follow-up urodynamics after bladder neck reconstruction for neurogenic bladder patients with incontinence

A major concern in patients offered isolated surgery for enhancing outlet resistance is the possibility of unrecognized poor bladder storage function causing renal deterioration. Patients with profound neurogenic incontinence present a technical problem during urodynamics. Severe incontinence precludes bladder filling and this may mask poor storage. Maneuvers such as peripenile compression while filling (in males) or tucking a balloon catheter against the bladder neck (in females) are imperfect but useful adjuncts to unmask such problems.

In a series of 82 patients undergoing isolated bladder outlet reconstruction or closure, 10 patients (12%) needed a subsequent augmentation over a mean follow-up of 60 months. These patients had poor compliance and reduced capacity.[43] In contrast, 45% patients in another study required augmentation at 2.6 years following outlet surgery.[44]

There seems to be a significant risk of postoperative elevated bladder pressures following isolated bladder

neck reconstruction. Careful preoperative urodynamics cannot eliminate this risk and this risk may persist even at 5 years. Hence, all patients undergoing isolated bladder neck reconstruction should be followed with long-term urodynamics.

Follow-up urodynamics after neurosurgical interventions in patients with neurogenic bladder

Some patients with relatively nonobtrusive neurosurgical problems are offered neurosurgical intervention with the expectation that lower urinary tract symptoms (among other problems) might resolve. In a recent systematic review, follow-up urodynamics was used to analyze patients who underwent detethering surgery and showed urodynamic improvement in 11%–55%.[45] Symptoms are not a good guide in this postoperative setting.[46] Urodynamics may also identify patients doing poorly before deterioration.[47]

Follow-up urodynamics as an investigational tool for evaluating newer modalities of treatment

Follow-up urodynamics remains an important outcome measure to evaluate new treatments. A recent study examining the benefit of sectioning of the filum terminale in occult tethered cord utilized a scoring system based on urodynamics before and after treatment to assess efficacy to demonstrate lack of benefit.[48] In another study, researchers performed an age-matched comparison of follow-up urodynamics in children who had previously undergone *in utero* meningomyelocele closure with those that underwent postnatal surgery to show that the investigative surgery was not beneficial.[49]

Follow-up urodynamics was used to assess the impact of intraurethral botulinum toxin in spinal cord injury patients on a partial voiding regimen and showed persistent need for intermittent catheterization in most studies.[50] Follow-up urodynamics is also used to evaluate the impact of novel pharmacological approaches. The measure showed the lack of efficacy of selective alpha-blocker in children with neurogenic bladder.[51]

LITERATURE ON THE IMPACT OF FOLLOW-UP URODYNAMICS

Only two studies directly examine the impact of follow-up urodynamics on clinical decision-making. Linsenmeyer and Linsenmeyer studied 96 consecutive adult spinal cord injury patients who had sustained their injury at least 2 years before evaluation.[52] 48% of these patients needed some form of intervention based on follow-up urodynamics, most often escalation of antimuscarinics (69%). Of note, none of these patients had any new urological symptoms. Interventions were needed in patients who were injured for up to 5, 6–10, 11–15, and 16 years and above in 47%, 39%, 52%, and 50%, respectively. Interventions continued to be required despite long-term follow-up implying that ongoing urodynamic surveillance may be critical. Urodynamics also helped exclude a urological etiology in some patients with autonomic dysreflexia leading to nonurological interventions such as aggressive constipation management. The authors concluded that annual urodynamics was useful in the management of these group patients.

Nosseir *et al*. retrospectively studied eighty adult spinal cord injury patients who had undergone at least one urodynamic evaluation in a year for five consecutive years following their injury.[53] Fifty-one of the patients were on CIC and seven were on indwelling catheters. Changes to treatment were required in 77 patients including surgical intervention in 15 (sphincterotomy 8, Brindley stimulator 3, augmentation cystoplasty 3, Kock's pouch 1), botulinum toxin injection in 12 and changes to antimuscarinic therapy in 22. None of the patients developed any sign of renal damage in the period when assessed by ultrasonography, urine examination, and serum biochemistry. The authors concluded that urodynamics had an important role to play in the preservation of the upper tracts.

