


International Consultation on Incontinence 2016; Executive summary: Urodynamic testing

Peter F. W. M. Rosier¹  | Hann-Chorng Kuo² | Mario De Gennaro³ |
Andrew Gammie⁴ | Enrico Finazzi Agro⁵ | Hidehiro Kakizaki⁶ |
Hashim Hashim⁴ | Philip Tooze-Hobson⁷

¹ Department of Urology, University Medical Center, Utrecht, The Netherlands

² Department of Urology, Buddhist Tzu Chi General Hospital, Hualien, Taiwan

³ Department of Nephrology-Urology Pediatric Ospedale Pediatrico Bambino Gesù, Rome, Italy

⁴ Bristol Urological Institute, Bristol, United Kingdom

⁵ Unit of Functional Urology, Tor Vergata University Hospital, Rome, Italy

⁶ Department of Renal and Urologic Surgery, Asahikawa Medical University, Asahikawa, Japan

⁷ Department of Gynaecology and Pelvic Floor Medicine, Birmingham Women's and Children's NHS Foundation Trust, Birmingham, UK

Correspondence

Peter F.W.M. Rosier, MD, PhD, P.F.W.M., Senior Lecturer Functional Urology and Neurourology, Department of Urology, University Medical Center, Utrecht, The Netherlands.

Email: rosier@umcutrecht.nl

Aims: The International Consultation on Incontinence has published an update of the recommendations for the diagnosis and management of urine incontinence (ICI2016). This manuscript summarizes the consultations committee—recommendations with regard to urodynamic assessment.

Methods: Expert consensus on the basis of structured evidence assessment has been the basis of the consultations publication and has been summarized by the committee for this manuscript.

Results: Patients that are not satisfied with their initial management on the basis of their reported signs and symptoms of urinary incontinence, as well as all patients with neurological abnormalities that are potentially relevant for the function of the lower urinary tract, may very likely profit from objective diagnosis and staging and grading of their dysfunction, with urodynamic testing, regardless their age, vulnerability and/or comorbidities. The principles and technical innovations as well as the principal recommendations for the utilization of (invasive) urodynamic assessment for women, men, children, and vulnerable elderly, with or without neurogenic lower urinary tract dysfunction with urinary incontinence are provided in this abbreviated ICI recommendations-document.

Conclusions: The ICI2016 committee on urodynamics presents an executive summary of the most important reasons and recommendations for the use of urodynamic investigations for patients with urinary incontinence.

KEYWORDS

clinical practice guideline, diagnosis, expert review, lower urinary tract dysfunction, neurogenic bladder dysfunction, practice recommendations, urinary incontinence children

1 | INTRODUCTION

The evidence around Urodynamic testing (UDS) for patients with signs and symptoms of urinary incontinence (UI) was reviewed by an expert panel for the 6th International Consultation on Incontinence; held in Tokyo 2016. The

conclusions and recommendations from ICI2013 regarding the application of UDS for the following discrete groups; women, men, children, neurogenic lower urinary tract dysfunction (NLUTD) and the frail elderly have been adapted to the new published evidence.¹ We present a summary of the recommendation—updates and selected literature references

from this chapter. Where relevant, the paragraphs begin with a summary of the earlier (2013) recommendation,² followed by the Tokyo-2016 update-text.

2 | METHODS

The book chapter text reflects expert consensus on the basis of (Oxford) graded evidence and recommendations, based on considered judgement. Literature synthesis methods are outlined in the introduction of the book.¹ In short for this sub-committee on urodynamics: Literature selection has initially been based on literature referred to in the ICI 2013² chapter but all co-authors have for their specific paragraph updated their search with publications up to June 2016. Sensitive searches were done in PubMed with terms for example: Uroynam* AND (Child* OR Pediatr*) or: Uroynam* AND (incont* AND male) etc. Specific searches or updates were sought when deemed necessary, usually deriving from literature cited in ICI2013. Many ICI2013 references are not repeated in the ICI2016 chapter usually the most generic, important, and/or recent have remained and the newest references have been added. This manuscript has however only imported the most relevant (and) recent references from the chapter.

2.1 | Principle of urodynamics

UDS allows direct assessment of lower urinary tract (LUT) function by the measurement of relevant physiological parameters (ICS-ST2002³),⁴ and invasive UDS (iUDS) is defined as any test that involves insertion of one or more catheters or any other transducers into the bladder and/or other body cavities, or insertion of probes or needles, for example for (needle-) EMG measurement⁵ (ICS-GUP2016). UDS is performed to (the only manner to) objectively measure and document the entire LUT *function and/or dysfunction* when it can have therapeutic consequences. UDS can also be performed as part of a surveillance or a research program.

UDS features are observed/measured in an objective manner and should identify all elements of LUT-function and dysfunction and their relative importance to explain the person's perceived signs or symptoms in broad clinical perspective. Every element of function and dysfunction can therefore be urodynamically staged and graded and be related to this perspective.

