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Original Contributions on

- Urinary Tract Function
- Urinary and Fecal Continence
- Pelvic Floor Function

Fundamental Assessment of Lower Urinary Tract Dysfunction

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TABLE OF CONTENTS

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TABLE OF CONTENTS

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The International Continence Society (ICS) Board of Trustees is glad to present a special supplement of *Neurourology and Urodynamics* which sets out the core knowledge for any practitioner needing to assess lower urinary tract dysfunction (LUTD) in their clinical work. The material will be useful to trainees, allied health professionals, and people working in related disciplines like neurology, primary care, and care of the elderly. The documents are written in a simplified way to offer a helpful source of education and knowledge of several different aspects of LUTD.

A significant motivation for this effort is the need to be concise, explicit, and definitionally correct when using a common lexicon, as with the ICS Standardization documents, that govern the manner in which professionals in our field define their research and report results thereof. A sequence of documents is included which covers;

- Urinary symptoms in general, and in specific patient groups (nocturia; neurological disease; chronic pelvic pain)
- Pelvic organ prolapse quantification
- Urodynamic tests (flow rate testing; filling cystometry with pressure flow studies; videourodynamics)
- The importance of standardization and how the ICS Standards are developed

The knowledge base is drawn from the ICS Standards, which constitute the basis of specialist practice in LUTD, supplemented by practical application. The authors were asked to write succinct and approachable documents, describing what they feel any practitioner really must know for everyday practice, and providing examples. Thus, these documents are derivatives of the many reports and publications that represent the ICS Standards but are not in themselves ICS Standardization documents. Inevitably, the choice of content is subjective, but each document seeks to offer simplicity and clarity. For those working to become specialists in the area, this supplement is a starting point for getting to grips with the comprehensive repository of detailed professional consensus documents established by the ICS over the course of several decades and available on the ICS website (https://www.ics.org/folder/189).

A significant aspect of the knowledge transfer is the education of those who are students or early career clinicians and investigators. Thus, the supplement aims to facilitate clarity, accuracy, and specificity of reports in the fields of urodynamics, neurourology, pelvic floor disorders, and urogenital reconstruction. Health care practitioners and clinicians will benefit from these documents, which give a brief review of those subjects related to LUT dysfunction, and as their knowledge grows, we hope they will feel enthused to engage with the full ICS Standards.

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A commentary on expectations of healthcare professionals when applying the international continence society standards to basic assessment of lower urinary tract function

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The Continence Society (ICS) has sustained a drive to improve the clinical assessment of lower urinary tract function for many years. Increasingly, healthcare professionals (HCPs) engage with the guidance, and patients benefit from the precision that results when their carers apply a sensible and logical approach to assessment. The current supplementary issue of Neurourology and Urodynamics (NAU) summarizes the fundamentals derived from major ICS initiatives, emphasizing what HCPs must know when dealing with these patients, regardless of the medical discipline in which they work. It also introduces the basics of urodynamics testing to trainees and HCPs who may refer patients for testing. In this editorial review we draw out some additional points of consideration. We emphasize the need to avoid using terms in a clinical context that could imply causative mechanism, until the mechanism has actually been identified. We caution against the use of severity thresholds, until there is proper data to justify their application for any given patient group. Finally, we provide a description of the philosophical basis of urodynamics testing, including videourodynamics. This commentary should be read in the context of the other articles provided in the NAU supplement.

KEYWORDS
LUTS, overactive bladder, standardization, urodynamics

1 | INTRODUCTION

LUTD is encountered in some form by a wide range of healthcare practitioners (HCPs), notably medical, nursing, and allied professionals working in Primary Care, Gerontology and Neurology. For these, awareness of a fundamental knowledge base should include the correct use of the terminology for lower urinary tract symptoms (LUTS), and the relevant signs and urodynamic observations. Likewise, residents in urology and gynaecology need to appreciate the fundamentals of LUTS and lower urinary tract dysfunction (LUTD), as a stepping stone for the more detailed knowledge used in specialist practice. The International Continence Society (ICS) has developed standards which set the specialist terminology and diagnostic methodology in great precision for the full scope of practice in LUTD with considerable detail as needed by specialists in the area. These documents produced by the Standardization Steering Committee and other ICS Committees meet the needs of specialists, and professionals who have mastered the fundamentals and who are strongly encouraged to engage with the full standards.

The ICS approach is founded on the importance of logical and clear-thinking clinical diagnosis and therapy selection,

Dr. Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

making sure that treatment options are specifically matched to the individual patient. Well-worded terminology has steadily evolved over the years to make sure that it is suited to the potential presentations. Standards for testing in Urodynamics have been refined to give practitioners the best chance to identify abnormalities in their patients and interpret the features appropriately. This supplement of Neurourology and Urodynamics was commissioned by the Trustees of the ICS to introduce a new generation of residents and recently appointed consultants to the important work of standardization in functional urology. It aims to set out and exemplify the fundamentals as a starting point to engaging with the ICS Standards. Experts have been asked to extract pertinent aspects from some of the most widely used Standards, to facilitate awareness of key points in LUTS, nocturia, neuro-urology, chronic pelvic pain, pelvic organ prolapse quantification, flow rate testing, urodynamics, and videourodynamics.

2 | LOWER URINARY TRACT FUNCTION

The description of lower urinary tract function breaks it down into symptoms, signs, and urodynamic observations. The terminology is phrased to ensure that patients and doctors can align their discussions appropriately. A key requirement is to ensure that the words HCPs use do not imply a mechanism without good justification. In male patients, words or phrases like "obstructive," "prostatism," or "prostate symptom score" insinuate that the mechanism of symptoms is already known, and caused by the prostate. Yet it is wrong to imply this at the start of the patient's assessment; it innately biases the doctor (and sometimes the patient) to expect therapy aimed at relieving obstruction and dealing with the prostate. That may come later, but only once other causes which can lead to very similar symptoms have been excluded. Weak or slow stream may be due to the prostate and the possibility of an underactive detrusor being the cause must also be considered. Likewise, "irritative" is not appropriate, given that there is generally no evidence for irritation in the context of storage LUTS. Fundamentally, the potential to misrepresent mechanism by careless use of terminology needs to be avoided.

Two areas where clinicians can get a little bit muddled by terminology are frequency and overactivity. "Frequency" indicates how often a person passes urine in a given time period, so it is a sign. "Increased daytime frequency" indicates that the patient feels he or she voids too often by day, so it is the correct phrase to describe a symptom reported by a patient. The word "Overactivity" is used in two terms: firstly, it is used in the context of overactive bladder (OAB), which is a symptom syndrome, and by its definition, everyone with OAB experiences urinary urgency. Secondly, detrusor overactivity (DO), is a urodynamic observation of a bladder contraction during filling, which is usually, but not always, associated with urgency. Therefore, DO and OAB are not interchangeable terms.

The categorization of LUTS relates the timing of the symptom to the micturition cycle, hence storage LUTS, voiding LUTS, and LUTS happening straight after voiding has finished (post-micturition symptoms). Many individuals present with several LUTS, and these can be grouped into symptom syndromes. OAB is one, in which storage LUTS are principal features. Underactive bladder (UAB) is another, in which voiding LUTS are prominent. Because OAB and UAB occur mainly in the storage and voiding phases, respectively, it is perfectly possible for one person to have both overactive and underactive symptoms, that may or may not be shown by urodynamics to be due to DO and detrusor underactivity (DU).

3 | SEVERITY THRESHOLDS

The HCPs need to be careful in setting thresholds to "qualify" someone as having symptoms (eg, not counting someone as having nocturia because they only get up once per night to pass urine). Unfortunately, there is only limited robust evidence to warrant thresholds. Furthermore, quantifying the significance of symptoms can be difficult as symptoms are subjective, and may vary a lot from day to day, so even a 3 day observation period of a bladder diary may not capture the full story. Furthermore there is considerable variation from person to person, so values are difficult to compare. Thus the ICS emphasises the need to distinguish a symptom's frequency from the impact on quality of life and bother it brings, as they are not necessarily correlated. For example, many men report a relatively severe level of slow stream, but do not describe themselves as particularly bothered by it. In contrast, symptoms like urgency and post micturition dribble can be highly bothersome even if severity appears relatively mild to the impartial observer. For nocturia, people who generally experience a single episode on average each night should be cataloged as having nocturia; it will be non-bothersome for many patients, but that does not mean nocturia is absent.

In practice, it seems reasonable to suggest;

- A symptom is important if the patient says it is bothersome. For example, the symptom of increased daytime frequency (the complaint by the patient who considers that he/she voids too often by day[1]) is very much dependent on the patient's attitude, and there is a large variation in what patients consider intrusive.
- A symptom or sign is important if it can explain mechanism or identify disease. For example, nocturia (**symptom**: the complaint that the individual has to wake at night one or more times to void; **sign**: the number of times an individual passes urine during their main sleep period[1]) may be non-bothersome to the patient if they only void once per night,

but it might identify the early stages of a systemic medical condition, such as chronic kidney disease, needing diagnosis and therapy.[2]

- All urodynamic observations should be noted, as they may explain symptoms or signs, and guide treatment selection. The urodynamic observation of detrusor overactivity (involuntary detrusor contractions during the filling phase) should be noted, even if the contraction is only very low amplitude.

4 | FUNDAMENTALS OF URODYNAMIC PRACTICE

Practitioners must show due consideration to their patients. It is important that staff recognize that somebody attending to do a flow rate test may be a patient experiencing urgency in their day to day life, so it is not appropriate to demand of them that they must pass a minimum voided volume of 150 mL, if they say that they are desperate to go! Furthermore, it is not appropriate to load somebody with very large volumes of liquid in an attempt to try to make them pass urine a bit more quickly for the convenience of the flow rate clinic. This is an unrealistic expectation, and is often detrimental to reliable voiding behavior. For filling cystometry and pressure flow studies, patients are apprehensive about undertaking a test in which their urethra and anus are going to be cannulated. People may feel the whole process is very undignified and compassionate handling by staff is essential. Patients are much more satisfied after urodynamics if they received an information leaflet before they come for their tests.

In flow rate testing, some key points are;

- Calibrate the equipment for reliable results.
- Ask the patient to complete a 3 day bladder diary in advance.
- Provide a suitable environment for testing (a place to wait, rapid access to the meter when needing to pass urine, privacy, a hygienic setting).
- Validate that the voided volume is representative, by comparing with the bladder diary.
- Check that bladder volume at the start of voiding (derived by adding voided volume and post void residual) is in a suitable range (150-500 mL).
- Identify key artefacts; knock, squeeze, and release, to ensure the values reported are indicative of the patient rather than an artefact.

Some basic principles are important for urodynamic units;

1. A urodynamic unit must follow the appropriate instructions given by the equipment manufacturers, and practitioners should calibrate and check their equipment regularly. All staff must be trained and properly supported by experienced clinicians.
2. Before a test, each patient's symptoms should be fully understood, with a symptom score and bladder diary completed. Ideally, potential treatment options should be considered before the test by the referring clinician, who has already discussed them with the patient. Thereby, the test can be done so as to help select the treatment, based on chance of success and identification of potential adverse outcome.
3. When running a test, the pressure traces should be scrutinized throughout the study to be confident recordings are genuinely picking up the pressures. This requires looking to see that the bladder and abdominal pressure lines detect breathing and movement similarly, and that

TABLE 1 Contents of a urodynamics report proposed in the UK continence society (UKCS) minimum standards for urodynamics[3]

UKCS recommendation	Possible urodynamic observations
Record of the urodynamic findings during filling, whether normal or abnormal	
Detrusor function during filling	Normal/detrusor overactivity
Urethral function during filling	Competent/incompetent
Bladder and urethral sensation	• At what volume did the patient report FSF, NDV and SDV? • Did they experience urgency?
Bladder capacity	Report volume
Record of the urodynamic findings during voiding, whether normal or abnormal	
Detrusor function during voiding	Normal/underactive or acontractile
Urethral function during voiding	Normal/obstructed
Post void residual	Report volume
Statement on whether the patient's everyday symptoms were reproduced[a]	

FSF: first sensation of filling; NDV: normal desire to void; SDV: strong desire to void?

[a]The report should document whether the patient's everyday symptoms were fully reproduced/ partly reproduced/ not reproduced.

coughs are done throughout filling, plus before and after voiding to monitor trace quality.

a) Regular labels must be applied during the study; these annotations will help anyone not present at the study to interpret the findings later on.

b) The "zero" button is a software button which drops the vesical and abdominal pressure lines onto zero. This must only be clicked when recording from atmosphere, not when the transducers are connected to the patient- this is a common mistake.

4. After the test, the trace must be scrutinized to make sure that crucial pressure and flow values are genuinely indicative of the patient's urinary tract function. High pressures caused by knocking the equipment, or low pressures because a tube got blocked, must be identified, corrected if possible, and interpreted accordingly. Urodynamic machines and software are not reliably able to identify artefacts with current technology. Key parameters such as maximum flow rate, bladder outlet obstruction (BOO) index or bladder contractibility index

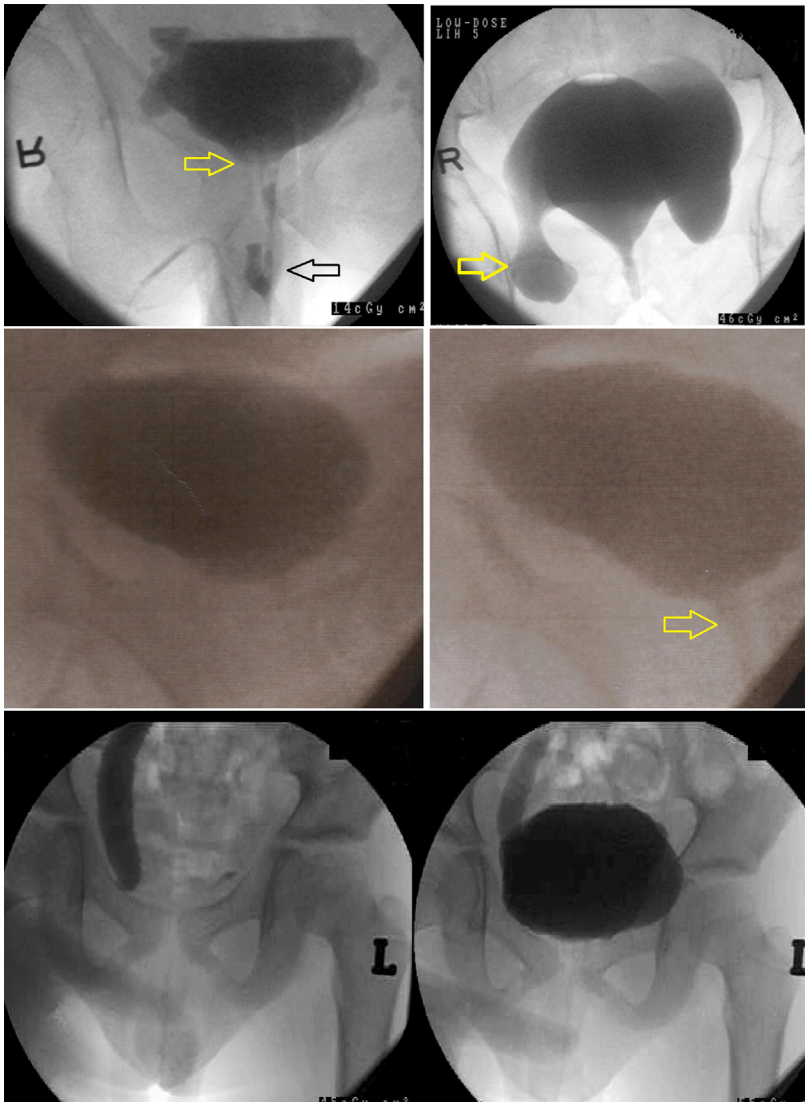

FIGURE 1 Additional information with radiological imaging during urodynamics. Top left; identifying the site of BOO in a man with Parkinson's disease. In this case, the obstruction is at the bladder neck (yellow upper arrow). This man also had significant pooling in the bulbar urethra (black lower arrow), which caused post micturition dribble. Top right; a man with large bladder diverticula, the one on the right entering an inguinal hernia (arrow). These diverticula made it very difficult to measure bladder pressure. Middle pictures; a man with prior transurethral resection of the prostate (TURP) whose presenting complaint was urgency. He did not have detrusor overactivity. During filling cystometry, contrast was not present in the proximal urethra to begin with (middle left image), but it was seen to enter the urethra (arrow, middle right) synchronous with the patient's report of urgency, which was the typical sensation of his presentation. Lower pictures; images taken at the end of voiding in a boy with vesico-ureteric reflux. The left hand image confirmed bladder emptying was complete. The right hand image was taken 30 s later, and a lot of contrast had re-entered the bladder- a "pseudo-residual." If this patient had been studied with a bladder scanner instead of videourodynamics, a post void residual might wrongly have been presumed

may be reported by a urodynamic machine, but practitioners must check the source traces for plausibility, noting any spikes which the machine may inappropriately have used for deriving those parameters, and moving the cursors to instruct the machine where the values can be taken.

The final report must be carefully phrased, describing whether symptoms reported by the patient were actually encountered during the test, and what was the urodynamic observation at that time (Table 1). Of course, certain symptoms simply cannot be reproduced during a urodynamic test- obvious examples being nocturia, nocturnal enuresis, and coital incontinence. For these symptoms, observations made during urodynamics must not be claimed as the cause of the symptom. The "only report what you see" approach is crucial for safer consideration to making treatment recommendations.

5 | VIDEOURODYNAMICS

Conventional urodynamic tests principally can be used if there is a relatively evident underlying mechanism. The main situations are;

- Post-obstetric stress incontinence in a healthy woman, where urethral hypermobility has been identified on physical examination.
- Voiding LUTS in a man in the right age range, where benign prostate enlargement is identified on rectal examination.