An interesting finding was the need for modification of therapy in patients on indwelling catheters in both the studies. These patients are usually not subjected to urodynamic follow-up with the expectation that a catheter would lower the intravesical pressure thus protecting the upper tracts. However, 40% of patients who had an indwelling catheter (urethral or suprapubic) required interventions often change in medication based on their urodynamic findings.[52] Hence, these patients must also be followed similar to the patients on more optimum therapies.

In a study of pediatric spinal cord injury patients follow-up showed improvement in bladder function and morphology with urodynamics-based initiation of antimuscarinics and CIC.[54] Another study of children with meningomyelocele showed that 8% of children showed renal damage and that at least one poor urodynamic parameter was noted in each these patients. The authors recommended follow-up urodynamics though the actual benefit of the follow-up studies was unclear.[55]

In another study of 100 spinal injury patients whose treatment was guided by urodynamics, 15% developed upper tract changes. It was unclear whether these were patients who had established renal dysfunction at enrollment. Of note, detrusor pressure was over 40 cm H_2O in 64% at final evaluation suggesting need for a more aggressive management approach.[28]

Follow-up urodynamics can confirm improvement in bladder storage volume and pressure and this has been correlated with improved estimated renal plasma flow on nuclear renogram.[56]

RISK OF FOLLOW-UP URODYNAMICS

Altered urinary tract morphology and function, poor perineal hygiene, and the use of catheters can all impact the morbidity of repeated testing. Urodynamics is an invasive evaluation associated with discomfort and occasionally bleeding, infection, or autonomic dysreflexia.[16] Urinary tract infection is not uncommon following urodynamics. In a study of 72 patients with spinal cord injury undergoing urodynamics, seven patients developed urinary tract infection, of which five were symptomatic.[57] Of note, the presence of asymptomatic bacteriuria did not have an impact on the development of urinary infection. Patients on CIC will often have bacteriuria and it is difficult and perhaps undesirable to sterilize the urine in this setting. Instead, antimicrobial prophylaxis given empirically is effective and should be preferred.[58] Anecdotally, the author has found children with upper tract dilatation and renal insufficiency to be specifically vulnerable.

Autonomic dysreflexia is a major concern in patients with high lesions above T6 spinal level. Lack of autonomic dysreflexia at earlier urodynamics is by no means protective. All quadriplegics must have blood pressure monitoring and in those with a previous history of autonomic dysreflexia, it is preferable to use prophylaxis with terazosin (5 mg 30 min before the test) or even anesthesia.[7,59] Clearly, one must balance the need for testing against the dangers.

Radiation exposure is an important consideration. The cumulative impact of radiation in those offered video studies, as recommended by the EAU guideline, could be considerable. In a study of the radiation dose due to a single videourodynamic study in 64 children, the mean exposure time was 1.8 min and the mean total radiation exposure was 10 mGy potentially adding up to a substantial proportion of permissible lifetime exposure with repeated testing.[60,61] Hence, the decision to use videourodynamics must be a deliberate, documented decision with a strategy for minimizing radiation exposure.

One must be careful while performing urodynamics in patients after augmentation cystoplasty. Reduced bladder sensation and a thin-walled potentially weaker augmented bladder can result in bladder rupture during filling.[62] Latex allergy can be an important issue in some of these patients who are undergoing repeated procedures.[63] While minor reactions are not uncommon, rare occurrence of anaphylaxis has been recorded.

SURROGATES FOR FOLLOW-UP URODYNAMIC FINDINGS

A reliable surrogate for bladder function would be very useful and could potentially help avoid repeated urodynamic testing. Symptoms are a poor surrogate. Studies show a striking lack of correlation between symptoms and urodynamic findings in patients with neurogenic bladder.[52] Symptom-based assessment would have missed 69% of the target patients in another group of spinal cord injury adults.[53] In patients with a bladder diverticulum, gross reflux and severe sphincteric incompetence normal storage pressures may be misleading and storage symptoms can be a clue to storage abnormalities.