Some recent studies have challenged iUDS with a clinical diagnosis as the comparator. Specifically, the "clinical diagnosis of SUI" was used as a predictor of outcome of sub-urethral tapes in a very selected group of patients.⁶ When this clinical diagnosis had been compared with one specific element (filling-cystometry) of the iUDS diagnosis in a

dichotomous manner ("yes-or-no (stress-) urine incontinence")⁷ neither way of diagnosis has been superior for the patients recruited in this study to predict the success of "continence" as the single outcome. The question remains whether the outcome of the surgery (or of alternative management, based on the urodynamic results⁵) could have been better than the $\pm 65\%$ overall success rate, when a more structured clinical as well as iUDS (staging and grading) diagnosis and/or analysis had been used in these clinical trials.^{5,8}

2.2 | Technological innovations

ICI2016 recommended again (ICI2013) that investigators planning to use air-filled catheters for intravesical and intra-abdominal pressure measurement in iUDS are advised to check for themselves that they have an equivalent performance to their current system for measuring pressure and to understand that these catheters are not equivalent to (ICS-standard) fluid-filled systems because pressure references for air-filled catheters are lacking.

Non-invasive measurements of vesical pressure studies during voiding in men by the penile cuff or condom catheter have not shown any applicability in the diagnosis of UI. Near-infrared detrusor spectroscopy has shown a relation with detrusor (over)activity in selected recordings but was not reproducible in follow up study. The committee does not currently recommend penile cuff pressure, urethral retro-resistance pressure measurements, and urethral pressure reflectometry, nor bladder wall thickness assessment or near infrared detrusor spectroscopy nor condom for the routine clinical diagnosis of UI or of LUTD.

The ICI2016 concluded that there is some evidence that abdominal LPP has been helpful as predictor of success of surgery in female patients with SUI-S⁹ or patients with post RRP UI.¹⁰ The ICI2016 did however not recommend abdominal LPP measurement as a single iUDS parameter in patients with UI. LPP may aid in the differentiation between intrinsic sphincter deficiency and urethral hypermobility and this ICI2016 committee on urodynamic testing refers to the management/treatment chapters for the relevance of this differentiation.

3 | URODYNAMIC TESTING OF WOMEN WITH URINARY INCONTINENCE

3.1 | Stress urinary incontinence syndrome

The ICI2013 concluded that the sensitivity and the specificity of the symptoms, when systematically assessed including voiding diary, is at best around 60%, in comparison with iUDS. The think tanks of the International Consultation of

Incontinence Research Society (ICI-RS) have discussed the diagnostic strategy for UI and suggest that the patients' presentation can be more precisely delineated as syndromes: SUI syndrome (SUI-S), the overactive bladder syndrome (OAB-S),³ and the neurogenic LUT dysfunction syndrome (NLUTD-S) are suggested as more precise and descriptive terms that can be used to delineate categories of patients based on symptoms and objective (clinical) signs.¹¹ The ICI2016 recommends iUDS when a patient presents with symptoms and signs of LUTD (especially UI) that are not typically "SUI-S" or typically "OAB-S(wet)." Furthermore the ICI2016 recommends (grade A), in agreement with all existing guidelines, iUDS for every patient that presents with new or persisting symptoms and signs of LUTD after initial (or subsequent) management or when a patient after initial conservative management or pharmacotherapy expresses the wish for more invasive and/or irreversible treatment. The committee recommended (grade D) that it is also at present (as in ICI2013) not possible to predict who will develop voiding difficulty following surgery for SUI and recommended (grade B) that patients with SUI-S are informed that the chance of developing urinary urgency (OAB-S) following surgery is unpredictable when an iUDS diagnosis of USUI is established. ICI2016 recommended again (ICI2013) that patients are informed before surgical intervention of a likely lesser success rate when OAB-S (without iUDS) or iUDS-DO or reduced compliance and/or cystometric capacity exist.^{12,13}

3.2 | Urgency urinary incontinence syndrome—Overactive bladder syndrome

Regarding patients with OAB-S the ICI2016 concluded also (ICI2013) that the quantity of symptoms or specific characteristics of OAB-S do not predict the response to the currently available therapeutic approaches. The committee concludes (grade A) that the absence of DO (eg, in patients with urgency and/or frequent voiding or OAB-s) is relevant for further management, because treatments for OAB-S lack a "mechanism of action" or lack specific evidence of efficacy for those patients. The committee recommends (grade A) iUDS in patients with persistent symptoms after initial management of OAB-s, asking for further management.