For these individuals, the underlying mechanism can be assumed with reasonable confidence. Thus, if stress urinary incontinence is seen in the first situation, the hypermobility is probably the cause. In the second, if BOO is seen, the prostate enlargement is probably the cause. However, many other presentations throw up more complex possibilities and a range of causes should be considered. Using X-ray contrast as the urodynamic filling medium, and taking images at key moments during the tests ("videourodynamics") allows greater confidence when deciding what mechanism(s) are present, and potentially linking them to symptoms. The additional information that X-ray screening can achieve includes;

1. Instantaneous detection of leakage.
   a) If there is delay for the leakage reaching the flow meter, for example, in men with post prostatectomy incontinence due to sphincter damage.
   b) When evaluating leak point pressures in a patient with neurological disease.
   This precision on identifying timing of leakage allows the urodynamicist to know the detrusor pressure at the precise moment when it matters.
2. Identifying the exact location of bladder outlet obstruction; bladder neck (Figure 1a), prostate, urethral sphincter/pelvic floor, stricture. This can be very valuable for establishing the cause of BOO, and hence deciding on treatment.
3. Detecting muscle function deficits in patients with neurological disease.
   a) An open bladder neck may indicate a deficit in sympathetic innervation.
   b) A poorly supported bladder base and proximal urethra, which can be seen to descend on straining, may be due to pelvic floor weakness and may reflect muscle denervation in men, or women with no obstetric history.
4. Explaining difficulty in detecting expected increased pressure change, due to dispersal into a low pressure region.
   a) A large bladder diverticulum (Figure 1b).
   b) Significant vesico-ureteric reflux (VUR).
5. Identifying VUR in its early stages; potentially it may be possible to treat early VUR with a bulking injection of the ureteric orifice.
6. Correlating a patient's reported urgency sensation with urine entering the proximal urethra (Figure 1c); this might help explain why some people with urgency do not gain benefit from medical therapy of OAB.
7. Demonstrating whether the bladder empties fully; a well-timed X-ray taken at the exact end of voiding confirms whether the bladder has emptied fully. This is more accurate than bladder scanning, since the scanner takes a while to get in position, during which time people with VUR may have had enough liquid come back in to the bladder to show up on a scanner- a "pseudo-residual" (Figure 1d).
8. Identifying pooling in patients with post micturition dribbling.
   a) Pooling in the male urethral bulb (Figure 1a).
   b) Vaginal pooling.

6 | CONCLUSIONS

The ICS has pushed a logical and systematic approach to terminology and assessment in lower urinary tract function. In the current review we emphasize the importance of being specific with the language used, the need to justify severity thresholds, the philosophy underlying urodynamic testing and the potential benefits of videourodynamics in patients whose underlying pathophysiology is potentially complex.

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Fundamentals of terminology in lower urinary tract function

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Aims: To summarize basic definitions in the International Continence Society (ICS) Standardization of Terminology in lower urinary tract (LUT) function and their application.

Methods: Fundamental terminology in the ICS Standardization of Terminology LUT Function was identified and summarized.

Results: Evaluation of LUT requires appreciation of symptoms, signs and urodynamic observations. Symptoms are categorized according to their occurrence during the micturition cycle into storage symptoms (eg, increased daytime frequency [IDF], urgency, nocturia, or incontinence) or voiding and post-voiding symptoms (eg, slow stream or post micturition dribbling). Several problems may be present, giving rise to symptom syndromes, notably overactive bladder (during the storage phase) or underactive bladder (during the voiding phase). Signs may be derived from a bladder diary or may be elicited on physical examination. Urodynamic observations may be made by assessing flow rate, and this is combined with pressure measurement when undertaking filling cystometry and pressure flow studies. Key elements of flow and pressure measurement are described.

Conclusions: The review provides a succinct summary of symptoms, signs, and urodynamic observations as set out in the ICS Standard on LUT Function.

KEYWORDS
LUTS, overactive bladder, standardization, urodynamics

1 | INTRODUCTION

The International Continence Society (ICS) has for many years led the development of standardized definitions of the symptoms, signs, urodynamic observations, and conditions associated with lower urinary tract dysfunction (LUTD). The current document is a summary of core terminology related to LUTD for use in a general medical context. For example, LUTD is commonly encountered by healthcare professionals working in gerontology, neurology, and nephrology. The terminology is also useful for residents in urology or gynaecology preparing for examinations. This document is not intended for subspecialists working in functional urology, urogynaecology, and neuro-urology, for whom the ICS has developed a range of standardizations (see www.ics.org). These cover the full scope terms in different contexts and patient groups for use in subspecialty research and clinical practice, which are beyond the scope of the current review.

2 | METHODS

Recommendations in the ICS Standard on LUTD[1] were reviewed and summarized, this document being selected as the terminology is applicable to all patients regardless of gender. Definitions of nocturia,[2] underactive bladder,[3] and pelvic organ

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

prolapse (POP)[4] are those given in subsequent context-specific ICS consultations or documents. Definitions and key terms are generally transcribed verbatim. In the original document, many of the definitions are accompanied by explanatory or exemplary footnotes. The footnotes have been adapted (non-verbatim) in certain cases for the current review, or have been excluded for the sake of brevity, and additional explanatory text is included. Readers should note that in urogynaecology practice, some terms have been updated in the International Urogynecology Association/ICS joint report on the terminology for female pelvic floor dysfunction,[4] where there is some divergence from the reported definitions in the current review. Accordingly, users are advised to specify the source of the definitions they employ when publishing in the area.

3 | LOWER URINARY TRACT SYMPTOMS

Normal lower urinary tract (LUT) function relies on the facility for storage of urine in the bladder, and the ability to pass urine (voiding) at a time to suit the individual. The alternation between these two modes of storage and voiding is known as the micturition cycle (Figure 1). lower urinary tract symptoms (LUTS) are categorized according to the time at which they are experienced in relation to the micturition cycle;

1. Storage symptoms

a) Increased daytime frequency (IDF) is the complaint by the patient who considers that he/she voids too often by day.[1] There is no minimum voiding frequency serving as a threshold for the symptom, since it is highly subjective, and there is a wide overlap between normal and symptomatic.

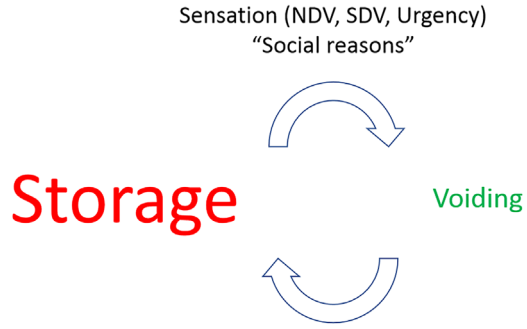

FIGURE 1 The micturition cycle as anchor for categorizing LUTS. Each individual person stores urine until they make an active decision to switch to voiding in response to a sensation or a social reason (eg, anticipation that toilets will be difficult to access in the foreseeable future as a result of a meeting or journey, or when going to bed for sleep). Once voiding is complete, storage mode is re-established. Voiding occupies only a very small part of the cycle (eg, if frequency is six times daily, and duration of each void is 20 s, then only 2 min of 24 h may be in voiding mode). NDV, normal desire to void; SDV, strong desire to void

b) Nocturia is waking at night to pass urine.[2] If a person typically passes urine once per night, they should be documented as having nocturia even if it does not cause them impairment of quality of life.

"Day" and "night" for IDF and nocturia refer to the patient's sleeping pattern, not environmental daylight and night-time.

These symptoms are strongly influenced by fluid intake, and healthcare practitioners need to factor in whether the symptom reflects LUTD, or rather a physiological mechanism dealing with excessive intake of free water or salt, or a pathological consequence of a systemic medical condition (eg, chronic kidney disease).[5]

c) Urgency is the complaint of a sudden compelling desire to pass urine which is difficult to defer.[1]

d) Urinary incontinence is the complaint of any involuntary leakage of urine.[1]

Incontinence is subclassified according to the circumstances most typically eliciting the problem

(i) Urgency urinary incontinence is the complaint of involuntary leakage accompanied by or immediately preceded by urgency.

(ii) Stress urinary incontinence is the complaint of involuntary leakage on effort or exertion, or on sneezing or coughing.

(iii) Mixed urinary incontinence is the complaint of involuntary leakage associated with urgency and also with exertion, effort, sneezing, or coughing.

2. Voiding and post-voiding symptoms

Voiding symptoms

a) Hesitancy is the term used when an individual describes difficulty in initiating micturition resulting in a delay in the onset of voiding after the individual is ready to pass urine.[1]

b) Slow stream is reported by the individual as his or her perception of reduced urine flow, usually compared to previous performance or in comparison to others.[1]

c) Intermittency is the term used when the individual describes urine flow which stops and starts, on one or more occasions, during micturition.[1]

In addition, a person may report splitting of the stream, or spraying. They may also describe straining to void, which is muscular effort used to either initiate, maintain, or improve the urinary stream.

Post-voiding symptoms are experienced immediately after voiding.

d) Feeling of incomplete emptying is experienced by the individual after passing urine.[1]

e) Post-micturition dribble describes the involuntary loss of urine immediately after an individual has finished passing urine.[1]

All these symptoms may vary considerably over time, even fluctuating on successive days. The healthcare professional needs to take into account this variability, and clarify with the patient how often each symptom may be experienced to try to build a representative picture. Likewise, the presence of a symptom (severity) does not always lead to impact on quality of life (bother), and healthcare professionals should consider both severity and bother for a complete evaluation of LUTS.

3.1 | Symptom syndromes

Initial management may rely on empirical diagnoses applied after clinical assessment of a patient's LUTS, combined with basic investigations, such as urinalysis. These may be used for the purposes of applying initial conservative management, and do not rely on invasive urodynamic observations.

1. Overactive bladder syndrome (OAB) is characterized by urinary urgency, with or without urgency urinary incontinence, usually with IDF and nocturia, if there is no proven infection or other obvious pathology.[6]
2. Underactive bladder syndrome (UAB) is characterized by a slow urinary stream, hesitancy, and straining to void, with or without a feeling of incomplete bladder emptying sometimes with storage symptoms.[3]

OAB is applicable during the storage phase of the micturition cycle, and UAB during the voiding phase, so it is possible for one individual to manifest both symptom syndromes.

4 | SIGNS SUGGESTIVE OF LOWER URINARY TRACT DYSFUNCTION

4.1 | Voiding frequency

Frequency refers to the number of voids observed in a defined time period[1]; it is not a symptom (ie, it should not be confused with IDF). The frequency of voiding is generally identified by asking the patient to complete a record;

1. A micturition time chart, which records only the times of micturitions for at least 24 h.
2. A frequency volume chart (FVC), which also records the volumes voided, as well as the time of each micturition, day and night, for at least 24 h.
3. A bladder diary: this records the times of micturitions and voided volumes (VV), and additional information appropriate for the individual being evaluated. It could include incontinence episodes, pad usage, fluid intake, the degree of urgency, and the degree of incontinence.

Three-day recordings are generally used in clinical practice. Any of these charts make it possible to identify 24-h frequency of voiding; provided the waking and sleeping times are marked, this can be broken down into the daytime frequency and nocturia (Figure 2). The sign of nocturia is the number of times an individual passes urine during their main sleep period.[2] Polyuria is the measured production of more than 2.8 L of urine in 24 h in adults.[1] Nocturnal polyuria is present when an increased proportion of the 24-h output occurs at night. If polyuria or nocturnal polyuria is present, the observation of a high voiding frequency may reflect a cause other than LUTD (eg, systemic illness or behavioral factors such as a high fluid intake).

A diary that includes fluid intake and urine output measurement generally shows the former exceeds the latter each day, but on some days there can be a discrepancy (as seen on the totals for the second day in Figure 2). Such discrepancies generally even out if the diary is completed over a longer time. Alternatively, they may suggest inaccurate completion of the diary, or inability to measure the liquid content of the person's food intake.

4.2 | Physical examination

In LUTD, examination should cover abdominal, pelvic, and perineal examination. In general, a focused neurological examination is needed, and this will be more extensive for patients with possible neurogenic LUTD.[7]

1. Urinary incontinence (the sign) is urine leakage seen during examination.[1]
   a) Stress urinary incontinence is the observation of involuntary leakage from the urethra, synchronous with exertion/effort, or sneezing or coughing
   b) Extra-urethral incontinence is the observation of urine leakage through channels other than the urethra.
2. POP is the descent of one or more of the anterior vaginal wall, posterior vaginal wall, the uterus (cervix), or the apex of the vagina (vaginal vault or cuff scar after hysterectomy).[4] The presence of any such sign should be correlated with relevant POP symptoms. More commonly, this correlation would occur at the level of the hymen or beyond.[4]
3. Pelvic floor muscle function can be qualitatively evaluated according to the tone at rest, and the strength of a voluntary or reflex contraction.[1] Strength, duration, displacement, and repeatability should be considered. It may be reported qualitatively as strong, weak, or absent, and there are validated grading systems.

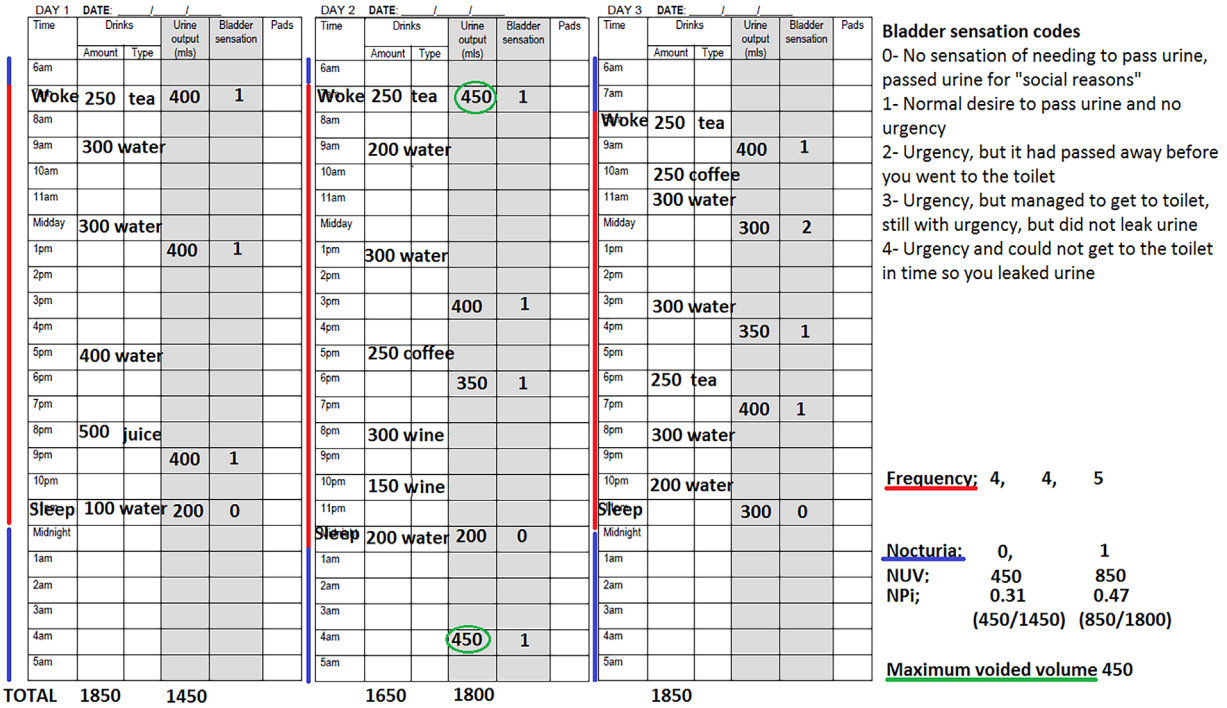

FIGURE 2 Information abstracted from a bladder diary,[10] showing some commonplace features. "Woke" indicates the start of each day, "sleep" for the start of each night. Daytime frequency is the number of voids recorded during waking hours and includes the last void before sleep and the first void after waking and rising in the morning. Frequency was 4-5 over the three complete days of the study period. Twenty-four hour production is measured by collecting all urine for 24 h. This is usually commenced after the first void produced after rising in the morning and is completed by including the first void on rising the following morning. The range in the current example was 1450-1800 mL/for the two complete 24 h using this definition. Nocturia (nocturnal frequency) is the number of voids recorded during a night's sleep: each void is preceded and followed by sleep. It was 0-1 over the two complete nights of the study period. Nocturnal urine volume (NUV) is the total volume of urine passed between the time the individual goes to bed with the intention of sleeping and the time of waking with the intention of rising; it excludes the last void before going to bed but includes the first void after waking. NUV was high on the second night, perhaps due to alcohol consumption in the preceding evening. This also is associated with a high nocturnal polyuria index (NPi, calculated from NPi = NUV/24 h volume) at 0.47. The maximum VV was normal (450 mL). Bladder sensation was generally 1 or 0; the only 2 was on day 3, and followed a couple of caffeine drinks

4. Pad testing may be used to quantify the amount of urine lost during incontinence episodes and methods range from a short provocative test to a 24-h pad test.[2]

5 | URODYNAMIC OBSERVATIONS

Bladder and bladder outlet function both need to be considered for a full understanding of a person's LUT. Urodynamics is a general term for tests that assess bladder and urethra function during the micturition cycle, and includes tests such as uroflowmetry, ambulatory urodynamics and videourodynamics. Urodynamics is also commonly used more specifically to indicate filling cystometry and pressure flow studies (PFS).

5.1 | Measurement of urine flow

Flow rate is defined as the volume of fluid expelled via the urethra per unit time (in mL/s) (Figure 3). "Free flow rate" means that no tube is present for recording bladder pressure. Urine flow is either continuous or intermittent, depending on whether any interruptions happen during flow. A continuous flow curve may be a smooth arc-shaped curve, or it may be fluctuating, when there are multiple peaks during a period of continuous urine flow. Maximum flow rate (Q_{max}) is the maximum measured value of the flow rate after correction for artefacts. VV is the total volume expelled via the urethra. Post void residual (PVR) is the volume of urine left in the bladder at the end of micturition.[1] If, after repeated voiding, no residual urine is demonstrated, then the finding of a PVR should be considered an artifact, due to the circumstances of the test.