Incontinence episodes recorded on a CIC diary could potentially be a useful marker. Persistence of incontinence in a patient with documented elevated storage pressure might indicate the need for intervention. However, patients may have unsafe storage pressures despite achieving continence.[32] The CIC diary can be used to titrate the dose of antimuscarinics, notwithstanding the caveats mentioned. It also gives vital information regarding 24-h urine volume and average CIC volumes, both of which have impact on clinical care.

Ultrasonographic measurement of bladder wall thickness has also been studied as a surrogate marker for urodynamic findings. However, although bladder wall thickness is higher in patients with poor compliance, meaningful cut-offs are elusive and standardization lacking.[64,65] Ultrasonography can only identify upper tract dilatation once its already occurred, a situation that follow-up urodynamics can avoid.

The degree of functional disability was correlated with urodynamics in a study of 134 adults with spinal dysraphism. Being wheelchair-bound increased the odds of finding unsafe storage pressures on urodynamics (odds ratio 5.36).[45] The authors suggested that in patients who are asymptomatic and not wheelchair-bound, urodynamics might not be necessary.

Aside from CIC diary, the author uses surrogate markers sparingly when there are technical issues that render the urodynamic findings less reliable.

URODYNAMIC PARAMETERS ASSESSED IN FOLLOW-UP

Follow-up urodynamics must include all parameters assessed at the initial study specifically those that had a demonstrable abnormality. One must record storage and voiding phase parameters including bladder sensation, capacity, compliance, presence of detrusor overactivity, the $P_{det.max}$ and $P_{det.Qmax}$, and the flow rate and pattern. In patients on a complete CIC protocol, the voiding phase parameters may lose some of their relevance while a tube-free uroflow may be relevant in patients who are voiding spontaneously.

Improvement in the bladder volume at first involuntary detrusor contraction and the height of that contraction may

be useful to assess the impact of medication. The detrusor leak point pressure, a term given to the pressure at which fluid starts leaking by the side of the urethral catheter at the time of filling in the absence of a detrusor contraction, is a useful parameter to assess safety of bladder pressures, with certain caveats (vide infra).

At urodynamics, multiple cycles of testing should always be performed. Patients on an indwelling catheter may show a significant increase in the volume at first involuntary detrusor contraction and cystometric capacity.[66] While such changes were not noted in patients on CIC by these authors, it is good practice to perform multiple cycles to ensure that any findings noted are consistently seen.[66,67]

Scoring systems have been sporadically used to identify patients at risk for upper tract damage. One study combined bladder volume, compliance, detrusor activity, and sphincter coordination into a score that could follow the impact of detethering and predicting retethering.[68] Others have shown that the 6-month score had prognostic value.[69] However, in the absence of clinical criteria, these scorings have limited utility.

Most authors recommend videourodynamics as the study of choice.[70] However, the evidence in this regard remains weak.[71] Surveys in Canada and the Netherlands have shown that few urologists use videourodynamics.[24,72,73] Video studies should be considered in patients with anatomical changes to the upper tracts but whether every follow-up should incorporate video is debatable.[74] While the American Urological Association guideline on urodynamics states that urologists "may perform" fluoroscopy during urodynamics, this seems to refer to the initial evaluation rather than follow-up.[16] Ambulatory studies have not been found to be useful in this setting.[75]

INCORPORATING FOLLOW UP URODYNAMICS INTO CLINICAL MANAGEMENT

Follow-up urodynamics must be considered in all patients offered an initial study, especially if the lower tract was unsafe or there are current clinical or investigative features showing deterioration.[76] Typically, these are patients with pontine and infrapontine lesions.[77] High-risk patients may be better served by an aggressive follow-up approach.[78] Ensuring optimum lower urinary tract function has been associated with an improved quality of life.[79]

The urodynamic question almost invariably pertains to safety of the lower tract or the etiology of ongoing incontinence episodes. Unfortunately, no specific cut-off storage pressure reliably defines safe storage despite the oft-quoted figure of 40 cm of H_2O.[80] Children may damage their upper tracts at lower pressures, especially in the presence of secondary vesicoureteral reflux. In fact, in the face of large volume bilateral reflux, any rise in storage pressure is suspicious. Storage pressures must be safe at the usual CIC volumes while storage volumes should be matched up to the age-adjusted expected urine volume such that five daily catheterizations are adequate to evacuate the bladder effectively.