4 | URODYNAMIC TESTING OF MEN WITH URINARY INCONTINENCE

ICI2016 recommends iUDS for objective diagnosis of male LUT function, certainly in men with UI without a history of (prostate) surgery. UI in men after surgery for BPE-BOO is reported to be the consequence of sphincter weakness or deficiency, sphincter weakness plus DO or of reduced compliance alone.^{14,15} The committee recommends iUDS

when elderly male patients have persisting LUTS and/or UI after surgery for prostatic BOO certainly if further (invasive) management is considered.^{16,17}

The most prevalent aetiology of UI in men is however retropubic radical prostatectomy (RRP).¹⁸ (Bothersome) UI after RRP is increasingly incident despite improvement in surgical techniques. Sphincter weakness is the main cause of UI after RRP is, but reduced compliance and DO, with or without neo-bladder neck outflow obstruction contribute in a proportion of those patients.^{19,20} iUDS have demonstrated value to identify the aetiology of LUTD after surgery or radiotherapy of prostate malignancy. The committee recommends that iUDS should be performed when RRP UI has not spontaneously improved and conservative measures have failed, after a minimum of 6 months post-surgery. The committee recommends that iUDS for patients with RRP UI is not only done to evaluate USUI but that it is also done specifically to evaluate bladder storage function. Thus it is advised to do cystometry with prevention of leakage during the test until (if possible) a practical volume for the patient (eg, 400 mL) is reached at low pressure (without pain).

5 | URODYNAMIC TESTING OF ADULT PATIENTS WITH NEUROGENIC LOWER URINARY TRACT DYSFUNCTION

Any disturbance of the nervous system can result in signs and symptoms of LUTD. The extent and location as well as the duration of the neurological dysfunction will determine the type of LUTD, which can be symptomatic or asymptomatic, partially also depending on-loss of-sensation. Neuro-urological dysfunctions can cause a variety of long-term complications; the most significant being deterioration of renal function.^{21–23} There is expert unanimity in every practice guideline, that patients with neurological disease known to be associated with LUTD should be objectively evaluated for the presence of NLUTD with iUDS.²⁴ Especially in spinal cord injury (SCI) and also adult patients with myelomeningocele. Specific management on the basis of iUDS results has very significantly added to the reduction of renal failure as a consequence of neurogenic dysfunction, and has very much reduced mortality.²⁵ The aims of therapy for NLUTD are to achieve bladder filling and voiding conditions a physiological as possible. Management should however always be balanced to the patient's acceptance and practicality in daily life. Lengthy periods of high detrusor pressure during bladder storage phase or (abnormally prolonged and/or high pressure) voiding pose a risk to the upper urinary tract (UUT).^{4,26} The committee recommends that iUDS should be considered as a baseline evaluation of patients with signs and symptoms, or with suspicion of NLUTD and that video iUDS is considered

when anatomical abnormalities with the NLUTD are not unlikely.

6 | URODYNAMIC TESTING IN CHILDREN WITH URINARY INCONTINENCE

ICI2016 confirmed ICI2013 that within the limits also provided for adults, (i)UDS in children is reliable and reproducible. Non-invasive tests as uroflowmetry are gradually achieving more evidence level, by constructing normative values and more standardized performance of the tests. Although it is plausible and considered useful to reduce filling speed and catheter size in relation to patient size, the exact values cannot be given and the influence of the transurethral catheter size on voiding in children is unknown. The committee has again (ICI2013) concluded that standards for pressure flow analysis in children are lacking. ICI2016 has also affirmed that the specific demands of children, psychologically as well as physically, are respected before iUDS is carried out as well as during the testing and recommends specialized workers, units and equipment to ensure this. ICI2016 recommends that non-invasive diagnostic tests should be preferred where possible, iUDS should be done only if deemed useful by the results of non-invasive procedures, when the outcome of iUDS can alter management. Clinicians should take into account the effect of the (apparent psychologically stressing) laboratory-situation on the child's behavior and the implications for the results and the representativeness of the tests. A publication of 2015 by the International Children Continence Society provided expert recommendations for the practice of iUDS²⁷ also practice for VUDS.²⁸ The indications for UDS evaluation in children with urinary incontinence (or LUTD) are usually, anatomical and/or functional abnormalities and frequently neurological. In children with relevant neurological lesions, UDS is done regardless of (specific) symptoms, to discover conditions causing upper urinary tract risk.

6.1 | Children with neurogenic lower urinary tract dysfunction

6.1.1 | Myelodysplasia and occult spinal dysraphism

iUDS is advised by the ICI2016 in all patients with MMC, on a regular basis throughout the entire life from earliest childhood (3 months), based on ample evidence. iUDS should be considered, apart from routine, by a change of lower body half function and/or clinical change of LUT or UUT function, or when significant management changes have been started. ICI2016 recommended again (ICI2013) that the advantages and disadvantages of the addition of imaging to iUDS

(videourodynamics) should be considered children with MMC on an individual basis, for example, the likelihood of new anatomical abnormalities.

6.1.2 | Spinal cord injury

The committee recommends that iUDS evaluation in children with SCI is done not earlier than 6 weeks after injury, and that follow up is scheduled on an individual basis.