5.2 | Measurement of bladder pressure

Both vesical pressure in the bladder (p_{ves}) and abdominal pressure (P_{abd}) are measured together, since the bladder is an abdominal organ. P_{abd} is generally estimated from rectal or vaginal recordings. Detrusor pressure (P_{det}) is that component of intravesical pressure that is created by forces

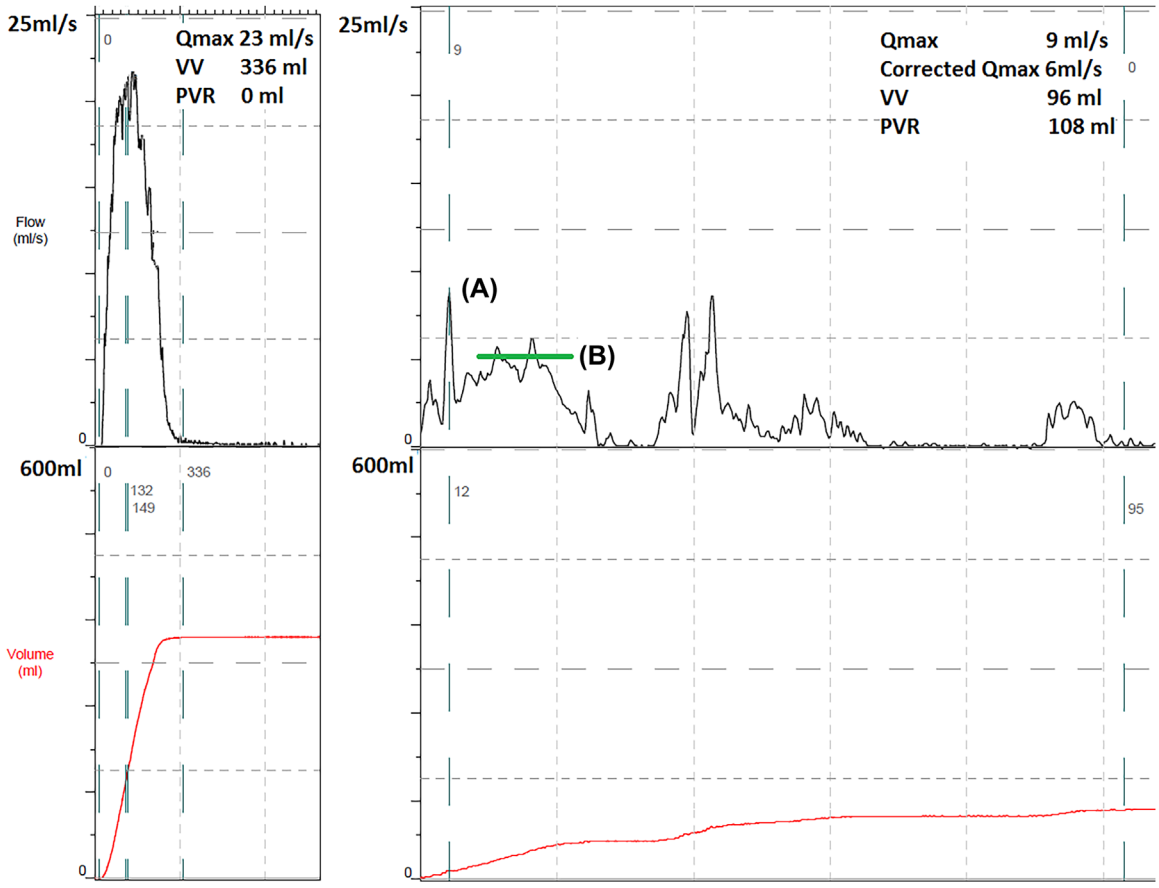

FIGURE 3 Uroflowmetry (free flow rate testing). On the left is a normal flow rate test for a women. It shows a continuous flow, with a good maximum flow rate (Qmax) and complete emptying, with a suitable VV. On the right is an abnormal test suggesting voiding dysfunction. The pattern of flow is interrupted. The Qmax reported by the machine was 9 mL/s, but inspection of the trace shows the machine interpreted a spike (A) as the maximum flow, which will not be indicative of the patient's own urinary tract function, but rather is likely to be an artefact (eg, an aberration of flow delivery to the meter, a strain by the patient, or the patient moving on the commode). By definition, Qmax must be corrected to exclude artefacts.[1] Correcting the Qmax to a part of the curve (B) that is likely to be properly representative of urinary tract function gives a lower Qmax of 6 mL/s. The VV was low, but when the PVR of 108 mL is factored in, the bladder volume can be considered adequate when the flow test was done (96 + 108 = 204 mL)

in the bladder wall (passive and active), and it is calculated by subtracting P_{abd} from P_{ves}.[1] P_{det} is computed throughout filling cystometry and PFS, and is plotted alongside the two measured pressures (P_{ves} and Pa_{bd}) and flow (Q) (Figure 4).

Filling cystometry assesses the storage phase of the patient's micturition cycle. Filling cystometry should be described according to bladder sensation, detrusor activity, bladder compliance, and bladder capacity. Bladder compliance describes the relationship between change in bladder volume and change in detrusor pressure, and is calculated by dividing the volume change by the change in p_{det} during that change in bladder volume[1] (Figure 4). The standards points are (i) p_{det} at the start of bladder filling and the corresponding bladder volume (usually zero) and (ii) the p_{det} and bladder volume at cystometric capacity or immediately before the start of any detrusor contraction that causes significant leakage. Both points are measured excluding any detrusor contraction. Detrusor overactivity (DO) is a urodynamic observation characterized by involuntary detrusor contractions during the filling phase which may be spontaneous or provoked. Provocative maneuvers are techniques used during urodynamics in an effort to provoke DO, for example, rapid filling, use of cooled medium, postural changes, and hand washing.[1]

Cystometric capacity is the bladder volume at the end of the filling cystometrogram. It is the volume voided, plus any PVR. The PFS starts when "permission to void" is given (Figure 4), or when uncontrollable voiding begins, and ends when the patient considers voiding has finished. PFS is a model of the patient's voiding phase and combines synchronous flowmetry with measurement of p_{ves}. Thus, flow rate testing in PFS differs from free flowmetry by the presence of a fine tube to enable pressure measurement. Normal voiding is achieved by a voluntarily initiated

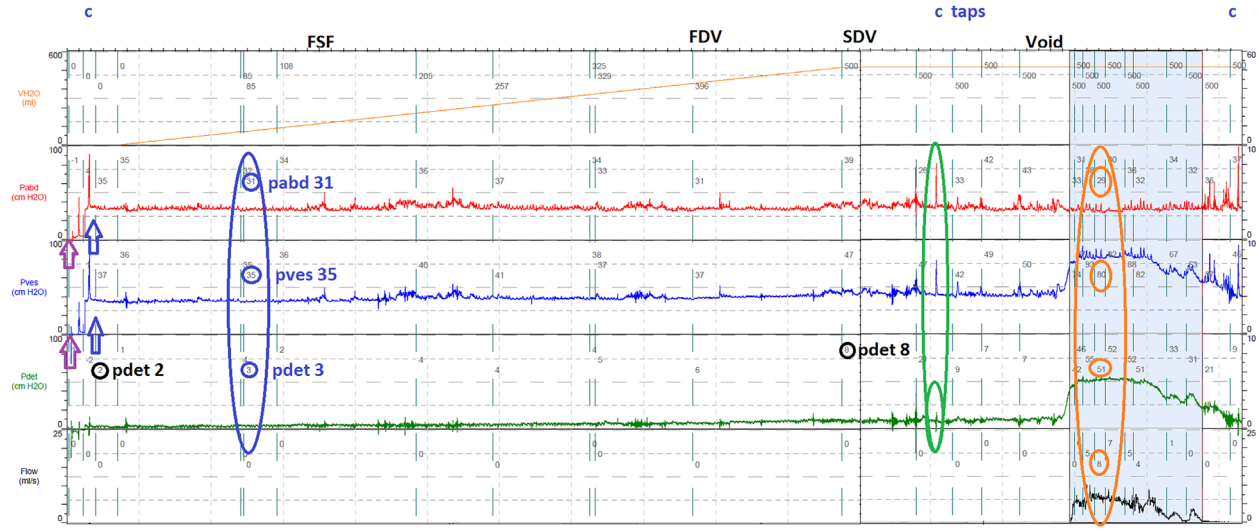

FIGURE 4 Pressure measurement. The record shows continuous tracings of two measured pressures; the abdominal pressure p_{abd} in red, and the vesical bladder pressure p_{ves} in blue. These are continuously subtracted (p_{ves}-p_{abd}) to give the detrusor p_{det}, in green. Also shown are the volume instilled in orange, and flow rate in black. Filling cystometry precedes permission to void (indicated with "void"), and the pressure flow study (PFS) follows it. The zero reference point is atmospheric pressure (purple arrows), so when the transducers are connected to the patient (blue arrows), there is an obvious rise in p_{abd} and p_{ves}, referred to as "resting pressures"—the blue oval indicates the resting pressures for this patient at one timepoint. Coughs (indicated with "c") are used to check that p_{abd} and p_{ves} detect a short spike of pressure (larger green oval), and that the p_{det} has a deflection which is equal above and below the line, the biphasic artefact (smaller green oval). It is important to check pressure recording with a cough at the start of filling, and on each side of the PFS. Normal detrusor function allows bladder filling with little or no change in pressure, and there should be no involuntary phasic contractions despite provocation.[1] In this study, the p_{det} was 2 cmH_2O at the beginning of the filling cystometry, and eight at the end; since filled volume was 500 mL, the compliance (change in volume/change in pressure = 100/[8-2]) was 17 mL/cmH_2O. Sensations are reported by the patient and annotated on the trace. First sensation of bladder filling (FSF) is the feeling the patient has, during filling cystometry, when he/ she first becomes aware of the bladder filling. First desire to void (FDV) is the feeling that would lead the patient to pass urine at the next convenient moment, but voiding can be delayed if necessary. Strong desire to void (SDV) is a persistent desire to void without the fear of leakage.[1] A provocation was applied to try to elicit DO by making the sound of running water "taps"; no change in p_{ves} or p_{det} was seen, so this patient had a stable detrusor. In the PFS, the key parameters derive from the time of maximum flow rate (Q_{max}). The current patient had a Q_{max} of 8 mL/s and detrusor pressure at Q_{max} of 51 cmH_2O, so his BOO Index was 35 and Bladder Contractility Index was 91. P_{abd} did not change at that time, so no allowance has to be made for the effect on P_{det}

continuous detrusor contraction that leads to complete bladder emptying within a normal time span, and in the absence of obstruction. Detrusor underactivity (DUA) is a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete emptying within a normal time span. Bladder outlet obstruction (BOO) is the generic term for obstruction during voiding and is characterized by increased detrusor pressure and reduced urine flow rate.[1] For male patients, BOO and DUA can be quantified using the BOO Index and the Bladder Contractility Index.[8] They rely on measuring Qmax and detrusor pressure at maximum flow, which is the lowest pressure recorded at maximum measured flow rate (see [9]).

6 | CONCLUSIONS

The ICS Standardization provides a logical framework and definitions to describe symptoms, signs, and urodynamic observations in relationship to the micturition cycle.

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Basic concepts in nocturia, based on international continence society standards in nocturnal lower urinary tract function

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Aims: To review the recommendations on nocturia in the International Continence Society (ICS) Standardization documents, setting out key definitions and parameters for use in clinical practice.

Methods: Definitions and evaluations described in the ICS Standards on Nocturia and Terminology for Lower Urinary Tract Function were identified and summarized.

Results: The terms have been divided into signs and symptoms. Nocturia as a symptom is waking at night to pass urine and as a sign is the number of times an individual passes urine during their main sleep period. Nocturnal polyuria as a symptom is passing large volumes of urine at night and as a sign is the excessive production of urine during the individual's main sleep period. These should be quantified using a 3-day bladder diary, thereby facilitating identification of 24-h polyuria, nocturnal polyuria, lower urinary tract dysfunction, or sleep disorder.

Conclusions: The summary reflects the multifactorial influences in nocturia and provides a pragmatic insight into bladder diary analysis for deriving key parameters relevant to clinical therapy.

KEYWORDS
enuresis, International Continence Society, nocturia, nocturnal polyuria, terminology

1 | INTRODUCTION

Nocturia is a significant problem affecting a large proportion of the population, especially in older age groups.[1,2] Increasing recognition of its prevalence and potential health impact for individual patients and for population health has led to recognition of the need to establish the specific underlying mechanisms relevant for anyone presenting with the symptom. Crucially, a range of observations need to be properly understood by any clinician responsible for caring for these patients.

In 2002, the International Continence Society (ICS) defined nocturia as the complaint that the individual has to wake at night one or more times to void.[3] In 2014, a new ICS Nocturia working group was set up to review the terminology related to that document and will be reporting in 2018. The current review sets out the principles underlying the fundamental nocturia terminology, and describes how they are applied in an example bladder diary to help direct healthcare professionals toward the most logical approach to investigation and therapy. The aim is for this to be a practical and pragmatic guide for use in both clinical and research settings.

2 | METHODS

Recommendations in the ICS standards on Nocturia[4] and Lower Urinary Tract Function,[5] and the 2018 ICS consultation on nocturia terminology, were reviewed and

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

summarized. From these, definitions and key terms are generally transcribed verbatim. Additional explanatory text is included for context. Explanatory or exemplary footnotes from the original documents have been adapted or excluded for the sake of brevity. Users are advised to refer to the source documents and specify the source of the definitions they employ when citing definitions.

The terminology is broken into symptoms, that is, as reported by the patient, and signs. Lower urinary tract symptoms (LUTS) are broken down into storage, voiding and post-voiding symptoms, depending on their timing in relation to the micturition cycle. Nocturia is categorized as a storage symptom, based on the fact that a person is in the storage phase of the micturition cycle when asleep. For nocturia, the key signs are the voiding frequency and the voided volumes during the main sleep period; these are usually captured from a frequency/volume chart (FVC) or bladder diary.

"Night-time" for the purposes of the nocturia terminology refers to the individual's sleep cycle, rather than the solar cycle (from sunset to sunrise). For this reason, a shift worker sleeping between shifts may experience nocturia during daylight hours.

3 | URINE OUTPUT

The production of urine by the kidneys is a continuous process of filtration in the glomeruli, and reabsorption (water and soluble nutrients) in the tubules. Urine production serves to balance water, salt, and acid levels according to the homeostatic needs of the person, and this is principally a result of adjustments to the tubular reabsorption. Surplus water increases urine production (diuresis), and surplus salt also increases urine production (natriuresis). Making urine also serves to dispose of toxins and by-products.

The rate of urine production increases if there is;

- Diuresis
- Natriuresis
- Products in the glomerular filtrate in such large quantities that the tubules cannot reabsorb it all (poorly controlled diabetes mellitus can cause this, due to glucosuria)
- Dysfunction of the renal tubules

Tubular dysfunction can occur in chronic kidney disease. If associated with disease affecting the glomeruli, estimated glomerular filtration rate (eGFR), and creatinine levels will be abnormal. If it is a selective tubular dysfunction, eGFR and creatinine levels may be normal.

The continuous production of urine is the task of the upper urinary tract (UUT). Expelling the urine at appropriate times, and storing at other times, is the task of the lower urinary tract (LUT). The "micturition cycle" is a concept describing how the LUT serves these two contrasting tasks of urine storage and voiding. Voiding generally can be initiated by someone at any time that suits them, but the main driver prompting people to take active steps to pass urine is when they feel their bladder is "full."

The number of times someone has to pass urine over a specified time period reflects;

1. How fast the UUT is producing urine
2. The bladder volume at which the LUT signals "fullness"

Renal regulation tends to see the rate of urine production reduced when the person is asleep. In young people living a healthy lifestyle, rate of UUT urine production is low and LUT storage volume is high, so nocturia is uncommon.

3.1 | Voiding frequency

The symptom of nocturia is present if the patient reports waking at night to pass urine. Nocturia is also a sign indicated by the number of times an individual passes urine during their main sleep period.

3.2 | Volume of voiding

In order to decide whether the presence of nocturia reflects production of large quantities of urine from the UUT, an estimate of urine output is needed. 24-h voided volume is the total volume of urine passed during a 24-h period excluding the first morning void of the period. A 24-h polyuria indicates that 24-h urine output is more than 40 mL/kg, in men and women. The general increase in urine output will elevate the voiding frequency in the daytime and night-time, outstripping even normal bladder capacity. The symptom of nocturnal polyuria is present if the patient reports passing large volumes of urine at night. Nocturnal polyuria is also a sign indicated by excessive production of urine during the individual's main sleep period. It is often expressed as a proportion of the 24-h voided volume. The nocturnal polyuria index is the nocturnal urine volume/24-h voided volume, expressed as a percentage. NP is said to be present if the NPi is more than 33% in the elderly (eg, aged more than 65), and more than 20% in younger individuals.

4 | CAPTURING THE SYMPTOMS

The ICS emphasises the need to distinguish a symptom's severity from the bother it brings, as they are not necessarily correlated. In nocturia, there are various symptom scores which can assess both the severity and associated bother of nocturia and other LUTS, such as the International Consultation on Incontinence Questionnaires (ICIQ).[6] There

is a specific score for quality of life in nocturia (ICIQ-NQoL[7]). Practitioners need to be clear that waking once per night to pass urine, on average, means nocturia is present. Research shows that a single episode of nocturia is generally of relatively low bother to the patient (assuming they return to sleep satisfactorily). However, even if causing low bother, it still constitutes nocturia. Future research is needed to identify whether nocturia once per night might actually be medically significant (eg, the start of a medical problem for which early identification and treatment might avoid future progression).

Direct questioning is needed to establish the symptom of NP. Some discussion is also needed to review "reason for waking"; the symptom of nocturia implies that the need to pass urine was the reason for waking. This is distinct from the situation that sleep disturbance may actually have been for some other reason, but the person went to pass urine because they happened to be awake.

5 | ASSESSING THE SIGNS

The fundamental tools for assessing signs in LUTS are the physical examination and the bladder diary. Examination can identify whether the person has risk factors for NP (eg, a physical body habitus suggesting risk of obstructive sleep apnoea or the presence of peripheral oedema), or whether they have chronic urinary retention.