Not just the actual pressure recorded, but the pattern of pressure rise and the usual CIC volume are equally critical in determining safety of the lower urinary tract [Figure 1]. Figure 2 summarizes these considerations in an algorithm. There is no unanimity regarding how long urodynamic follow-up should continue. In infants with spinal dysraphism, annual urodynamics until the age of 6 years or until growth is complete, followed by triggered testing has been suggested.[74,81] However, the need for surgery in over one-fourth of adults treated earlier for spina bifida may indicate need for routine long-term evaluation.[8] A recent review noted the need for regular urodynamics and the possibility of changing patterns with time while acknowledging the lack of adequate evidence.[82] Others have suggested long-term urodynamics (without defining an end-point) for patients on intermittent catheterization and antimuscarinics.[15,70] The National Institute for Health and Clinical Excellence guideline suggests that long-term repeated urodynamics might not be necessary after augmentation cystoplasty.[19,40] A recent Center for Disease Control protocol is examining routine urodynamics at 3 months and thereafter annually for all children with spina bifida with additional studies at 6 months if the pressures are unsafe.[83] The author practices routine urodynamics in children until the age of 18 years and for the first 5 years in adults followed by triggered testing alone.

Patients with neurogenic bladder cross path with a broad cross-section of physicians from various departments. Clear

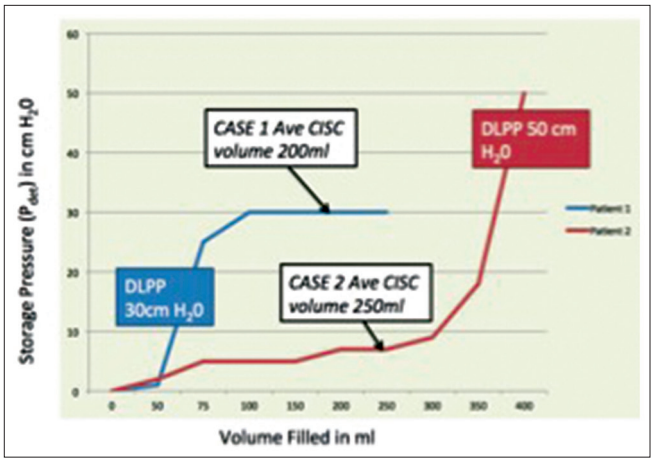

Figure 1: Impact of pattern of storage pressure in two hypothetical children 8 years old on clean intermittent catheterization and antimuscarinics with reduced compliance and a history of urinary incontinence. Child 1 has an average clean intermittent catheterization volume of 200 ml, a detrusor leak point of 30 cm H_2O and high storage pressures at 100 ml fill volume. Child 2 has an average clean intermittent catheterization volume of 250 ml, a detrusor leak point of 50 cm H_2O but storage pressures remain low till about 350 ml. Interpretation: The second child is likely to be safe in the long run but the first child needs escalation of therapy