6.1.3 | Cerebral palsy

Some studies have shown that clinically unexpected LUTD can be present in children with cerebral palsy, especially when voiding symptoms are present. Observation and non-invasive testing are helpful, but iUDS should be considered when UTIs or UUT dilation occur.

6.1.4 | Anorectal malformation and sacral agenesis

Diverse studies have shown that a significant proportion of children with ARM has (primary-neuro-anatomical and/or secondary-functional) dysfunction of the LUT and pelvic floor. Clinicians should (grade C) consider iUDS in children with anorectal malformation, imperforate anus, or sacral agenesis when clinical signs of LUTD or when relevant neurologic abnormalities (clinical and or on imaging) exist. Around one third of children with ARM have MMC or tethered spinal cord, with (iUDS demonstrable) and clinically relevant NLUTD. Clinicians should also consider iUDS after (surgery for) sacrococcygeal teratoma.²⁹

6.2 | Children with anatomic abnormalities and dysfunctions

6.2.1 | Bladder exstrophy

Once the exstrophied bladder is closed it may be difficult to manage persistent UI, UUT dilation or VUR. UDS for diagnosis and follow up are relevant, also to decide on interventions to improve continence function and/or if augmentation cystoplasty would be required.^{30,31,32} UDS remain also helpful to evaluate LUT before (and after) further surgical procedures and for research matters.^{33,34,35}

6.2.2 | Posterior urethral valves

In the past iUDS had been essential to understand (functional) outflow obstruction, LUT dysfunction, persistence of UI and UUT (and renal) impairment evolution in boys with PUV.^{36,37} Also with early valve ablation, gradual detrusor “decompensation” and/or secondary BOO and finally DU or acontractility may be

expected in a proportion of boys. It is reasonable to follow these patients by non-invasive UDS exams and iUDS when clinical progression is noted.³⁸

6.2.3 | Vesicoureteral reflux

VUR may be a secondary phenomenon resulting from LUT dysfunction, not (only) from a primary anatomic ureterovesical junction abnormality, in a significant proportion of children^{39–41} and that for example, DO may lead to VUR in a marginally competent ureterovesical junction mechanism.^{42,43} Many clinicians advocate UDS especially for those patients that still have UI, renal damage, or when surgical correction is considered.^{44,45}

6.3 | Children with functional disorders of the lower urinary tract

When assessing functional disorders involving the LUT in children, one must take into account the dynamics of the maturing nervous system and the LUT, including the normal learning curve for pelvic floor muscle, bladder, and bowel function, its abnormalities and the social and other positive and negative influences. iUDS has a limited place in diurnal incontinence, before age 5 or 6.⁴⁶ Uroflowmetry with PVR determination is the test of choice and results from uroflowmetry (mL) should be compared with information from the patient's frequency voiding charts. Persistent daytime and night-time UI, resistant to conventional therapy may require (V)UDS.⁴⁷ It is generally not necessary to conduct UDS for Mono-symptomatic Nocturnal Enuresis. The committee recommends bladder diary, uroflowmetry (with pelvic floor EMG) and PVR assessment in all children with LUTS, UI and with nocturnal enuresis resistant to first line therapy.^{48,49} The committee suggests to consider urological assessment in children with chronic constipation and/or fecal incontinence.

7 | URODYNAMIC TESTING OF FRAIL ELDERLY PERSONS WITH URINARY INCONTINENCE

UI in the frail elderly commonly has diverse and multiple coexisting factors. Retrospective single center cohort reports confirm that aging, general health, mobility, medications, and neurologic diseases all have effects on LUT function. ICI 2016 concludes again (ICI2013) that also in the frail elderly, symptoms, and signs are unreliable to predict the type and grade of LUT dysfunction. Especially, but not exclusively, as an example, male elderly patients with central neurological disease, can also have urologic disease (eg, prostatic BOO) as a cause for UI or other LUTD.

Frail elderly with UI should be evaluated by a clinician skilled in the care of those patients. All contributing factors

are managed, before further urological diagnostics are performed. ICI2016 recommended that (standard) UDS should be offered to all elderly patients with signs and symptoms or LUTD not responding to relevant initial management regardless of the age and/or comorbidity if specific invasive treatment is deemed appropriate and/or possible. Every invasive procedure can cause harm but there is no published evidence that iUDS cause significantly more harm in the vulnerable elderly.

“Simple” bedside UDS (observing fluid level in a vertically placed bladder-catheter tube) has an inherent unreliability that very likely does not outweigh its “simplicity.” PVR measurement (by ultrasound) is, as earlier (ICI2013), recommended before institution of pharmacological or surgical treatment of UI and should be repeated to monitor the effect of such treatment. Uroflowmetry should be used to screen for voiding abnormalities prior to invasive treatment in the elderly. If its inherent (but unknown) unreliability is taken into account, simple cystometry can be considered as a “screening test” for consideration of non-invasive low risk treatments, when a urethral or suprapubic catheter is already present for management. ICI2016 recommends however offering iUDS to all elderly with due consideration to any co-morbidity, who have not responded to management of relevant contributing factors and/or behavioral or pharmacological therapy and in whom further invasive therapy is considered.