A well-completed FVC or bladder diary[8] recorded for three days[9] is invaluable. The time of going to bed and the time of waking up from sleep must be clearly marked by the patient (it is rather common for patients to overlook noting these, rending the diary uninterpretable for analyzing nocturia). From the chart or diary the following can be calculated (Figure 1):

- The daytime and night-time voiding frequency
- 24-h voided volume: the total volume of urine passed during a 24-h period excluding the first morning void of the period.
- Nocturnal urine volume: the total volume of urine produced during the individual's main sleep period.
- Nocturnal polyuria index: the nocturnal urine volume/24-h voided volume.
- Maximum voided volume, average voided volume, and bladder sensation scores

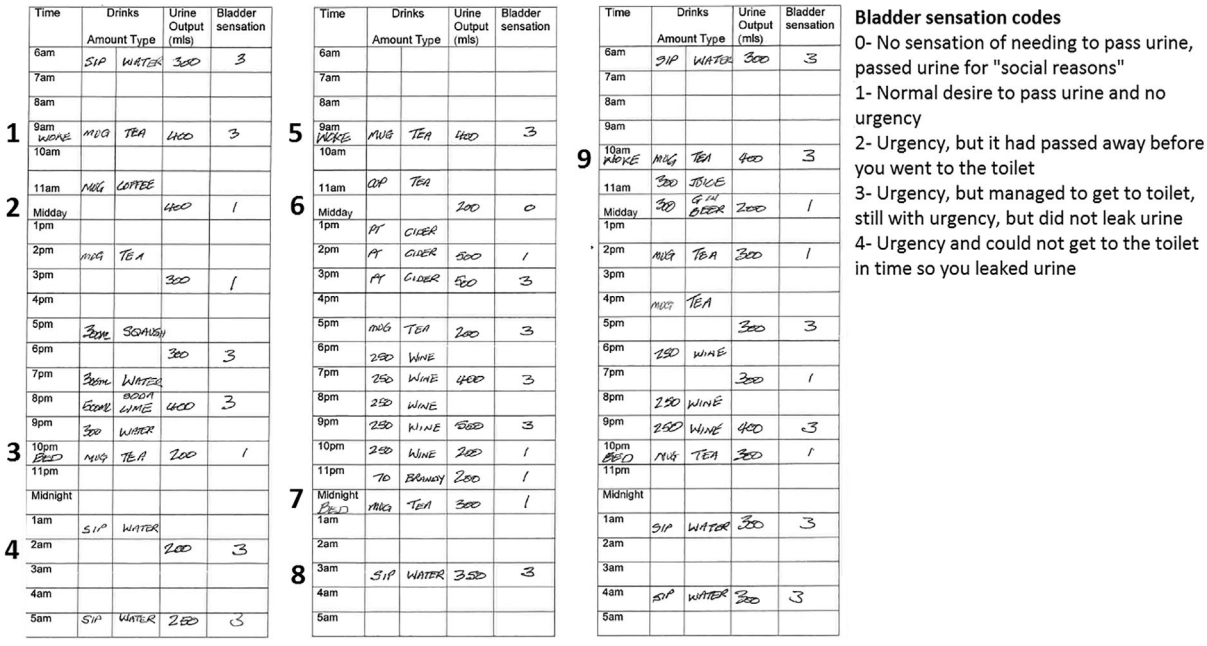

FIGURE 1 Analysis of a 3-day bladder diary. On the first day, the person woke at 9 am (1), went to bed at 10 pm (3), and woke the following morning at 9 am (5). To calculate the first complete 24-h voided volume, we need to exclude the first morning void of Day 1 as that is part of the previous night's volume. Thus, the first 24 h voided volume includes the voids between points 2 and 5 (400 + 300 + 300 + 400 + 200 + 200 + 250 + 400 [1st morning void from Day 2]) = 2450 mL. The contribution of night-time voided volume is from point 4 to 5 (200 + 250 + 400) = 850. The nocturnal polyuria index (NPi) was 850/2450 = 35%. Nocturia is the voids between points 3 and 5 but excludes the voids at points 3 and 5 (so the voids at 2 am and 5 am), that is, nocturia was twice. For the second complete 24-h period, the voided volume should be taken from points 6 to 9, and totals 4050 mL. The nocturnal voided volume is from points 8 to 9, totaling 1050 mL. The NPi was 26% (1050/4050), and nocturia was twice (3 am and 6 am). This patient was 32 years old, so they had nocturnal polyuria (NPi >20% in a patient below the age of 65). Their body weight was 60 kg, so they also had 24-h polyuria (>40 mL/kg/24 h). A 3-day diary contains two complete 24-h periods and two complete nights, since there is no information to complete the third night (unless the patient keeps recording up until they wake on Day 4)

6 | EXPLAINING THE PROBLEMS

For anyone with nocturia, a basic interpretation of the bladder diary can be used to categorise likely contributory factors,[10] and thereby guide subsequent evaluation and treatment.[11,12]

- 24-h polyuria; caused by a range of medical problems, such as diabetes insipidus, salt loss, or poorly controlled diabetes mellitus. These people often report constant thirstiness.
- NP; caused by problems such as obstructive sleep apnoea or peripheral oedema.
- LUTD; generally associated with storage LUTS, and with increased bladder sensation scores on the bladder diary.
- Sleep disturbance; should be considered if the patient describes anxiety, restless legs, nightmares, and sleep-walking.

Simple behavioral tendencies should be considered, for example identification of a high fluid intake in someone who does not experience constant thirst. LUTD is actually a relatively uncommon explanation for nocturia in the wider population, so urologists or urogynecologists should identify the other possible situations and avoid urological or gynecological interventions, where not specifically indicated.

7 | ENURESIS

Enuresis is a symptom in which the patient complains of intermittent incontinence that occurs during periods of sleep. It is also a sign of "wetting" while asleep. This is not the same as waking with urinary urgency and having insufficient time to reach the toilet, which is urgency urinary incontinence.

Enuresis may have more in common with voiding dysregulation (urination in situations which are generally regarded as socially inappropriate) or involuntary voiding (sporadic bladder emptying when awake)[13] than nocturia. Thus, they must be clearly distinguished when both nocturia and enuresis are reported by a patient.

8 | CONCLUSION

The symptom of nocturia is present if the patient reports waking at night to pass urine and nocturia is also a sign indicated by the number of times an individual passes urine during their main sleep period. NP is present if the patient reports passing large volumes of urine at night, and this can be quantified with the nocturnal polyuria index. The bladder diary is an important diagnostic tool, helping identify 24-h polyuria, NP, LUTD, and sleep disturbance. Enuresis is distinguished from nocturia, as the patient fails to wake up for passing urine.

CONFLICT OF INTEREST

Dr. Hashim reports personal fees and non-financial support from Ferring, personal fees from Astellas, personal fees from Medtronic, personal fees from Boston, personal fees and non-financial support from Allergan, outside the submitted work. Dr. Drake reports grants, personal fees and non-financial support from Ferring, during the conduct of the study; grants, personal fees and non-financial support from Astellas, grants, personal fees and non-financial support from Allergan, outside the submitted work.

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Neurological lower urinary tract dysfunction essential terminology

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Aims: To introduce basic concepts and definitions in the International Continence Society (ICS) Standardisation of Terminology in adult Neurogenic Lower Urinary Tract Dysfunction (NLUTD).

Methods: Fundamental terminology in the ICS Standardisation of Terminology of Adult NLUTD was identified and summarized.

Results: NLUTD is often associated with impairment of cognitive, motor, sensory, and/or autonomic functions. Lesions are categorized into suprapontine, pontine/suprasacral spinal, sacral spinal, cauda equina/peripheral nerve, or mixed lesions. People affected with neurological disease are also at risk of the conditions seen in the general population, such as benign prostate enlargement. Symptoms of NLUTD include alterations in bladder or urethral sensation and incontinence. Loss of urine can result from incontinence, involuntary passing of urine and factors that impair toilet use, incorporating problems such as impaired cognition urinary incontinence, impaired mobility urinary incontinence, and voiding dysregulation. Signs may be discerned by physical examination and recording of a frequency volume chart or bladder diary. Urodynamic observations during filling cystometry may include altered sensations, neurogenic detrusor overactivity, and reduced bladder compliance. During pressure flow studies, there may be detrusor underactivity or bladder outlet obstruction (BOO). BOO may be caused by various forms poorly co-ordinated muscle activity in the bladder outlet. Symptoms, signs, and urodynamic observations may be useful in diagnosing the presence and specific location of neurological impairment.

Conclusion: The review provides a succinct summary of symptoms, signs, and urodynamic observations as set out in the ICS Standard on Adult NLUTD.

KEYWORDS
incontinence, LUTS, neurological disease, standardization

1 | INTRODUCTION

Adult neurogenic lower urinary tract dysfunction (NLUTD) refers to abnormal or difficult function of the bladder, urethra (and/or prostate in men) in mature individuals in the context of clinically confirmed relevant neurologic disorder. NLUTD is a key subgroup of the broad range of lower urinary tract symptoms (LUTS), due to the severity of the symptoms, and the implications of urinary dysfunction for wider health. The International Continence Society (ICS) categorizes symptoms, signs, urodynamic observations, and conditions

Alan Wein led the peer-review process as the Associate Editor responsible for the paper.

associated with lower urinary tract dysfunction (LUTD) in relationship to the storage and voiding phases of the micturition cycle. Neurological disease brings additional dimensions to the LUTD as experienced in the lives of affected individuals. The current document is a summary of core terminology in NLUTD for use in the wider context of LUTS in people known to have a neurological disease, or suspected of potentially having one which has not yet been diagnosed.

2 | METHODS

Recommendations in the ICS Standard on Adult Neurogenic Lower Urinary Tract Dysfunction[1] were reviewed and summarized. Definitions and key terms are generally transcribed verbatim and highlighted in bold. In the original document, many of the definitions are accompanied by explanatory or exemplary footnotes which have been adapted or excluded for the current review for the sake of brevity. Readers requiring more detailed information are referred to the full ICS Standard, and other documents produced by the ICS Standardisation Steering Committee.

3 | NEUROLOGICAL CONTROL

The nervous system controls many facets that are essential for the normal micturition cycle (storage and voiding). Particularly crucial are cognition (eg, decision making, anticipation, awareness of environment/social context, and conscious perception of sensation), motor functions (eg, mobility, balance, and dexterity), sensory nerve activity, and autonomic functions (eg, regulation of the detrusor and sphincter). The neurological functions act together to make sure that both urine storage and voiding reflect timings and contexts appropriately, with full voluntary control (Figure 1).

Neurological diseases are diverse and differ in terms of the parts of the nervous system affected (eg, the cognitive-predominant effects of dementia) and their behavior (eg, progressive, such as multiple sclerosis, or non-progressive, such as spinal cord injury). Thus, neurological disease may have differing effects on cognitive, sensory, motor, and autonomic functions which manifest in the specific NLUTD experienced by the patient. Inevitably, the consequences of neurological disease extend beyond LUTD, and mean that affected patients have a range of issues that influence treatment potential and health risk. Problems with bowel function, sexual and reproductive function, cognition, mobility, and blood pressure control are particularly relevant.

In describing the features of an individual patient's dysfunction, clinicians should appreciate the distinction between symptoms, signs, and urodynamic observations as set out in the ICS Standardisation of Terminology of Lower Urinary Tract Function[2] (for summary see[3]). A summary of the classification of neurological lesions,[1] including the potential clinical and urodynamic features, is given in Figure 2.

4 | NLUTD SYMPTOMS

People with NLUTD may describe storage, voiding, and post voiding symptoms consistent with the definitions used for the general population.[2,3] Sometimes, a patient may not express that a symptom is present, so it is appropriate to discuss with the caregiver as well when establishing the presenting complaint. Storage symptoms may converge in **Neurogenic Overactive Bladder**, **which is a symptom syndrome characterized by urgency, with or without urgency urinary incontinence, usually with increased daytime frequency and nocturia in the setting of a clinically relevant neurologic disorder with at least partially preserved sensation**.

4.1 | Bladder and urethral sensation

Neurologically healthy people are intermittently aware of bladder sensations related to filling and voiding, and urethral sensation with voiding. Someone with NLUTD may describe alterations, for example:

Increased bladder sensation: **the desire to void during bladder filling occurs earlier or is more persistent than that previously experienced. Reduced: the definite desire to void occurs later to that previously experienced despite an awareness that the bladder is filling. *Absent*: the individual reports no sensation of bladder filling or desire to void**. Such patients may have a significant post voiding residual in the bladder, without any sensation of incomplete emptying.

Non-specific bladder awareness: the individual reports no specific bladder sensation, but may perceive, for example, abdominal fullness, vegetative symptoms, urethral sensations, or spasticity as bladder filling awareness or a sign of bladder fullness. This may indicate that the usual sensory nerve pathways are not communicating centrally. Instead anatomical routes which do not usually contribute to everyday sensations may be intact and functional.

In addition, some people report they are unable to feel flow of urine along the urethra. They may report that they can only discern whether bladder emptying is finished by looking, or listening for the splash of urine in the toilet to stop.

4.2 | Loss of urine

Mature CNS regulation ensures storage (detrusor relaxation with outlet contraction) and the transition to voiding (detrusor

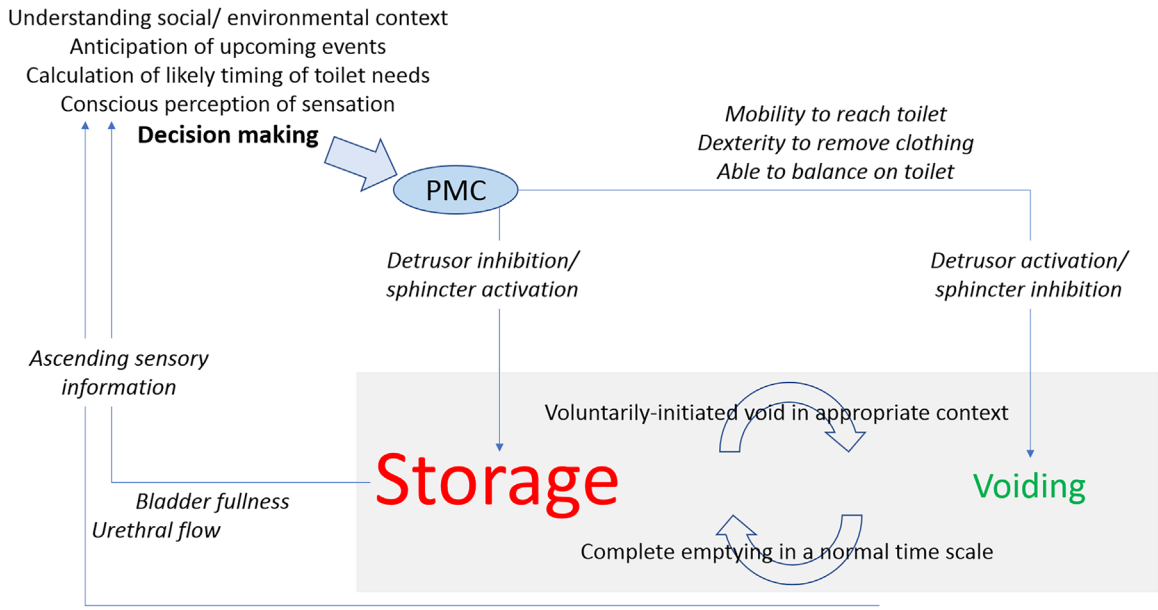

FIGURE 1 The micturition cycle viewed from the context of the person's social and environmental context. PMC, pontine micturition center

contraction with outlet relaxation) is under voluntary control. Various situations in NLUTD may lead to a loss of urine:

1. Incontinence; categorized into stress urinary incontinence, urgency incontinence and mixed urinary incontinence, and reflecting LUT dysfunction. Definitions used in NLUTD are the same as those used in the general population.
2. Involuntary passing of urine; no LUT abnormality is necessarily present, but instead the voiding reflex may activate at times not consciously initiated by the patient. This may be during occasions generally considered socially inappropriate. It may reflect a dysfunction in the cerebrum, for example, a stroke or dementia. Abnormal voiding reflexes, or disinhibition, may result in the person passing urine without voluntary control.
3. Factors that impair toilet use, such as immobility, cognitive disability, and decreased motivation.

Thus, some additional incontinence definitions are standardized in NLUTD:

- **Impaired cognition urinary incontinence is periodic urinary incontinence that the individual with cognitive impairment reports to have occurred without being aware of it.**
- **Impaired mobility urinary incontinence is inability to reach the toilet on time for voiding because of physical or medical disability**. This inability includes (any combination of) the individual's physical as well as social causes or reasons. Other signs or symptoms of LUTD should not be present, or should be reported by the professional (as primary or as accessory) (eg, "Urgency urinary incontinence" with "mobility impairment"; or "Mobility impairment urinary incontinence" with "stress urinary incontinence.
- **Voiding dysregulation is urination in situations which are generally regarded as socially inappropriate, such as while still fully dressed, or in a public setting away from toilet facilities.**
- **Involuntary voiding is both a symptom and a diagnosis of sporadic bladder emptying when awake, without intention to void. Usually the voiding reflex is preserved, and there is only lack of proper inhibition of the voiding reflex**. If that happens when asleep it is called Acquired Enuresis.
- **Enuresis is intermittent incontinence that occurs during periods of sleep**. Enuresis is considered different from urgency urinary incontinence. Confirming the precise underlying mechanism(s) is often not possible in routine clinical practice.
- **Continuous (urinary) incontinence: complaint of continuous involuntary loss of urine**.

4.3 | Signs

NLUTD evaluation incorporates the examination used for the general population, since people with neurological disease are the same risk of aging-related and other changes as any other person. Accordingly, physical examination must include abdominal, pelvic and perineal examination, and should elicit the following where present:

- Incontinence
- Pelvic organ prolapse
- Pelvic floor muscle function

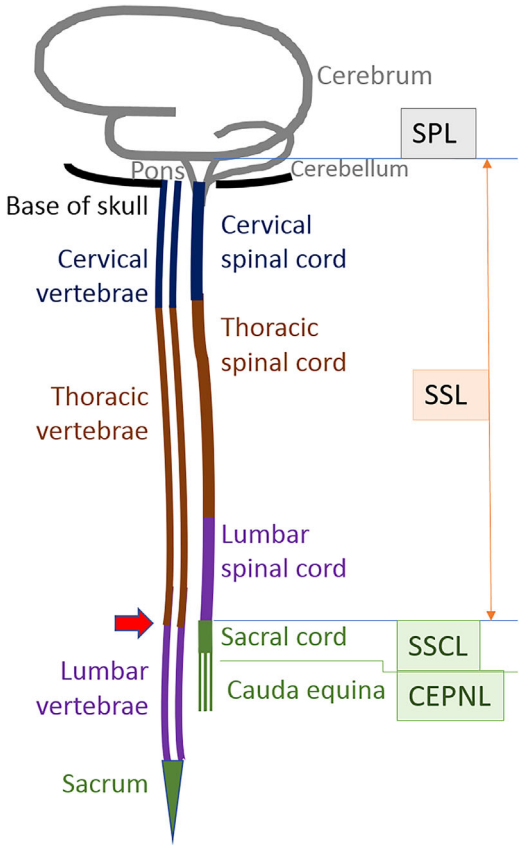

FIGURE 2 Classification of neurological lesions. Suprapontine Lesion (SPL) is a neurological lesion above the pons (forebrain or midbrain). NLUTD in SPL: there is a reflex contraction of the detrusor with impaired cerebral regulation and central inhibition and usually synergistic voiding/bladder emptying. Suprasacral spinal cord/pontine lesion (SSL) is a neurological lesion in suprasacral spine and/or pons. NLUTD in SSL: Detrusor overactivity (DO) and DO incontinence are common, with or without detrusor-urethral sphincter dyssynergia (DSD), often resulting in a significant post void residual (PVR) and "high pressure" bladder. Sacral Spinal Cord Lesion (SSCL) is a neurological lesion in the sacral spinal cord. NLUTD in SSCL; findings include acontractile detrusor with or without decreased bladder compliance and usually with impaired sphincter activity. Infrasacral (cauda equina and peripheral nerves) Lesion (CEPNL) is a neurological lesion affecting the cauda equina and/or peripheral nerves. NLUTD in CEPNL: acontractile detrusor and/or SUI may be present. Mixed Neuronal Lesion results from lesions of the neural pathway at different levels of the central nervous system concurrently. Note that in the adult, vertebral levels and spinal cord levels do not lie adjacent. Thus a T12/L1 prolapsed intervertebral disc (classified by its vertebral level) will affect the sacral part of the spinal cord (red arrow)

- Palpable bladder after voiding
- Pad testing

A frequency micturition chart, frequency volume chart, or bladder diary[2] is needed within the constraints of patient capacity or carer availability. This may be particularly important in NLUTD, where the underlying condition may give rise to an endocrine dysfunction, such as central diabetes insipidus.

Physical examination is also used to identify signs which could point toward the localization of the exact neurological deficits caused by the responsible condition, for example, perineal numbness.

5 | URODYNAMIC OBSERVATIONS

Bladder and bladder outlet function both need to be considered for a full understanding of a person's LUT. Since the pathophysiology is complex in NLUTD, and symptoms cannot be relied on for understanding mechanism, urodynamic testing provides a valuable insight into mechanisms and may identify observations that could indicate a risk to the patient's future health.