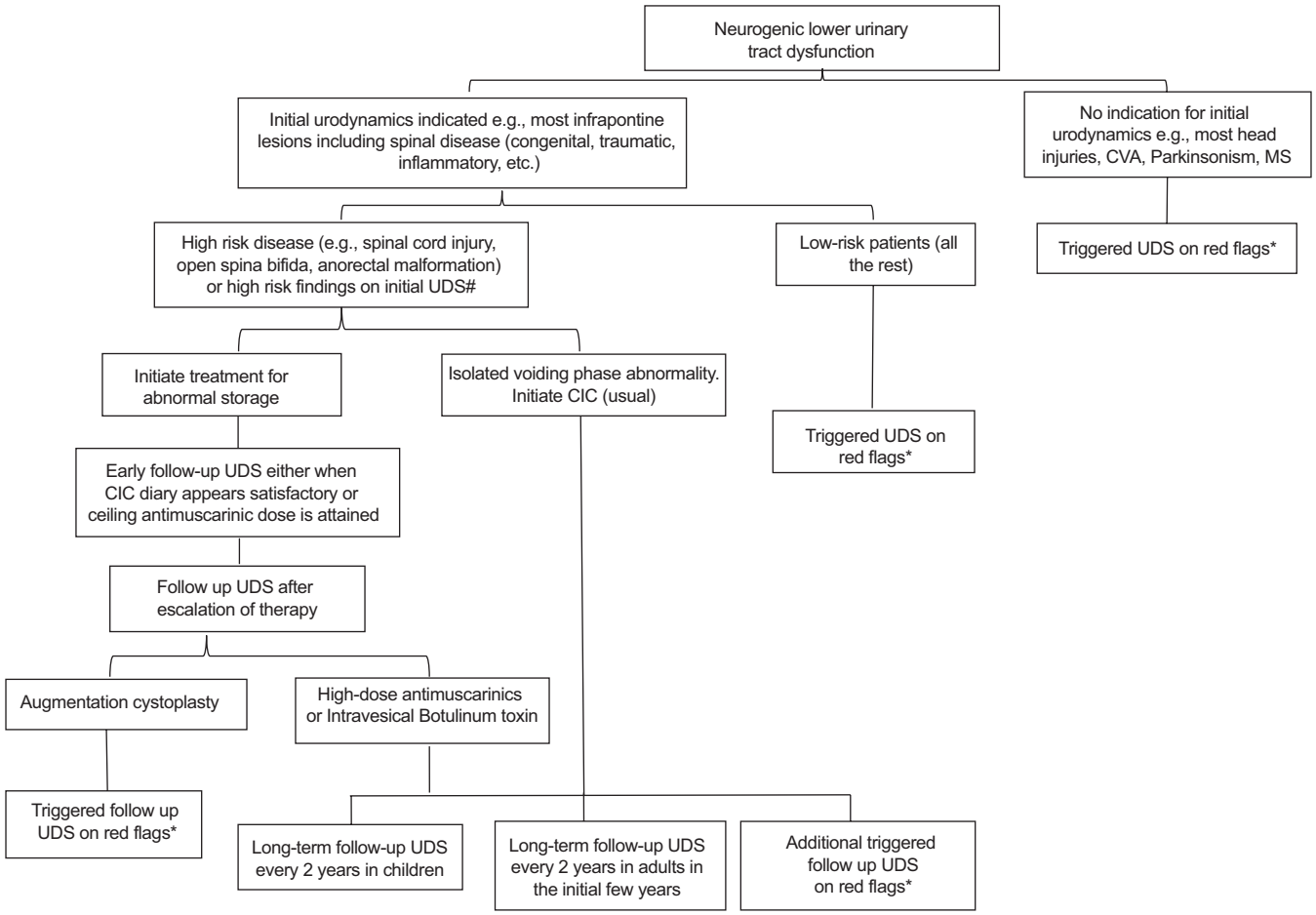

Figure 2: Algorithm for follow-up urodynamics in the management of neurogenic lower urinary tract dysfunction *Red flags - incontinence, need for additional catheterizations in clean intermittent catheterization regimen, recurrent urinary infection, worsening of upper tract morphology or function, stone formation. #High risk findings on initial urodynamics - poor compliance, high pressure neurogenic detrusor overactivity, detrusor sphincter dyssynergia with high voiding pressures

urodynamic-based goals and an unambiguous algorithm could greatly improve our ability to manage this complex problem.

CONCLUSIONS

Follow-up urodynamics is critical in the management of neurogenic bladder patients. It is useful for monitoring response to therapies, safety of the lower urinary tract, and the identification of patients needing escalation of their management. Patients need periodic urodynamic evaluation and triggered testing guided by red flags in patient care. Select patients may be eligible for less aggressive follow-up. Existing guidelines while generally recommending follow-up urodynamics give little detail regarding the incorporation of the test in clinical practice. An algorithm based on limited evidence must suffice until more evidence is available.

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