7.1 | Urinary urgency incontinence in frail elderly patients

In non-systematic reviews it appears safe to pragmatically initiate (oral) medical treatment for OAB-S in the frail elderly.^{50–52} In frail elderly women, DO is reported to be the commonest iUDS diagnosis in a large retrospective series of symptomatically referred elderly women.⁵³ On the other hand cautiousness is needed because OAB-s may represent ineffective emptying⁵⁴ With regard to male elderly patients, a total of 185 men who had persistent LUTS after TURP were evaluated with VUDS in one single center study and only 9% had normal function.⁵⁵

7.2 | Stress urinary incontinence in frail male elderly patients

UI in elderly men may be the consequence of ineffective emptying and BOO, commonly referred to as overflow urinary incontinence. “Pure” SUI is almost entirely confined to patients after RRP but approximately 1% of geriatric patients suffers from post prostatectomy (TURP) SUI. The majority of SUI after RRP is caused by surgical damage and not related to the aging. However with iUDS a (secondary) reduced bladder compliance, de novo DO, and DU are commonly observed and UDS may have a role in order to establish appropriate treatment strategy.

7.3 | Evidence that performing urodynamic studies improves clinical outcomes in the geriatric population

iUDS was not able to predict the outcome of SUI surgery in older women in a single center uncontrolled cohort.⁵⁶ Regarding the diagnostic evaluation of LUTS in older men, an International Consultation on New Development in Prostate Cancer and Prostate Diseases concluded that the frequency/volume chart is recommended to exclude nocturnal polyuria when nocturia is a bothersome symptom. The use of (i)UDS and also transrectal ultrasound is especially relevant when surgery is considered.⁵⁷ DO or LUTD with or without BOO are present in patients with Parkinson's disease.⁵⁸

7.4 | Indications for urodynamic testing in the elderly

ICI2016 recommends PVR urine measurement before management of UI, either by life style adaption, with pharmacotherapy or by SUI surgery. A consistently large PVR is a cause for caution, and careful monitoring of bladder emptying is recommended.^{54,59} After intradetrusor BoNT-A injection for OAB-S, the chance of large PVR volume (greater than 150 mL) was significantly higher in the frail elderly group than in the non-frail elderly or younger patient groups⁶⁰ and ICI2016 recommends monitoring of PVR. A normal uroflowmetry pattern without much PVR probably rules out significant BOO or DU, but this finding is unusual in the elderly. Uroflowmetry (with PVR measurement) may be a useful screening tool prior to instituting therapy.⁶¹

After screening with uroflowmetry and PVR measurement, pressure-flow studies may be indicated in older men in whom BOO cannot be ruled out otherwise. There is weak evidence to suggest that prostatectomy may improve continence if iUDS shows BOO in Parkinson's disease patients.⁶² ICI2016 concluded that there seems little point in performing surgery (prostatectomy) to alleviate the signs and LUTS if BOO is equivocal or absent.

7.5 | The urodynamic parameters important in various geriatric conditions

UDS can be of relevance to determine the most important cause of the LUTS in the elderly, where central nervous system disease is a prevalent comorbidity and where clinical signs and symptoms of LUTD are regularly more difficult to obtain or to isolate. Brain disorders such as stroke, Parkinson's disease and white matter disease affect LUT function and likely for example, the prevalence of OAB-S in the elderly population.⁶³

7.5.1 | Parkinson's disease

The duration and severity of Parkinson's disease were reported not to associate with iUDS results in a prospective

observational study.⁶⁴ iUDS is therefore recommended to stage the LUT dysfunction in men with Parkinson's disease with LUTD as specific (urological) treatment can improve the LUT function and quality of life.⁵⁸

7.5.2 | Other CNS disorders

Acute urinary retention and/or voiding difficulty are frequently encountered signs of LUTD in stroke patients. The majority of stroke patients ($\pm 60\%$) had remained able to void spontaneously at rehabilitation admission. During rehabilitation this percentage increased, partially because iUDS had provided the arguments to remove the indwelling catheter. At discharge $\pm 20\%$ of the patients depended on intermittent or indwelling catheter or on condom conduit.⁶⁵

8 | CONCLUSION

Patients that are not satisfied with their initial management on the basis of their reported signs and symptoms of urinary incontinence, as well as patients with neurological abnormalities potentially relevant for the lower urinary tract, may very likely profit from objective diagnosis and staging and grading of their dysfunction, with urodynamic testing, regardless their age, vulnerability, and/or comorbidities. This manuscript presents an executive summary of the ICI2016 committees most important recommendations for the use of urodynamic investigations for patients with urinary incontinence.