5.1 | Filling cystometry

- **Neurogenic detrusor overactivity is characterized by involuntary detrusor contractions during the filling phase which may be spontaneous or provoked in the setting of a clinically relevant neurologic disease. Provoked contraction may be elicited by cough, change of position, etc., or by urethral/sphincter to bladder reflex. Neurogenic Detrusor Overactivity Incontinence is incontinence due to involuntary neurogenic detrusor overactivity**.
- **Detrusor Overactivity Leak Point Pressure (DOLPP) is defined as the lowest detrusor pressure rise with detrusor overactivity at which urine leakage first occurs in the absence of voluntary detrusor contraction or increased abdominal pressure**. This is in contrast to Detrusor Leak Point pressure where urine leakage occurs in the absence of either a detrusor contraction or increased abdominal pressure.[2]

Reduced **bladder compliance (the relationship between change in bladder volume and change in detrusor pressure**[2]) is an important observation (Figure 3) in interpreting the clinical risk for renal function.

In neurogenic LUTD, the cystometric capacity cannot be defined in the same terms as for filling cystometry for the general population. In the absence of sensation, the cystometric capacity is the volume at which the clinician decides to terminate filling. The reason(s) for terminating filling should be defined in the report, for example, high detrusor filling pressure, large infused volume or pain. If there is uncontrollable voiding/bladder emptying, it is the volume at which this begins. In the presence of sphincter incompetence the cystometric capacity may be significantly increased by occlusion of the urethra, for example, by a Foley catheter balloon.

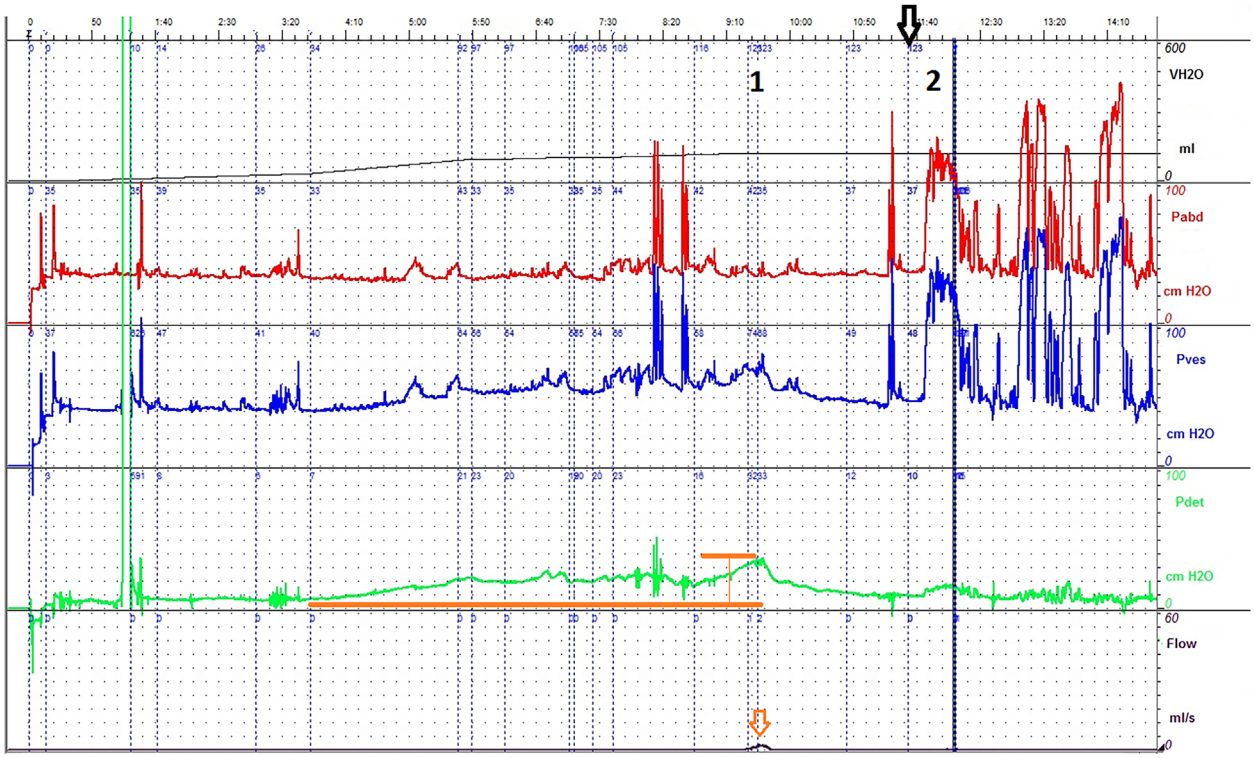

FIGURE 3 Filling cystometry in a sacral spinal cord lesion (SSCL) showing reduced compliance; the lower orange line indicates the phase during which the detrusor pressure (green trace, second from bottom) is climbing, even though the filling rate is slow (10 mL/min). The upper orange line indicates the detrusor leak point pressure. The change in volume over this time was 123-34 = 89 mL, and the change in pressure was 33-7 = 26 cm H_2O. Compliance (change in volume divided by change in pressure) was thus 89/26 = 3.4 mL/cm H_2O. Detrusor Leak Point Volume (DLPV) is defined as a bladder volume at which first urine leakage occurs (1), either with detrusor overactivity or low compliance (orange arrow). The leakage is seen in the flow trace (black, bottom trace), and the leakage causes the elevated detrusor pressure to dissipate. The arrow indicates permission to void. However, there is no flow generated, and the patient does several Valsalva strains, shown by the substantial pressure rises in both abdominal pressure, and hence bladder pressure (2), signifying neurogenic acontractile detrusor. At time of urodynamics, neurological diagnosis had not previously been suspected, and subsequently he was identified to have multiple system atrophy

5.2 | Pressure flow studies

When passing urine, a slow stream may be explained by impaired detrusor contraction, bladder outlet obstruction (BOO), or a combination of both. Potential causes of neurogenic BOO include:

- **Non-relaxing urethral sphincter, characterized by a non-relaxing, obstructing urethral sphincter resulting in reduced urine flow.**
- **Delayed relaxation of the urethral sphincter, characterized by impaired and hindered relaxation of the sphincter during voiding attempt resulting in delay of urine flow.**
- **Detrusor-Sphincter Dyssynergia (DSD), which describes a detrusor contraction concurrent with an involuntary contraction of the urethral and/or periurethral striated muscle.** Occasionally flow may be prevented altogether.

DSD is an indicator that the pontine micturition center is not communicating effectively with the sacral spinal cord, and occurs in people with a suprasacral spinal cord/pontine lesion. The term should not be used in other forms of NLUTD, and it is not a general term for neurogenic BOO.

Other causes of BOO present in the general population, such as benign prostatic obstruction, bladder neck obstruction, or urethral stricture in men, can also be present in people with neurological disease, and videourodynamics may be appropriate to discern the proximal site of BOO.

Impaired detrusor contraction can indicate:

- **Neurogenic detrusor underactivity; a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within a normal time span in the setting of a clinically relevant neurologic disorder.**

- **Neurogenic acontractile detrusor; the detrusor cannot be demonstrated to contract during urodynamic studies in the setting of a clinically relevant neurologic lesion** (Figure 3).

Balanced bladder emptying is a bladder emptying with physiological detrusor pressure and low residual as perceived by the investigator, and should be defined in the report.

6 | NLUTD CLINICAL DIAGNOSES

- **Spinal Shock Phase is usually temporary following acute neurologic insult or SCI that is characterized by loss of sensory, motor, and reflex activity below the level of injury**. NLUTD in Spinal Shock is usually a temporary complete painless urinary reten`tion.
- **Autonomic Dysreflexia is a syndrome resulting from an upper thoracic or cervical spinal cord injury above T6, elicited by a stimulus in the field of distribution of the autonomous sympathetic nucleus, characterized by unregulated sympathetic function below the lesion and compensatory autonomic responses**. It is potentially a medical emergency characterized by hypertension, bradycardia, severe headaches, and flushing above, with pallor below the cord lesion, and sometimes convulsions. An increase of blood pressure without any other symptoms is called Asymptomatic Autonomic Dysreflexia.

Urinary retention is an inability to properly empty the bladder. Retention may be complete or incomplete:

- **Acute retention of urine is an acute event of painful, palpable or percussable bladder, when the patient is unable to pass any urine when the bladder is full**. Although acute retention is usually thought of as painful, in certain circumstances pain may not be a presenting feature, for example, when due to prolapsed intervertebral disc, post-partum, or after regional anesthesia such as an epidural anesthetic. The retention volume should be significantly greater than the expected normal bladder capacity.
- **Chronic retention is a non-painful bladder, which remains palpable or percussable after the patient has passed urine. Such patients may be incontinent**. Chronic retention, excludes transient voiding difficulty, for example, after surgery for stress incontinence, and implies a significant residual urine.

7 | DIAGNOSING NEUROLOGICAL DYSFUNCTION

In order to understand the full picture of the neurological deficit, the history may be used to identify features which could localize the site of a problem or suggest the causative condition and its behavior. Such observations can be helpful to a patient's neurologist in localising areas of deficit. These features are important in defining a patient's condition, since it guides subsequent testing (such as the anatomical sites and scan protocols for MRI). For example, retrograde ejaculation reported by a man who has not had bladder neck or prostate surgery may indicate a neurological deficit in the thoracolumbar spine or related peripheral nerves; this may be accompanied by visualization of an open bladder neck during videourodynamic filling cystometry. Signs can also help; for example, loss of the anal reflex indicates a lesion affecting the sacral spinal cord or its sensory or motor nerves.

In rare but important cases, urinary dysfunction may present for urological evaluation in a patient with no known neurological background whose ultimate cause may subsequently prove to be a neurological disease. This can occur for example in MS, normal pressure hydrocephalus, multiple system atrophy, and early Parkinson's disease.[4] Key symptoms include erectile dysfunction, retrograde ejaculation, enuresis, loss of filling sensation, or unexplained stress urinary incontinence.[4] If there is any suspicion that an undiagnosed neurological disease could be present, questioning should enquire about visual symptoms, back pain, anosmia, bowel dysfunction and incontinence, or memory loss.[4] Specialist evaluation is likely to be needed.

8 | CONCLUSIONS

NLUTD is categorized into: suprapontine; pontine/suprasacral spinal; sacral spinal; cauda equina/peripheral nerve; mixed lesions. Loss of urine can result from impaired cognition urinary incontinence, impaired mobility urinary incontinence, and voiding dysregulation. Urodynamic observations during filling cystometry may include altered sensations, neurogenic detrusor overactivity, and reduced bladder compliance. During pressure flow studies, there may be detrusor underactivity or bladder outlet obstruction (BOO). BOO may be caused by various forms poorly co-ordinated muscle activity in the bladder outlet. Symptoms, signs, and urodynamic observations may be useful in diagnosing the presence and specific location of neurological impairment.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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The fundamentals of chronic pelvic pain assessment, based on international continence society recommendations

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Aims: Chronic pelvic pain (CPP) is defined as a noncyclical pain that has duration of at least 6 months and can lead to decreased quality of life and physical performance. The pain can be attributed to problems in the pelvic organs and/or problems in related systems, and possible psycho-social attributes may contribute to the manifestation. Due to the complex nature, CPP syndromes are multifactorial and the terminology needs to reflect the setting.

Methods: The current review is a synthesis of key aspects of the recent International Continence Society Standardization for Terminology in CPP Syndromes.

Results: Nine domains can be used for a detailed description of CPP. They include four domains specific to the pelvic organs (lower urinary tract, female genital, male genital, gastrointestinal), two related to other sources of pain which may be perceived in the pelvis (musculoskeletal, neurological) and three which may influence the response to the pain or its impact on the individual (psychological, sexual, and comorbidities). For an individual patient with CPP, each domain should be reviewed in terms of symptoms and signs, noting that positive findings could reflect either a primary cause or a secondary consequence. The findings will guide further evaluations and subsequent treatment.

Conclusion: We present a synthesis of the standard for terminology in CPP syndromes in women and men, which serves as a systematic framework to consider possible sources of pain (pelvic organs or other sources) and the individual responses and impact.

KEYWORDS
chronic pelvic pain, lower urinary tract dysfunction, LUTS, pelvic floor muscle pain, standardization

1 | INTRODUCTION

CPP is defined as a noncyclical pain that has duration of at least 6 months, and it can lead to decreased quality of life and physical performance.[1] The presentation can be a challenge to assess and treat. This is because the pain can potentially be attributed to several contributory factors, in the context of the varied nature of pain responses manifested by individuals. Healthcare professionals (HCPs) need to consider gynecological, urological, gastrointestinal, musculoskeletal, neurological, or

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

rheumatological factors, with possible psycho-social attributes. Due to its complex nature, CPP syndromes are multifactorial and the current terminology aims to standardize descriptions, regardless of which type of specialist is performing the evaluation.

2 | METHODS

A standard for terminology in CPP syndromes was developed in accordance with the International Continence Society (ICS) Standardization Steering Committee methodology.[2] The current review is a synthesis of the key aspects of the standard for practical use in everyday practice.

3 | OVERVIEW

For a patient presenting with pelvic pain, thorough history is crucial, including establishing that the pain has been present for at least 6 months, identification of any potential inciting event and/or triggers, character, radiation, and severity. An indication of the source of pain is vital, yet it can be obscured in individual cases by the range of possible primary sources and secondary consequences, and the varied responses. To ensure a systematic approach, the ICS sets out a series of "domains" which facilitate consideration of possible issues.

The domains of chronic pelvic pain (CPP) syndromes include four which consider the pelvic organs;

1. Lower urinary tract domain
2. Female genital domain
3. Male genital domain
4. Gastrointestinal domain

Two domains consider other sources of pain which may be perceived in the pelvis, even if the actual site of the problem may not be within the pelvis;

5. Musculoskeletal domain
6. Neurological domain

The final three domains relate to general factors that could influence the response to the pain or its impact on the individual;

7. Psychological domain
8. Sexual domain
9. Comorbidities

In any domain, features may be present as a result of a primary problem, or a secondary consequence. Each domain is evaluated with directed history-taking and a comprehensive physical examination done with a focus on the lower abdomen/pelvis to identify pain triggers and patterns of referred pain. The HCP can surmize the possible source of the

TABLE 1 Lower urinary tract domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Bladder			
Increased daytime frequency	Suprapubic tenderness	Questionnaires	Hypersensitivity bladder
Increased night-time frequency	Tenderness of bladder	Voiding diary	Interstitial cystitis/bladder pain syndrome
Urgency	Tenderness of the pelvic floor muscles	Urine analysis	Interstitial cystitis/Hunner lesion
Hypersensitivity		Optional: urine culture/ cytology Intravesical anesthetic challenge	
Pain, pressure, discomfort with filling		Urodynamics Cystoscopy (biopsy)	
Hesitancy			
Intermittency			
Feeling of incomplete bladder emptying			
Urethra			
Frequency/urgency painful urination	Tenderness of the urethra	Urine analysis	Urethral pain

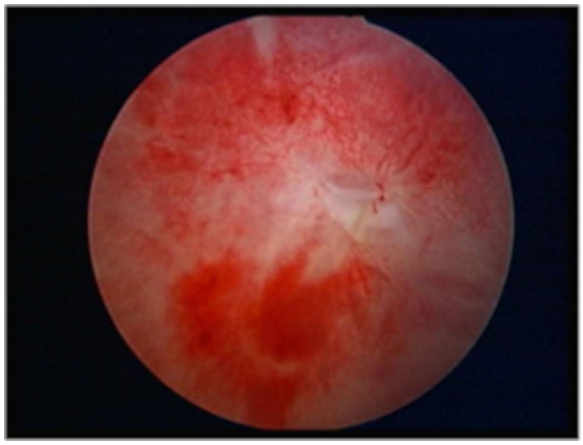

FIGURE 1 The endoscopic appearances of bleeding and ulceration during general anesthetic cystoscopy indicate that the lower urinary tract domain is a contributory factor in CPP, especially if there are pain reactions such as tachycardia, tachypnoea, and hypertension

pain, relevant additional factors, and potential secondary consequences. Specific assessment and treatment requires access to multidisciplinary support, and awareness of the initiatives and guidance developed by a range of organizations and expert groups.[3–5] Imaging, endoscopy and special tests may be needed for evaluation of each domain considered influential for a patient. With the individual evaluation in mind, further investigation and initial therapy can be planned based on the multidisciplinary support and up-to-date awareness of clinical recommendations and guidelines.

As an example, chronic prostatitis will be associated with history and examination features in the male genital domain (the primary site of the problem), and the lower urinary tract and musculoskeletal domains (where secondary problems such as increased urinary frequency and muscle spasms may be experienced). The full scope of impact on the patient may be further driven by issues in the psychological and sexual domains.

3.1 | Domains related to the pelvic organs

The lower urinary tract domain (Table 1) incorporates the bladder and urethra. The global definitions for bladder pain syndrome (BPS) and interstitial cystitis (IC) are not fully standardized, as several professional organizations have an interest in the area. Society for Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction proposed the definition of IC/BPS as "an unpleasant sensation (pain pressure, discomfort) perceived to be related to the urinary bladder, associated with lower urinary tract symptoms of more than 6 weeks duration in the absence of other identifiable causes."[6] For the bladder, patients may complain of increased urinary frequency (day and night), urgency, hypersensitivity, pain, pressure, discomfort, hesitancy, pain with filling, and sensation of incomplete emptying. The situation may be associated with relevant findings on general anesthetic cystoscopy (Figure 1). If the urethra is a significant contributor, pain is perceived usually when voiding and can be combined with a dull pressure that may radiate towards the groin or perineum.