ACKNOWLEDGMENTS

Prof. Linda Cardozo; Prof. Paul Abrams; Prof. Adrian Wagg and Prof. Alan Wein have, directly and indirectly contributed to the chapter that has been the basis for this manuscript and have been inspiring and indispensable leaders for the International Consultation of Incontinence.

CONFLICTS OF INTEREST

None.

ORCID

Peter F. W. M. Rosier  <http://orcid.org/0000-0003-0445-4563>

REFERENCES

1. Abrams, P, Cardozo, L, Wagg, A, Wein, A. Incontinence 6th Edition (2017). ICI-ICS. International Consultation on Incontinence –International Continence Society, Bristol UK, ISBN: 978–

0956960733. Committee 6: Urodynamic Testing: Chair: Rosier Peter F.W.M. p. 599–670.
2. Abrams, P, Cardozo, L, Khoury S, Wein, A. Incontinence 5th Edition (2013). International Consultation on Incontinence-European association of Urology, Paris, France, ISBN: 978-9953-493-21-3. Committee 6: Urodynamics: Chair: Rosier Peter F.W.M. p. 431–508.
 3. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology*. 2003;61:37–49. Review. PubMed PMID: 12559262.
 4. Schäfer W, Abrams P, Liao L, et al. Good urodynamic practices: uroflowmetry, filling cystometry, and pressure-flow studies. *Neurourol Urodyn*. 2002;21:261–274. PubMed PMID: 11948720.
 5. Rosier PF, Schaefer W, Lose G, et al. International Continence Society Good Urodynamic Practices and Terms 2016: Urodynamics, uroflowmetry, cystometry, and pressure-flow study. *Neurourol Urodyn*. 2017;36:1243–1260.
 6. Nager CW, Brubaker L, Litman HJ, et al. A randomized trial of urodynamic testing before stress-incontinence surgery. *N Engl J Med*. 2012;366:1987–1997.
 7. Zimmern, N, Albo, F. Mohr McDermott Urinary Incontinence Treatment Network (UITN) Urodynamic inter-rater reliability between local and central physician reviewers for the filling cystometogram in the stress incontinence surgical treatment efficacy trial; Abstract 16 ICS/IUGA 2004.
 8. van Leijssen SA, Kluivers KB, Mol BW, et al. Value of urodynamics before stress urinary incontinence surgery: a randomized controlled trial. *Obstet Gynecol*. 2013;121:999–1008.
 9. Lee KS, Choo MS, Doo CK, et al. The long term (5-years) objective TVT success rate does not depend on predictive factors at multivariate analysis: a multicentre retrospective study. *Eur Urol*. 2008;53:176–182.
 10. Barnard J, van Rij S, Westenberg AM. A valsalva leak-point pressure of >100 cmH₂O is associated with greater success in AdVance™ sling placement for the treatment of post-prostatectomy urinary incontinence. *BJU Int*. 2014;114:34–37.
 11. Rosier PF, Giarenis I, Valentini FA, Wein A, Cardozo L. Do patients with symptoms and signs of lower urinary tract dysfunction need a urodynamic diagnosis? ICI-RS. *Neurourol Urodyn*. 2013; 33:581–586.
 12. Serati M, Cattoni E, Siesto G, et al. Urodynamic evaluation: can it prevent the need for surgical intervention in women with apparent pure stress urinary incontinence? *BJU Int*. 2013;112:E344–E350.
 13. Serati M, Braga A, Athanasiou S, et al. Tension-free vaginal tape-Obturator for treatment of pure urodynamic stress urinary incontinence: efficacy and adverse effects at 10-year follow-up. *Eur Urol*. 2016;pii:S0302-2838(16)30527-9.
 14. Porena M, Mearini E, Mearini L, Vianello A, Giannantoni A. Voiding dysfunction after radical retropubic prostatectomy: more than external urethral sphincter deficiency. *Eur Urol*. 2007;52: 38–45.
 15. Huckabay C, Twiss C, Berger A, Nitti VW. A urodynamics protocol to optimally assess men with post-prostatectomy incontinence. *Neurourol Urodyn*. 2005;24:622–626.
 16. Mebust W, Holtgrewe HL. Current status of transurethral prostatectomy: a review of the AUA National Cooperative Study. *World J Urol*. 1989;6:194.
 17. Krambeck AE, Handa SE, Lingeman JE. Experience with more than 1,000 holmium laser prostate enucleations for benign prostatic hyperplasia. *J Urol*. 2010;183:1105–1109.
 18. Dubbelman Y, Groen J, Wildhagen M, Rikken B, Bosch R. Quantification of changes in detrusor function and pressure-flow parameters after radical prostatectomy: relation to postoperative continence status and the impact of intensity of pelvic floor muscle exercises. *Neurourol Urodyn*. 2012;31:637–641.
 19. Lee H, Kim KB, Lee S, et al. Urodynamic assessment of bladder and urethral function among men with lower urinary tract symptoms after radical prostatectomy: a comparison between men with and without urinary incontinence. *Korean J Urol*. 2015;56:803–810.
 20. Elliott CS, Comiter CV. Maximum isometric detrusor pressure to measure bladder strength in men with postprostatectomy incontinence. *Urology*. 2012;80:1111–1115.
 21. Groen J, Pannek J, Castro Diaz D, et al. Summary of European Association of Urology (EAU) Guidelines on Neuro-Urology. *Eur Urol*. 2016;69:324–333.
 22. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. *Neurourol Urodyn*. 2002;21:167–178.
 23. Drake M, Apostolidis A, Emmanuel A, et al. Neurologic urinary and faecal incontinence. In: Abrams P, Cardozo L, Khoury S, et al., eds. *Incontinence*. 5th ed. Paris: ICUD-EAU; 2013:827–1000.
 24. Dorsher PT, McIntosh PM. Neurogenic bladder. *Adv Urol*. 2012;2012:816274.
 25. DeVivo MJ, Krause JS, Lammertse DP. Recent trends in mortality and causes of death among persons with spinal cord injury. *Arch Phys Med Rehabil*. 1999;80:1411–1419.
 26. Tanaka H, Kakizaki H, Kobayashi S, Shibata T, Ameda K, Koyanagi T. The relevance of urethral resistance in children with myelodysplasia: its impact on upper urinary tract deterioration and the outcome of conservative management. *J Urol*. 1999;161:929–932.
 27. Bauer SB, Nijman RJM, Drzewiecki BA, Sillen U, Hoebeke P. International children's continence society standardization report on urodynamic studies of the lower urinary tract in children. *Neurourol Urodyn*. 2015;34:640–647.
 28. Spinoit AF, Decalf V, Ragolle I, et al. Urodynamic studies in children: standardized transurethral video-urodynamic evaluation. *J Ped Urol*. 2016;12:67–68.
 29. Mosiello G, Gatti C, De Gennaro M, et al. Neurovesical dysfunction in children after treating pelvic neoplasms. *BJU Int*. 2003;92: 289–292.
 30. Diamond DA, Bauer SB, Dinlenc C, et al. Normal urodynamics in patients with bladder exstrophy: are they achievable? *J Urol*. 1999;162:841–844. discussion 844-5.
 31. Burki T, Hamid R, Duffy P, Ransley P, Wilcox D, Mushtaq I. Long-term followup of patients after redo bladder neck reconstruction for bladder exstrophy complex. *J Urol*. 2006;176:1138–1141. discussion 1141-2.
 32. Gargollo PC, Borer JG, Diamond DA, et al. Prospective followup in patients after complete primary repair of bladder exstrophy. *J Urol*. 2008;180:1665–1670. discussion 1670.
 33. Diamond DA, Bauer SB, Dinlenc C, et al. Normal urodynamics in patients with bladder exstrophy: are they achievable? *J Urol*. 1999;162:841–844. discussion 844-5.
 34. Burki T, Hamid R, Duffy P, Ransley P, Wilcox D, Mushtaq I. Long-term followup of patients after redo bladder neck reconstruction for