The genital domains comprise the female genital domain (Table 2) and the Male Genital Domain (Table 3). Female patients may report pain with menstruation, abnormal bleeding, dyspareunia, vaginal discharge or itching, voiding/defecatory pain, and/or abdominal/pelvic pain. Pain mapping with a Q-tip is done to elicit localized areas of tenderness, which may be identified in the vagina or external genitalia. Generalized vulvar pain syndrome refers to pain/burning that cannot be localized by pain mapping. It is important to identify any ulcers, fissures, or cysts of the vulva. In addition, intra-abdominal signs related to the uterus and adnexa may indicate other pathology, such as fibroids, cysts, pelvic masses, endometriosis, or adhesive disease. These can present with uterine tenderness, cervical discharge or tenderness, or adnexal tenderness

Male patients may reports symptoms related to the lower urinary tract and sexual dysfunction. There may be complaints of dysuria, sensation of incomplete emptying,

TABLE 2 Female genital domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Vagina			
Dyspareunia Sharp burning and/or stabbing Provocation of pain with touch	Tenderness Erythema	Pain mapping Q-tip touch sensitivity	Vaginal/vulvar/perineal pain
Intraabdominal female genital			
Dysmenorrhea Abnormal uterine bleeding Dyspareunia Itching, stabbing, burning pain Cyclic (episodic or persistent)	Tenderness: uterine/adnexal	Laboratory testing Pelvic ultrasound Laparoscopy/biopsy CT-scan	Ovarian Pelvic congestion Uterine Tubal

TABLE 3 Male genital domain

Symptoms	Signs	Evaluation	Syndrome/ Disease
Pain LUTS Dyspareunia Erectile dysfunction (Persistent) or episodic	Tenderness on rectal/genital examination Urethral discharge	Questionnaires Culture PSA/biopsy Cystoscopy/biopsy Ultrasound	Prostate pain
	Tenderness on physical examination Scars	Questionnaires Ultrasound	Scrotal pain Epididymal pain Testicular pain Penile pain

TABLE 4 Gastrointestinal domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Pain with defecation Evacuation dysfunction Pain/pressure with sitting	Tenderness on rectal exam	Questionnaires Culture Colonoscopy/biopsy	Anorectal pain
Abdominal pain Nausea Constipation/diarrhea Persistent or episodic	Abdominal tenderness Bloating	Ultrasound CT/barium enema/MRI	Colorectal pain

TABLE 5 Musculoskeletal domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Abdominopelvic pain	Altered muscle tone Tension: spasms	Questionnaires Pain mapping	Pelvic muscle pain syndrome Coccyx pain syndrome
Pain at rest, with movement/ sitting/sexual activity Pain with voiding/defecation Unilateral/bilateral Persistent or episodic	Stiffness Trigger point tenderness Taut band Twitch response, referred pain	Ultrasound	Pelvic joint, ligament, bony pain

TABLE 6 Neurological aspects domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Characteristic sensation of: Burning Throbbing Stabbing Shooting Electric shock-like Sensation paresthesia Atrophy Persistent or episodic	Tenderness (nerve distribution) Referred pain Possible skin change	Questionnaires Quantitative sensory testing Pain mapping Nerve block imaging: Ultrasound MRI	Somatic neuropathic pain Complex regional pain syndrome

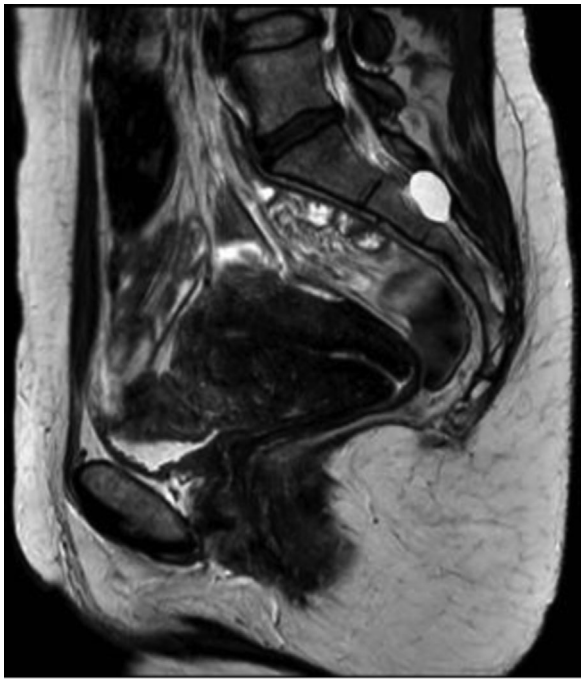

FIGURE 2 Observation of a sacral nerve root "Tarlov" cyst suggests the neurological domain may be a factor in a patient's CPP

increased daytime frequency, change in urinary stream, urgency, and dyspareunia (assuming infection, surgical complications, or other pathology have been excluded). The assessment of CPP in males should prompt questioning to assess for onset, duration, inciting factors, laterality and any effect on urination and sexual function. A rectal examination is needed, and thorough evaluation of the genitalia, which may be performed in the supine and standing positions to identify any lesions, masses, and discharge.

Patients affected in the gastrointestinal domain (Table 4) commonly report constipation, diarrhea, defecatory pain, obstructive defecation, abdominal cramping, or rectal pain/pressure/burning. The main components are the anorectum or colorectum. Anorectal problems may result from hemorrhoids, abscesses, fissures, ulcers, levator ani syndrome, or chronic proctalgia. Colorectal problems may give rise to abdominal tenderness, watery/bloody diarrhea, or rectal bleeding and systemic features (weight loss and fever). Inflammatory bowel disease and malignancy must be excluded. Functional disorders should be ruled out, including irritable bowel syndrome.[7]

TABLE 7 Psychological aspects domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Worry Anxiety Fear Catastrophizing Persistent or episodic	Helplessness Hopelessness Avoidance of certain activities	Formal psychological assessment Asking patient what is wrong and what worries him/her about pain Questionnaires	Worry/anxiety/fear/depression

TABLE 8 Sexual aspects domain

Symptoms	Signs	Evaluation	Syndrome/Disease
Lack of desire, arousal, orgasm Dyspareunia Persistent or episodic	Depression Relationship issues	Questionnaires Laboratory Doppler ultrasound	Sexual dysfunction

TABLE 9 Comorbidities

Symptoms	Signs	Evaluation	Syndrome/Disease
Allergies Fatigue Widespread muscular and joint pain Irritation of the eyes Dryness Sleep disorder	Fatigue Skin lesions Dry eye Muscular skeletal tenderness	General medical evaluation Laboratory Imaging	Allergies Chronic pain and fatigue syndrome Systemic autoimmune diseases

3.2 | Domains related to other causes of pain

Musculoskeletal problems are common, and sometimes are hard to localize for the patient. In CPP, they may be the principle cause of pain, or they may be consequential as the patient makes physical adaptations to deal with their primary problem (Table 5). Features that indicate a primary or secondary musculoskeletal problem include; tenderness, abnormal movement and alterations in the muscle (tone, stiffness, tension, spasms, cramping, fasciculation, and trigger points). Pain may originate from muscles, fascia, ligaments, joints, or bones, so familiarity with the anatomy and approaches to clinical examination is needed. Particularly key regions include;

- Muscular: the pelvic floor[8] (levator ani group/perineum), the lower abdominal wall, or posterior pelvic and gluteal regions.
- Joints, ligaments and bones: Coccyx pain syndrome, sacroiliac or pubic symphysis joints, sacrospinous or sacrotuberous ligaments, or the pubic ramus, ilium, and ischial spine

Where there is an issue in the neurological domain (Table 6), patients commonly use characteristic terms to describe pain (burning, stabbing, throbbing, tingling, stinging, electric shock-like) or they may report paresthesia. Somatic Neuropathic pain is secondary to a specific nerve injury, and is associated with symptoms related to the nerve distribution. In CPP, the relevant nerves could be sacral (Figure 2), pudendal, thoracolumbar, ilioinguinal, iliohypogastric, genitofemoral or obturator. A neuroma secondary to surgery or other trauma may give a localized tender point in the specific location, and if present should be identified and removed.

Complex regional pain syndrome (CRPS)[9] is a situation whose precise etiology is uncertain, but it can be categorized by burning pain and changes in the skin (increased sensitivity, and changes in skin temperature, color, and/or texture). CRPS type 1 is triggered by tissue injury without an underlying nerve injury and CRPS type 2 is attributed to a history of a nerve injury.

Pain in someone with a history of surgery which involved placement of synthetic is a specific issue. It can present as pain during physical activity, dyspareunia, vaginal discharge, and/or exposure of the mesh in the vagina or surrounding tissues.

3.3 | Domains affecting response or impact

Psychological aspects are an important element in the individual situation (Table 7). Patients may report symptoms of anxiety, worry, low mood, sleep disturbances, helplessness, hopelessness, difficulty concentrating, and pain impairing enjoyment. Alternatively, people close to the affected person may observe these features.

Sexual function may be affected by CPP in both men and women, and relationships may be affected (Table 8). Patients may report decreased libido, inability to become aroused, dyspareunia, and difficulty achieving an orgasm, and there may also be partner concerns. Several disorders can be identified;

- Sexual desire disorders; Hypoactive sexual disorder or Sexual aversion disorder
- Sexual arousal disorder
- Orgasmic disorder
- Sexual pain disorder

A comorbidities domain is also included (Table 9), as patients with CPP syndromes have a higher prevalence of problems such as allergies, chronic fatigue syndromes, fibromyalgia, and autoimmune diseases that may affect multiple systems.

4 | CONCLUSIONS

The current document extracts some of the pertinent elements that should be identified in order to understand fully the range of factors potentially present in CPP. The domain structure serves as a checklist to aid consideration of the several issues, and thereby ensure key relevant factors are not overlooked. The approach aids a logical sequence in considering the pelvic organs, other potential sources of pain, and factors that affect individual pain response and its impact.

CONFLICTS OF INTEREST

Drs Neha Rana, Marcus J. Drake, Rebecca Rinko, and Melissa Dawson have nothing to disclose. Dr Kristene Whitmore reports grants from Allergan, grants from Astellas,and grants from Coloplast clinical research during the conduct of the study.

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How to use the Pelvic Organ Prolapse Quantification (POP-Q) system?

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Aims: To set out the basic description of pelvic organ prolapse (POP) using the International Continence Society/International Urogynecology Association Pelvic Organ Prolapse Quantification (POP-Q) system.
Methods: The basic approach to use of the POP-Q was identified and summarized.
Results: Six defined points in the vagina are identified; points Aa and Ba for the anterior vagina, Ap and Bp for the posterior vagina, and C and D for the cervix/vault. Point D is not used in women who previously had a hysterectomy. The patient is asked to strain, ideally when in the standing position, to elicit the POP to its maximum extent. The location of the defined points is then gauged relative to the hymenal ring and recorded on a grid. Three additional measurements are taken to achieve a full description; the genital hiatus length, perineal body length, and total vaginal length. Staging a POP relies on identifying the lowest extent of any part of the six defined points; if any point reaches close to the hymenal ring (at least stage 2), the prolapse is usually symptomatic.
Conclusions: The POP-Q system is readily cataloged and offers detailed description of considerable benefit in clinical practice and research.

KEYWORDS
Pelvic organ prolapse quantification. POP-Q, Prolapse assessment

1 | INTRODUCTION

The International Continence Society (ICS), the American Urogynecologic Society, and the Society of Gynecologic Surgeons published a consensus document in 1996 to describing an objective system to describe female pelvic organ prolapse, which was called the Pelvic Organ Prolapse Quantification system (POP-Q).[1] This is the classification system that should be used to describe pelvic organ prolapse, as recommended by the ICS/International Urogynecology Association (IUGA) joint report on terminology for female pelvic floor dysfunction.[2,3] The POP-Q has been used variably in both clinical practice and research.[4,5] The ICS/IUGA have recently made some suggestions to better define the disease of pelvic organ prolapse.[3] The aim of this article is to briefly summarize the key points in performing the POP-Q examination system to assist in its routine use.

2 | METHODOLOGY

The technique of performing the POP-Q has been described in detail in the ICS/IUGA documents.[2,3] We have summarized the key points that should be considered while performing the POP-Q examination.

Jan-Paul Roovers led the peer-review process as the Associate Editor responsible for the paper.

TABLE 1 Showing the POPQ measurements (Adapted from Haylen et al[2])

POPQ: Measurements
The locations of the six defined points when the prolapse is fully reduced.
Anterior vaginal wall:
1. **Point Aa**: A point located in the midline of the anterior vaginal wall three (3) cm proximal to the external urethral meatus. The potential range of position of Point Aa relative to the hymen is −3, indicating no anterior vaginal POP,to +3 cm which is full prolapse
2. **Point Ba**: A point that represents the most distal (ie, most dependent) position of any part of the upper anterior vaginal wall (between the vaginal cuff or anterior vaginal fornix and Point Aa). Point Ba coincides with Point Aa (−3 cm) in a woman who has no anterior POP. In a woman with severe POP, Ba coincides with Point C.
Upper vagina:
3. **Point C**: A point on either the most distal (ie, most dependent) edge of the cervix or the leading edge of the vaginal cuff (hysterectomy scar).
4. **Point D**: The posterior fornix in a woman who still has a cervix.[a]
Posterior vaginal wall:
5. **Point Ap**: A point located in the midline of the posterior vaginal wall three (3) cm proximal to the hymen. The potential range of position of Point Ap relative to the hymen is −3 to +3 cm
6. **Point Bp**: A point that represents the most distal position of any part of the upper posterior vaginal wall (between the vaginal cuff or posterior vaginal fornix and Point Ap).
Three further descriptive landmarks and measurements.
1. The **genital hiatus (GH)** is measured from the middle of the external urethral meatus to the posterior margin of the hymen.
2. The **total vaginal length (TVL)** is the length of the vagina (cm) from posterior fornix to hymen when Point C or D is reduced to its full normal position.
3. The **perineal body (PB)** is measured from the posterior margin of the hymen to the mid-anal opening.

[a]Point D is included as a point of measurement to differentiate suspensory failure of the uterosacral-cardinal ligament "complex" from cervical elongation. When the location of Point C is significantly more positive than the location of Point D, this is indicative of cervical elongation which may be symmetrical or eccentric. Point D is omitted in the absence of the cervix.

3 | RESULTS

POP-Q can be performed using the following four steps:
Step1: Pre-procedure considerations

Examination should be performed with an empty bladder and if possible an empty rectum. A full bladder is potentially associated with underestimation of the POP-Q severity.[6] Any position that best demonstrates the maximum extent of the

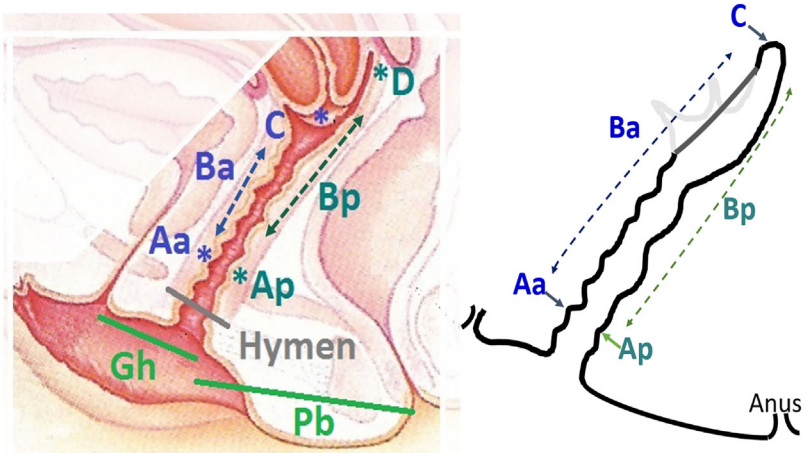

FIGURE 1 The six defined points used to quantify POP in women without (left) or with (right) a previous hysterectomy. Aa and Ap are 3 cm from the hymen when there is no POP, or any POP is fully reduced. POP-Q identifies where these points come to lie relative to the hymenal plane with the POP fully evident. Ba and Bp reflect the lowest point reached by a POP, relative to the hymenal plane. Any part of the vagina could potentially descend furthest, so Ba may lie anywhere from Aa-C. Bp may lie anywhere from Ap-D, or Ap-C in a woman post hysterectomy, from respectively reaching the locoincide with Aa and Ap in a woman who does not have POP. Three measurements complete the description; the genital hiatus (Gh), the perineal body (Pb), and the total vaginal length (not shown)

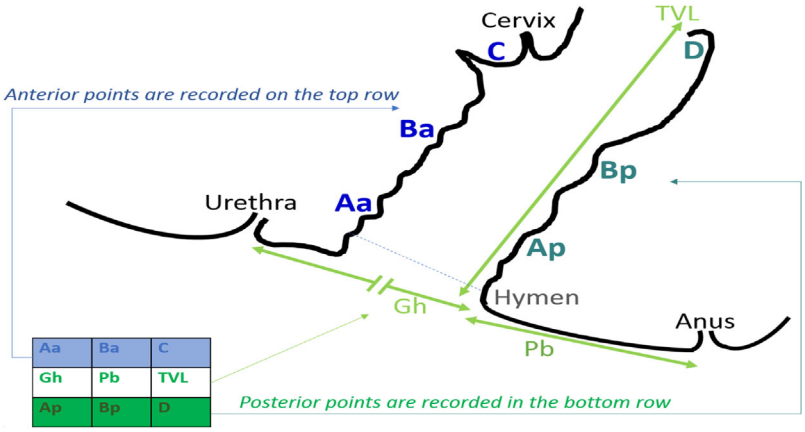

FIGURE 2 How the six defined point and three measurements relate to a 3 × 3 grid used for clinical documentation. Gh, genital hiatus; Pb, perineal body; TVL, total vaginal length

prolapse and which can be confirmed by the woman, by digital palpation or use of a mirror, should be used (left lateral, standing, lithotomy, or standing). Use a Sim's speculum if necessary to retract the anterior and posterior vaginal walls to assess for prolapse. The techniques and positions used should be recorded, as they may influence findings.[7]

Step 2: Measurements ("points to remember") (Table 1, Figure 1):

- There are six defined points (Aa, Ba, C, D, Ap, Bp) that are considered while recording the POP-Q, which are used to report the extent of descent or prolapse of the anterior vaginal wall, vaginal apex, and posterior wall.
- The positions of these six defined points are measured during maximal Valsalva or cough in relation to the hymen. If the point descends to the hymen it is measured as 0 cm, if it remains above the hymen it is measured in centimeters and described as negative integers and if it descends beyond the hymen it is measured in centimeters and described as positive integers. For example, if point C remains 4 cm above the hymen during Valsalva/cough it is recorded as −4 cm. If point C descends 4 cm beyond the hymen during Valsalva/cough it is recorded as +4 cm.
- There are three further descriptive measurements, which are also recorded independent of the hymen (genital hiatus-point GH, perineal body-point PB, and total vaginal length at rest-point TVL). Of note, all of the POP-Q points are recorded during maximal Valsalva or cough except for point TVL which is recorded at rest with the prolapse reduced.

Step 3: Recording the measurements (Figure 2):

The above measurements are recorded on a 3 × 3 grid. The anterior vaginal wall and the cervix or vault are documented on the top row, the posterior vaginal wall, and the posterior fornix on the bottom row. The descriptive measurements of the genital hiatus, perineal

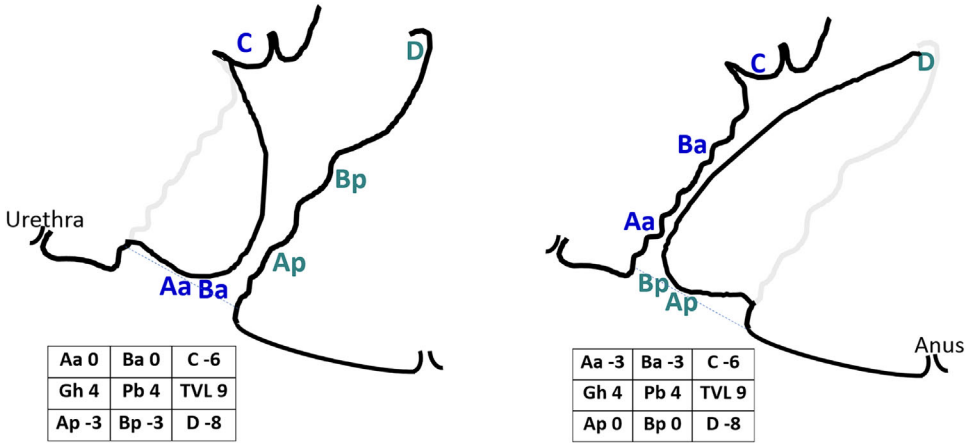

FIGURE 3 POPQ staging of a second stage anterior (left) and second stage posterior (right) vaginal wall prolapse

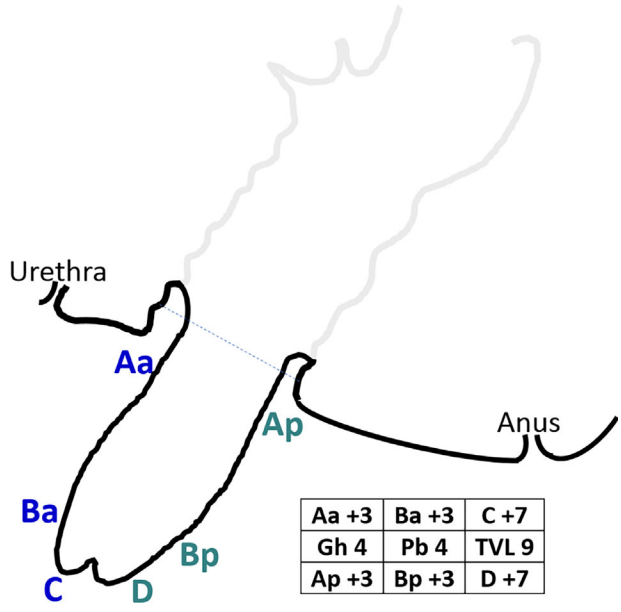

FIGURE 4 POPQ staging of a stage 4 pelvic organ prolapse (procidentia)

body, and total vaginal length at rest are recorded in the middle row.

Step 4: Staging of the prolapse

Depending on the measurements, prolapse of each of the compartments is staged based on its relationship to the hymen.

- Stage 0: No prolapse is demonstrated (points Aa, Ba, C, D Ap, and Bp are all </ = −3 cm).
- Stage I: The most distal portion of the prolapse is more than 1 cm above the level of the hymen (points Aa, Ba, C, D, Ap, and Bp are all <−1 cm).
- Stage II (Figure 3): The most distal portion of the prolapse is situated between 1 cm above the hymen and 1 cm below the hymen (any of the points Aa, Ba, C, D, Ap, and Bp has a value between −1 cm and +1 cm).
- Stage III: The most distal portion of the prolapse is more than 1 cm beyond the plane of the hymen, but not completely everted meaning no value is >/ = TVL −2 cm (any of the points Aa, Ba, C,D,Ap, Bp is >/ = +2 and </ = tvl −3 cm)
- Stage IV (Figure 4): Complete eversion or eversion to within 2 cm of the total vaginal length of the lower genital tract is demonstrated (any of the Points Ba, C, D, or Bp is >/ = to TVL −2 cm).

The steps of performing a POP-Q are summarized in Figure 5 and some examples of POPQ recording and staging of various prolapse are demonstrated in Figures 3 and 4.

4 | DISCUSSION

Since its introduction in 1996, POP-Q has been used variably in peer-reviewed publications.[8] It may be perceived as complex, but it has shown good inter-observer agreement and is the most common system used in peer-reviewed literature.[9–11] It has been criticized as being too complicated, difficult to use, teach, and communicate.[12] Various approaches and tools have been used to teach POP-Q and have all been shown to be effective.[13,14]

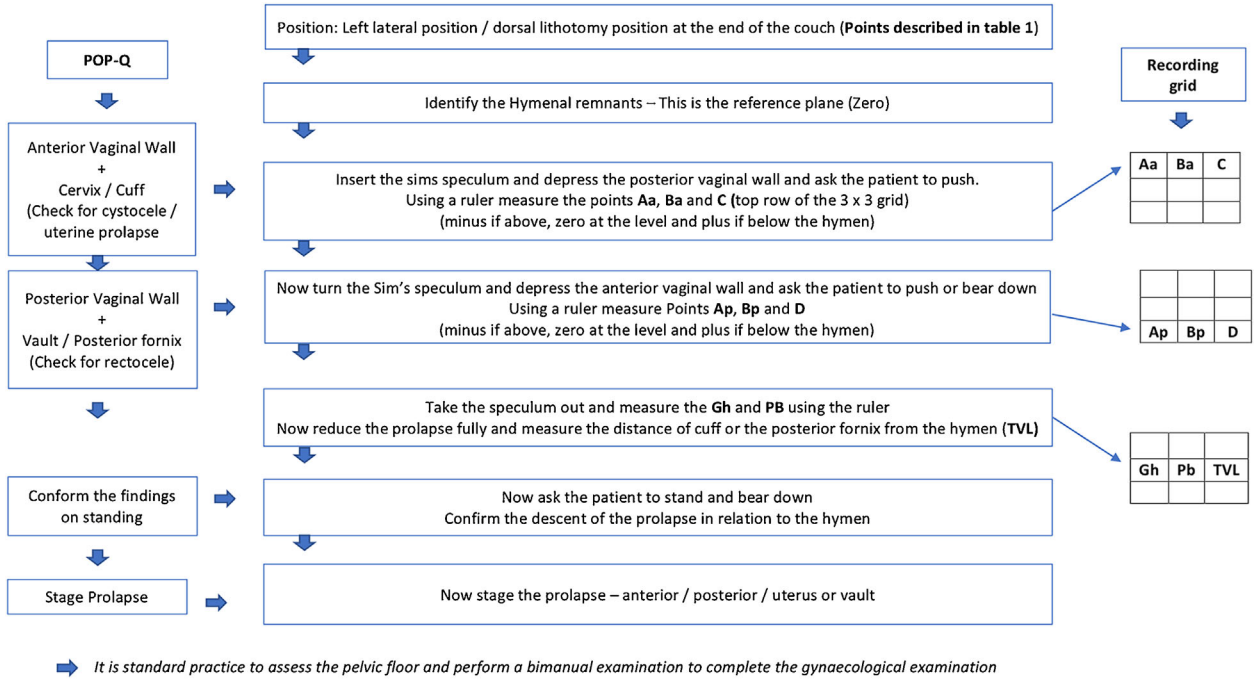

FIGURE 5 Practical aspects of performing POP-Q

4.1 | Clinical relevance of POP-Q

Women with POP generally present with several complaints of bladder, bowel, and pelvic dysfunction; however, the symptom of a vaginal bulge is considered specific to prolapse and correlates well with the severity for the prolapse.[15,16] POP is generally considered to be symptomatic when the leading edge of the prolapse is at or beyond the level of the hymen (≥stage 2 POP-Q).[17] Another study suggested that the prolapse becomes symptomatic if it descends lower than a level 0.5 cm above the hymen (≥Stage 2 POP-Q).[18] Genital hiatus size is associated with and predictive of apical vaginal support loss.[19,20] These factors need to be taken in to consideration when diagnosing and offering treatment options to women with prolapse.

5 | CONCLUSION

POP-Q is a useful way of objectively assessing and recording pelvic organ prolapse and helps in better communication of findings. Stage 2 or above POP-Q seems to correlate well with a symptomatic prolapse.

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The fundamentals of uroflowmetry practice, based on International Continence Society good urodynamic practices recommendations

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Aims: To review the recommendations on uroflowmetry in the International Continence Society (ICS) Standardization documents in order to identify a systematic approach to the delivery and interpretation of free flow rate testing in clinical practice.
Methods: Expectations of service and good practice in uroflowmetry described in the ICS standards on Urodynamic Practice, Urodynamic Equipment, and Terminology for Lower Urinary Tract Function were identified and summarized.
Results: Urodynamic centers should provide a suitable uroflowmetry testing environment. Equipment should be calibrated and maintained according to manufacturer requirements. Patients should be well-informed in advance of the test. They should be advised to avoid: knocking the machine; allowing the stream to move; squeezing the urethra; and body movements. It is generally appropriate to get more than one flow trace for each patient. Voided volume should be representative for the patient, for example by comparing with values recorded on a Bladder Diary. Post void residual (PVR) should be measured soon after testing. After the test, the urodynamicist should review the trace and ensure maximum flow rate and end of micturition are correctly identified in case the equipment has inappropriately taken the values from a trace artefact.
Conclusions: The summary provides a systematic approach to ensure a representative, high quality, non-invasive flow test is carried out for individual patients.

KEYWORDS
free flows, standards

1 | INTRODUCTION

Urodynamics is the general term to describe the measurements that assess the function and dysfunction of the lower urinary tract (LUT) by any appropriate method. In the clinical assessment of LUT symptoms (LUTS), evaluating the nature of an individual's voiding is a fundamental component of the diagnostic pathway, especially for men. Uroflowmetry is a non-invasive urodynamic test in which specific measurements are made of the rate of flow of urine and the volume voided. It is normally followed by an ultrasonically scanned measurement of post void residual (PVR) urine volume, and an interpretation of the flow pattern recorded by the machine over the duration of the void.

The work was undertaken at Bristol Urological Institute, Southmead Hospital, Bristol, UK.

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

A recent think tank on uroflowmetry[1] recommended that specific, practical guidance be made available to increase the quality of uroflowmetry testing. Accordingly, the current article reviews the recommendations on uroflowmetry in the International Continence Society (ICS) Standardization documents in order to identify a systematic approach to the delivery and interpretation of free flow rate testing in clinical practice.

2 | METHODS

The ICS, through its Standardization Steering Committee (SSC), has an ongoing strategy to standardize LUT terminology and functional assessment, and link it to published evidence.[2] We reviewed key expectations of service and good practice in uroflowmetry described in the ICS standards on Urodynamic Practice,[3,4] Urodynamic Equipment,[5] and Terminology for LUT Function.[6,7] The current document is a synthesis of the key aspects applicable to uroflowmetry.

3 | GENERAL COMMENTS

A good urodynamic practice comprises: a clear indication for, and appropriate selection of, relevant test measurements and procedures; precise measurement with data quality control and complete documentation; accurate analysis and critical reporting of results. These general principles apply to all forms of urodynamic testing, including uroflowmetry.

Departments should develop uroflowmetry protocols on the basis of the ICS Urodynamic standards,[3–5] they should facilitate specific staff training and undertake regular evaluation of performance and adherence.[3] ICS Terminology Standards should be used when alluding to LUT symptoms, signs, and urodynamic observations.[6,7] Equipment should meet the requirements of the ICS guideline on equipment performance.[5]

Uroflowmetry is a test that measures the urinary stream as volume passed per unit time in milliliters per second (mL/s).[4] Maximum flow rate (Q_{max}) and total volume voided must be reported.[4] The PVR should also be reported. This is the remaining intravesical fluid volume determined immediately after completion of voiding. The technique (eg, ultrasound or catheter) used to measure the PVR should be specified.

4 | EQUIPMENT AND ENVIRONMENT

The basic set up for a flow test environment is illustrated in Figure 1. The requirement of a uroflowmeter is that it can continuously measure the flow rate of urine voided and the total volume voided. The method used to make this measurement is not clinically significant. Accuracy need only be to ±1 mL/s of true flow rate and to ±5% of true volume voided (or ±2 mL if that is greater than 5%).[5]

Units should regularly check the performance of their system and calibrate according to manufacturer recommendation.[5] Flowmeter calibration can be verified by pouring a precise volume into the flowmeter and checking the recorded volume. Calibration should be verified regularly, for example, at the start of every clinic or week of clinics, and documented. If frequent recalibration is necessary, the flow transducer might need to be replaced.

Uroflowmetry equipment should be placed in a private, quiet environment[3] that can be easily cleaned, with the machine ready for immediate use, as many LUTS patients having flow rate testing will experience urgency. PVR measurement is ideally done in the same room and immediately following the void. A sluice room with connecting door to the flow test room is preferable to an unconnected room.

5 | PREPARATIONS IN ADVANCE OF A UROFLOWMETRY TEST

An explanatory leaflet about uroflowmetry with sufficient information, which uses clear, unambiguous wording, will be appreciated by most patients. To reduce possible waiting time, patients can be asked to attend the clinic with a comfortably full bladder.

When sent the explanatory leaflet, the patient can also be asked to complete a frequency volume chart (FVC) or Bladder Diary. A FVC records the time of each micturition and the voided volumes, while a Bladder Diary also captures symptoms and events such as fluid intake, urgency, pain, incontinence episodes, and pad usage.[6,8] Average and maximum voided volumes, voiding frequency, and day/night urine production can be determined.

FIGURE 1 A suitable environment for uroflowmetry. The flowmeter can be accessed quickly from the waiting area if the patient experience surgency, achieves privacy (here by having a curtain in addition to a locked doorway), is easy to clean, and has direct access to a sluice room (not in above picture). Female uroflowmetry would have a commode seat in addition to the funnel

6 | FLOW RATE TESTING

Patients should be asked to pass urine when they feel a "normal" desire to void,[4] and should undergo uroflowmetry in their preferred position. Intracorporeal modulations of the flow rate should be minimized, for example, by asking the patient to relax and not to strain.[4] Men should be asked not to move the urine stream around the funnel, and not to squeeze the penis, both of which will affect the flow rate measurement (Figure 2).[7]

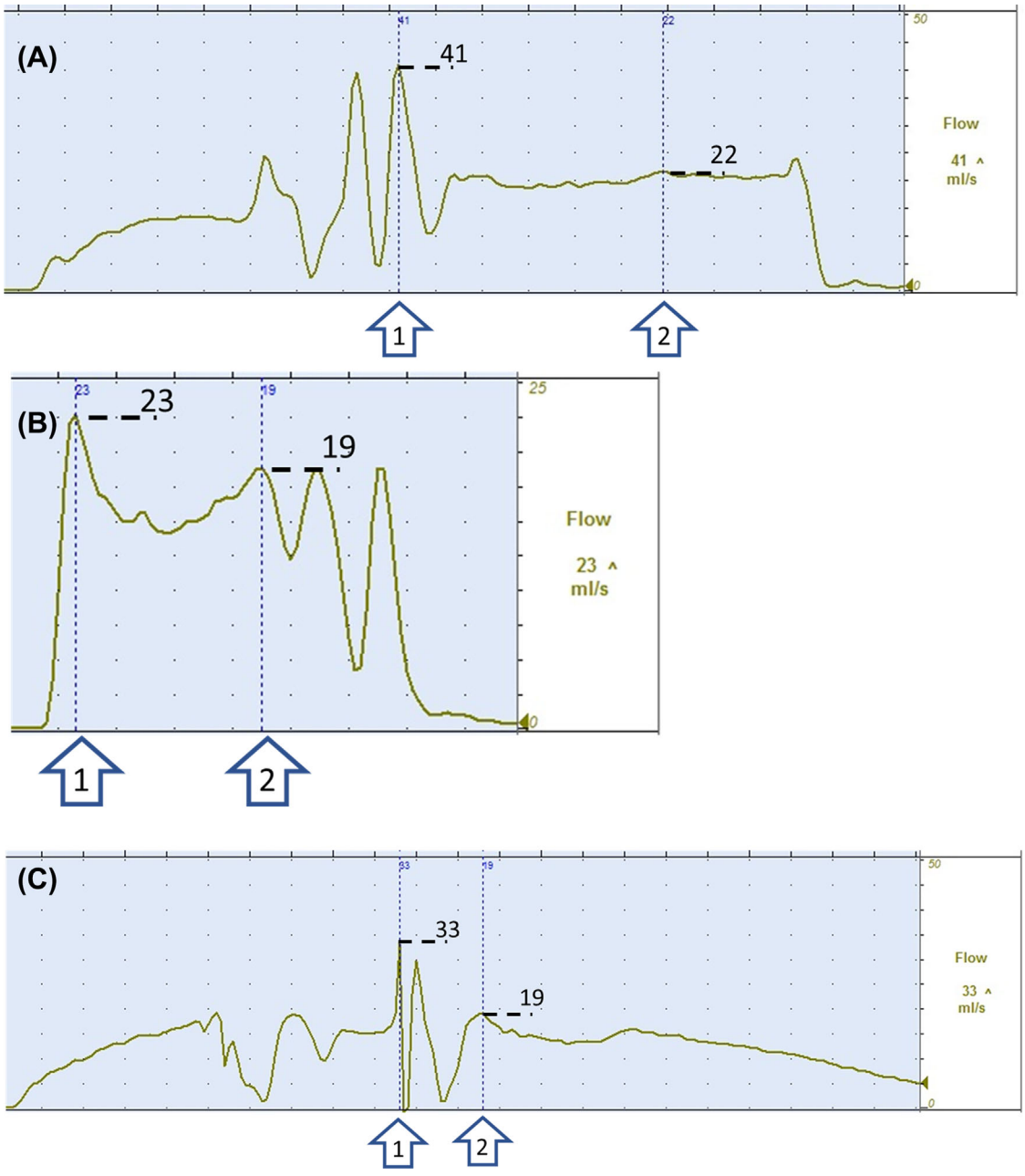

FIGURE 2 Some artefacts encountered in uroflowmetry, and the importance of correcting for the error in Q_{max} to establish the representative parameter. A, A male patient moving the urine stream back-and-forth across the funnel. B, A male squeezing and releasing the urethra at the start of flow, with straining toward the end of flow. C, A "knock artefact" (arrowed), resulting from a patient inadvertently kicking the uroflowmetry machine. In each case, the uroflowmetry machine has given a Q_{max} value which is a result of the artefact, displayed on the right hand side, and taken from the point marked with arrow "1." This is not representative of the patient's own function, so the urodynamicist has scrutinized the trace after the test and selected the highest point in the trace that does appear to result from the patient's own unimpeded bladder and outlet behavior, at the point marked with arrow "2." This means the representative values change, for instance in A from 41 to 22 mL/s, which may well result in a clinically significant difference in interpretation. Before a flow test, the patient should be instructed to keep his stream in the same part of the funnel, not to squeeze his penis, and try to avoid knocking the machine

TABLE 1 Task list to assist good practice in uroflowmetry

Task No.	Good practice question	If "No," correction needed
1	Has equipment calibration been checked?	Check calibration
2	Is the patient aware of the reason for the test and what is required of them?	Explain to patient
3	Has the bladder diary been completed and examined?	Discuss with patient to gain estimates
4	Does the patient have a normal desire to void?	Wait until normal desire
5	Is the equipment set at the right height and position?	Adjust to suit patient
6	After the void, has urinalysis been carried out?	Perform urinalysis
7	Is the void known to be a representative normal void?	Repeat flow test after drinking
8	Is the trace clear of artefacts from movement of body, flowmeter or urine stream?	Adjust trace markers if possible, and instruct patient for improved next flow
9	Is Q_{max} marked at a point away from artefacts?	Move Q_{max} marker to smoothed maximum position
10	Are the markers for start and end of void away from artefacts or drops of urine?	Move markers away from artefacts
11	Does the scale of printing make the flow trace clearly visible?	Adjust scale of display/print
12	Has the residual urine volume been measured immediately after voiding?	Measure volume, including comment on any time delay
13	Does the report include: Q_{max}, voided volume, residual volume, Void%, flow and voiding times, flow trace shape description, whether flow is representative? The report may also include if required: Clinical history summary, urinalysis, bladder diary summary and any lifestyle advice given.	Complete report

Practitioners should check if the voiding is representative, based on the patient's report, and comparing with other information, such as Bladder Diary volumes. Increasing bladder volume increases the potential bladder power,[4] notably in the range from empty up to 150-250 mL. At volumes higher than 400-500 mL, the detrusor may become overstretched and contractile strength may decrease. Thus, interpretation should evaluate the bladder volume at time of testing (voided volume plus PVR).