- bladder exstrophy complex. *J Urol.* 2006;176:1138–1141. discussion 1141–2.
35. Gargollo PC, Borer JG, Diamond DA, et al. Prospective followup in patients after complete primary repair of bladder exstrophy. *J Urol.* 2008;180:1665–1670. discussion 1670.
 36. Mitchell M. Persistent ureteral dilation following valve resection, in Dialogues in Pediatric Urology. 1982;5:8–10.
 37. Glassberg KI. The valve bladder syndrome: 20 years later. *J Urol.* 2001;166:1406–1414.
 38. Capitanucci ML, Marciano A, Zaccara A, La Sala E, Mosiello G, De Gennaro M. Long-term bladder function followup in boys with posterior urethral valves: comparison of noninvasive vs invasive urodynamic studies. *J Urol.* 2012;188:953–957.
 39. Sillen U, Bachelard M, Hansson S, Hermansson G, Jacobson B, Hjalmas K. Video cystometric recording of dilating reflux in infancy. *J Urol.* 1996;155:1711–1715.
 40. Capitanucci ML, Silveri M, Mosiello G, Zaccara A, Capozza N, de Gennaro M. Prevalence of hypercontractility in male and female infants with vesico-ureteral reflux. *Eur J Pediatr Surg.* 2000;10:172–176.
 41. Podesta ML, Castera R, Ruarte AC. Videourodynamic findings in young infants with severe primary reflux. *J Urol.* 2004;171:829–833. discussion 833.
 42. Khoury AE, Dave S, Peralta-Del Valle MH, Braga LH, Lorenzo AJ, Bagli D. Severe bladder trabeculation obviates the need for bladder outlet procedures during augmentation cystoplasty in incontinent patients with neurogenic bladder. *BJU Int.* 2008;101:223–226.
 43. Chandra M, Maddix H. Urodynamic dysfunction in infants with vesicoureteral reflux. *J Pediatr.* 2000;136:754–759.
 44. Musquera Felip M, Errando Smet C, Prados Saavedra M, Arano Bertran P, Villavicencio Mavrich H. False postvoid residual volume diagnosed by videourodynamics. *Actas Urol Esp.* 2004;28:792–795.
 45. Fotter R, Riccabona M. Functional disorders of the lower urinary tract in children. *Radiologe.* 2005;45:1085–1091.
 46. Austin PF, Bauer SB, Bower W, et al. The standardization of terminology of lower urinary tract function in children and adolescents: update report from the standardization committee of the international children's continence society. *J Urol.* 2014;191:1863.
 47. Borzyskowski M, Mundy AR. Videourodynamic assessment of diurnal urinary incontinence. *Arch Dis Child.* 1987;62:128–131.
 48. Rittig N, Hagstroem S, Mahler B, et al. Outcome of a standardized approach to childhood urinary symptoms-long-term follow-up of 720 patients. *Neurourol Urodyn.* 2014;33:475–481.
 49. Sehgal R, Paul P, Mohanty NK. Urodynamic evaluation in primary enuresis: an investigative and treatment outcome correlation. *J Trop Pediatr.* 2007;53:259–263.
 50. Kraus SR, Bavendam T, Brake T, Griebing TL. Vulnerable elderly patients and overactive bladder syndrome. *Drugs Aging.* 2010;27:697–713.
 51. Staskin DR. Overactive bladder in the elderly: a guide to pharmacological management. *Drugs Aging.* 2005;22:1013–1028.
 52. Wagg AS, Cardozo L, Chapple C, et al. Overactive bladder syndrome in older people. *BJU Int.* 2007;99:502–509.
 53. Valentini FA, Robain G, Marti BG, Nelson PP. Urodynamics in a community-dwelling population of females 80 years or older. Which motive? Which diagnosis? *Int Braz J Urol.* 2010;36:218–224.
 54. Taylor JA, 3rd, Kuchel GA. Detrusor underactivity: clinical features and pathogenesis of an underdiagnosed geriatric condition. *J Am Geriatr Soc.* 2006;54:1920–1932. Review.
 55. Kuo HC. Analysis of the pathophysiology of lower urinary tract symptoms in patients after prostatectomy. *Urol Int.* 2002;68:99–104.
 56. Sevestre S, Ciofu C, Deval B, Traxer O, Amarenco G, Haab F. Results of the tension-free vaginal tape technique in the elderly. *Eur Urol.* 2003;44:128–131.
 57. Abrams P, Chapple C, Khoury S, Roehrborn C, De la Rosette J, International Consultation on New Developments in Prostate Cancer and Prostate Diseases. Evaluation and treatment of lower urinary tract symptoms in older men. *J Urol.* 2013;189:S93–S101.
 58. Xue P, Wang T, Zong H, Zhang Y. Urodynamic analysis and treatment of male Parkinson's disease patients with voiding dysfunction. *Chin Med J (Engl).* 2014;127:878–881.
 59. Thuroff JW, Abrams P, Andersson KE, et al. EAU guidelines on urinary incontinence. *Eur Urol.* 2011;59:387–400.
 60. Liao CH, Kuo HC. Increased risk of large post-void residual urine and decreased long-term success rate after intravesical onabotulinumtoxinA injection for refractory idiopathic detrusor overactivity. *J Urol.* 2013;189:1804–1810.
 61. Valentini FA, Robain G, Marti BG, Nelson PP. Urodynamics in a community-dwelling population of females 80 years or older. Which motive? Which diagnosis? *Int Braz J Urol.* 2010;36:218–224.
 62. Gormley EA, Griffiths DJ, McCracken PN, Harrison GM, McPhee MS. Effect of transurethral resection of the prostate on detrusor instability and urge incontinence in elderly males. *Neurourol Urodyn.* 1993;12:445–453.
 63. Pizzi A, Falsini C, Martini M, Rossetti MA, Verdesca S, Tosto A. Urinary incontinence after ischemic stroke: clinical and urodynamic studies. *Neurourol Urodyn.* 2014;33:420–425.
 64. Sakushima K, Yamazaki S, Fukuma S, et al. Influence of urinary urgency and other urinary disturbances on falls in Parkinson's disease. *J Neurol Sci.* 2016;360:153–157.
 65. Ersoz M, Erhan B, Akkoc Y, et al. An evaluation of bladder emptying methods and the effect of demographic and clinical factors on spontaneous voiding frequency in stroke patients. *Neurol Sci.* 2013;34:729–734.

How to cite this article: Rosier PFWM, Kuo H-C, De Gennaro M, et al. International Consultation on Incontinence 2016; Executive summary: Urodynamic testing. *Neurourology and Urodynamics.* 2019;38:545–552. <https://doi.org/10.1002/nau.23903>