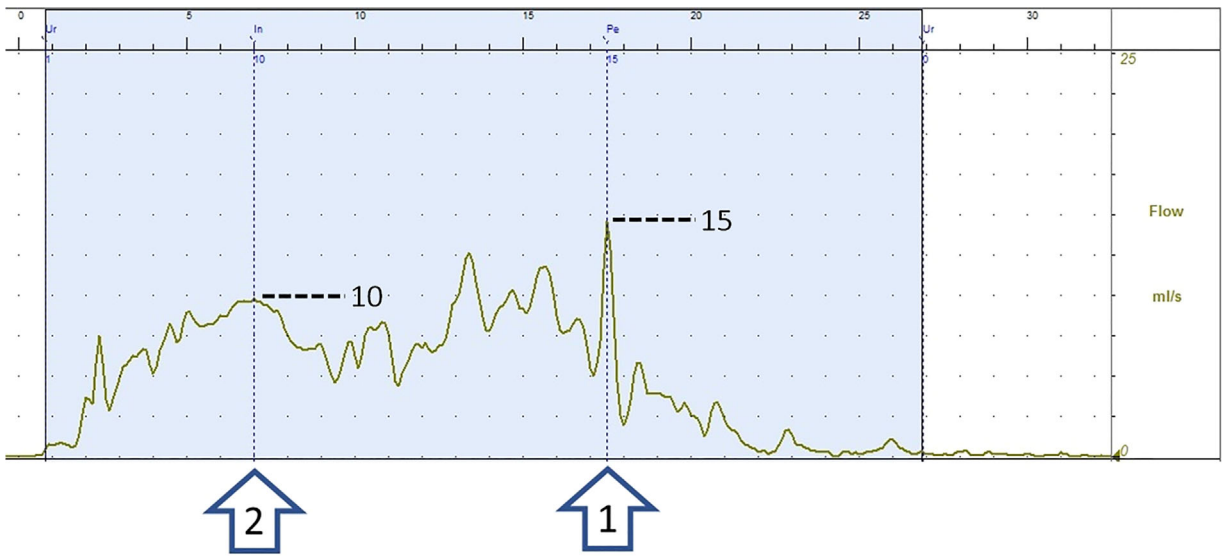

FIGURE 3 Example of a female patient who may have some pelvic floor contractions during voiding, leading to the uneven shape of the curve. This patient may also have moved about on the commode seat, giving rise to the particularly sharp spike. The computer-generated report reads $Q_{max} = 15$ mL/s, taking the value at arrow "1." After the test, the urodynamicist identified this is not representative, and moved the cursor to the position of arrow "2," where a portion of the flow unaffected by pelvic floor contraction and patient movement suggests an interpretable and representative flow. Q_{max} value was accordingly corrected to 10 mL/s, and should be recorded as such, with comment on whether the flow was representative

Consider repeating the uroflowmetry if the result has not been representative for the patient or it indicates abnormality, with reasonable fluid intake and diuresis time before the flow is repeated.[9]

A list of tasks to aid good practice is contained in Table 1.

7 | QUALITY CONTROL

Several artefacts can occur which are readily identified: knocking of the flowmeter (Figure 2C), passing of feces or disposal of tissues result in high, sudden values of flow rate and/or volume. If such fast changes are observed and confirmed with the patient, instruction of the patient will improve the next flow test.

Moving the urine stream back and forth across the funnel results in phasic variations around the true flow rate (Figure 2A). Some men have developed the habit of squeezing the penis to build up pressure, in order to give a faster flow after release. This "squeeze and release" habit gives gaps in the flow followed by high flow rate spurts, illustrated in Figure 2B. In both cases, the patient should be instructed not to do so, in order to better evaluate the LUT itself. For some patients, pelvic floor muscle action or body movement can result in smaller, artefactual variations in flow rate, see Figure 3. Uroflowmetry machines will automatically, and perhaps wrongly, measure the highest peak of flow, rather than smooth out the flow rate to remove these artefacts. Accordingly, in each of these situations, the operator will need to move the Q_{max} marker to a nearby point, or smooth the flow signal by eye, in order to establish the clinically representative value (Figures 2 and 3). A moving average using a 2 s window is advised.[3]

If the flow and voiding times are being reported, the operator will need to check that the end of flow is correctly marked by the machine. If drops due to coughs or other movement are included in the voiding time, the final marker will need to be moved back to the true end of micturition (Figure 4) and only then should the time values be recorded.

8 | REPORTING

All results and observations should be carefully reported. It is good clinical practice to integrate the uroflowmetry results with the history, examinations and Bladder Diary summary. A urinalysis should also be evaluated and reported with the flow results, since current urinary tract inflammation could alter the patient's flow characteristics.

The report after uroflowmetry should include; voiding position, Q_{max} (corrected for any artefacts), voided volume and PVR. Flow time and voiding time may be reported if required. The ICS suggests a standard reporting format of "VOID: Maximum Flow Rate/Volume Voided/Post Void Residual Volume," where flow rate is rounded to the nearest integer and volume rounded to the nearest 10 mL.[3] Scaling of the printout has been suggested as follows: 1 mm can equal 1 s on the x-axis and 1 mL/s and 10 mL voided volume on the y-axis,[3] but the trace must be clearly readable whatever scale is used.

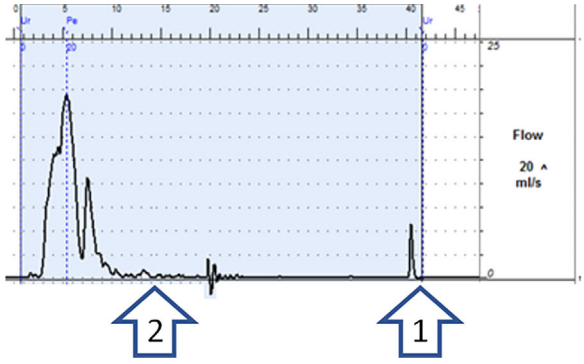

FIGURE 4 Similar to correcting the Q_{max} value after a test, the indicator identifying the end of micturition may need to be moved, from the point marked by arrow "1" to the point marked by arrow "2" arrow, if the patient experiences a post micturition dribble, or if the machine gets knocked as the patient moves away

Nomograms have been produced (summarized in Gammie et al[1]) that show the likelihood of the Q_{max} and voided volume recorded resulting from a normal urinary tract. Clinicians must be aware that these nomograms are not diagnostic, but may be a useful screening tool for dysfunction.

Comment may also be made when reporting on the voided percentage (Void%) and the flow curve shape. Void% is the numerical description of the voiding efficiency, which is the proportion of bladder content emptied. Calculation: volume voided/(volume voided + PVR) *100%.

The shape or pattern of the flow curve may suggest specific types of abnormality, but reliable and specific information about the cause cannot be derived from a flow curve alone.[1,3] The shape of the flow curve can be described as continuous or intermittent, and smooth or fluctuating.[6]

9 | CONCLUSIONS

This summary provides a systematic approach to ensure a representative, high quality, non-invasive flow test is carried out for individual patients. Adherence to the fundamentals of the ICS Standards, as synthesized in this review and summarized in Table 1, will enable urodynamic units to deliver high quality of uroflowmetry studies.

CONFLICTS OF INTEREST

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Fundamentals of urodynamic practice, based on International Continence Society good urodynamic practices recommendations

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Aims: To review the recommendations on basic urodynamic testing in the International Continence Society (ICS) standardization documents, specifying key recommendations for delivery and interpretation in clinical practice.

Methods: Fundamental expectations described in the ICS standards on good urodynamic practices, urodynamic equipment, and terminology for lower urinary tract (LUT) function were identified and summarized.

Results: The ICS standard urodynamic protocol includes clinical history, including symptom and bother score(s), examination, 3-day voiding chart/diary, representative uroflowmetry with post-void residual, and cystometry with pressure-flow study (PFS). Liquid filled catheters are connected to pressure transducers at the same vertical pressure as the patient's pubic symphysis, taking atmospheric pressure as the zero value. Urodynamic testing is done to answer specific therapy-driven questions for treatment selection; provocations are applied to give the best chance of reproducing the problem during the test. Quality of recording is monitored throughout, and remedial steps taken for any technical issues occurring during testing. Labels are applied during the test to document events, such as patient-reported sensation, provocation tests, and permission to void. After the test, the pressure and flow traces are scrutinized to ensure artefacts do not confound the findings. An ICS standard urodynamic report details the key aspects, reporting clinical observations, technical, and quality issues. Urodynamic services must maintain and calibrate equipment according to manufacturer stipulations.

Conclusions: The review provides a succinct summary of practice expectations for a urodynamic unit offering cystometry and pressure flow studies (PFS) to an appropriate standard.

KEYWORDS
LUTS, overactive bladder, standardization, urodynamics

Alan Wein led the peer-review process as the Associate Editor responsible for the paper.

1 | INTRODUCTION

Urodynamics is the general term to describe the measurements that assess the function and dysfunction of the lower urinary tract (LUT) by any appropriate method. The aim of urodynamics is to make clinical observations while taking these measurements, in order to surmise the underlying causes for the symptoms, and to quantify the related pathophysiological processes. This should establish objectively the presence of a dysfunction and understand its clinical implications. This may either confirm a clinical diagnosis or give a new, specifically urodynamic, diagnosis.

The International Continence Society (ICS), through its Standardization Steering Committee (SSC), has an ongoing strategy to standardize LUT terminology and functional assessment, and link it to published evidence.[1] Several ICS publications underpin the professional standard in Urodynamic testing, and describe in detail the underlying thinking and the evidence base. The current document is a synthesis of the key aspects applicable for the more common Urodynamic tests used in clinical pathways.

2 | METHODS

We reviewed recommendations in the ICS standards on urodynamic practice,[2,3] pressure flow studies (PFS),[4] urodynamic equipment,[5] terminology for LUT function,[6,7] and a publication on artefacts.[8] The review focusses on cystometry and PFS in adults without relevant neurological abnormalities and with intact "normal" anatomy of the LUT. Flow rate testing[9] and video-urodynamics[10] are described in separate documents.

2.1 | General comments

A good urodynamic practice comprises: a clear indication for and appropriate selection of relevant test measurements and procedures; precise measurement with data quality control and complete documentation; accurate analysis; reporting of results which evaluates urodynamic observations and places them into the patient's clinical context.

Departments should develop urodynamic practice protocols on the basis of the ICS urodynamic standards,[2,3,5] they should facilitate specific staff training and undertake regular evaluation of performance and adherence.[2] ICS terminology standards should be used when alluding to LUT symptoms, signs, and urodynamic observations.[6,7] Equipment, including the catheters and transducers, should meet the requirements of the ICS guideline on equipment performance.[5]

2.2 | Equipment

The basic requirement of a standard urodynamic system is that it can measure at least two pressures and calculate detrusor pressure (p_{det}) in real time, defined as the simultaneous difference between intravesical (p_{ves}) and abdominal (p_{abd}) pressures. It can measure the flow rate of the voided volume and regulate the rate of fluid infusion. It has an on-line display of pressures and flow, with adequate scale and resolution; no information should be lost electronically when tracings go off-scale on display. It is possible to record standard information about sensation and additional comments (event recording).[5]

Systems using liquid-filled catheters and external transducers are recommended by the ICS.[2,3] The transducer is levelled to the pubic symphysis, an anatomical landmark for the bladder, and the zero-point set to atmospheric pressure. Equipment should have the facility to move the transducers vertically in order to bring the transducers back to the level of the symphysis pubis, since patients may change position during a test. Micro-tip or air-filled catheters are not interchangeable with liquid-filled systems[2]; centers that utilize them should provide reference values for their data.

Using ICS standard pressures based on liquid-filled systems allows comparison of data between patients and centres. New technologies need to prove their usefulness and accuracy compared to existing ICS standard urodynamic tests before clinical application.[11] To date, there are no standardized pressure measurements for air-charged catheters.

2.2.1 | Calibration

Pressure transducer calibration is achieved by exposing the catheter tip to two different well-defined pressures (a pressure difference of $\geq$50 cmH_2O is recommended).[5] The calibration should be verified regularly (eg, every 10 urodynamic measurements for non-disposable transducers) and documented.

Flowmeter calibration can be achieved by pouring a precise volume at a constant flow into the flowmeter and checking the recorded volume. Calibration should be verified regularly (eg, every 10 urodynamic measurements). If frequent recalibration is necessary, the flow transducer might need to be replaced.

Infusion pumps are tested by measuring the time to deliver a known volume. The filling catheter should be connected, as peristaltic type pumps (where a series of rollers compress a flexible tube) may show errors due to downstream resistance. Load cell measurement of infused volume is advised, as peristaltic pumps may turn even when the downstream tube is blocked.

2.3 | Preparations in advance of a urodynamic test

A leaflet clearly explaining urodynamic investigation in adequate detail will be appreciated by most patients. A table suggesting content to include in an information leaflet is

available.[2] Instructions must be given to the patient regarding continuation of usual LUT management (eg, medication).

A urinalysis to screen for infection or haematuria should be evaluated.

Patients should attend with a completed frequency volume chart (FVC) or bladder diary.[6,12] They can be used to determine fluid intake, maximum and average voided volume, voiding frequency, and day/night urine production. This information supports the patient's symptom reporting, and aids plausibility control of subsequent urodynamic studies (eg, to prevent over-filling of the patient's bladder).

Urodynamic tests should be requested with the goal of answering a specific question.[3] "Formulating the urodynamic question" is a process of reviewing the clinical assessment already available and what potential therapy options may subsequently be appropriate, so the test can identify appropriate treatment options and potential adverse effects.

2.4 | ICS standard urodynamics protocol

- Clinical history, including valid symptom and bother score (s) and medication list.
- Relevant clinical examination (abdominal/pelvic/genital examination, and checking for possible neurological disease or oedema).
- Three day FVC or bladder diary.[13]
- Representative uroflowmetry with post-void residual (PVR).[9]
- A complete ICS standard urodynamic test[2]: Uroflowmetry and PVR plus cystometry and pressure-flow study (PFS).

Cystometry[2]: Continuous liquid filling of the bladder via a transurethral (or other route eg, suprapubic) catheter, at least with intravesical and abdominal pressure measurement and display of detrusor pressure, including quality checks and provocations to aid eliciting symptoms. Cystometry ends with "permission to void" or with severe incontinence. The fluid type and temperature, filling method and rate, catheter sizes, pressure recording technique, and patient position should all be specified.

Pressure-Flow study[2]: The intravesical and abdominal pressures are measured, from "permission to void," while uroflowmetry is performed with a transurethral (or suprapubic) catheter in place. The position of the patient, the catheter sizes and the pressure and flow recording technique should be specified.

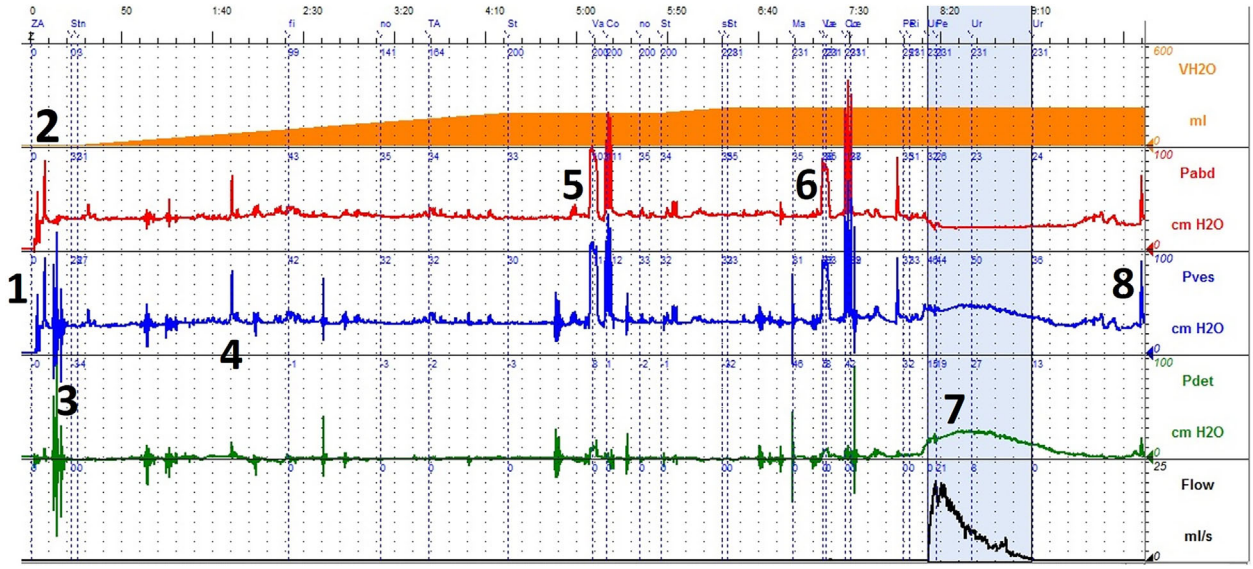

FIGURE 1 A specimen urodynamic test for a female patient. Transducers are zeroed to atmosphere at the start, as the p_{abd} and p_{ves} are at zero (1), before patient pressures are exposed to the transducers. When the transducers are connected to the patient (2), the clear rises in p_{abd} and p_{ves} are termed the "resting pressures"; the resting pressures of p_{abd} and p_{ves} are never zero (unless the urodynamic practitioner makes the technical mistake of zeroing the displayed pressures while recording from the patient, or the transducers are not placed in the required plane level with the pubic symphysis). In this case, p_{abd} and p_{ves} are both within normal limits, and similar magnitude, so p_{det} is zero. A cough test shows equal response on p_{abd} and p_{ves} (2). Some artefactual noise is recorded when the p_{ves} line is knocked (3). Cough tests are carried out and live signal is present throughout the test (4). At (5), filling is paused and a Valsalva manoeuvre and a stress cough test is carried out, but no leak occurs. Further filling is done, and these two tests repeated at (6) where leakage occurs on both (markers confirm this, and small changes in the flow trace have occurred but are not visible at this scale). After "permission to void" is given, the patient voids (7) and care is taken with the placement of the Q_{max} marker, and with the slight fall in p_{abd} at this point. Finally, a cough test (8) verifies that pressure transmission has remained good throughout the voiding phase

2.5 | Practice of cystometry and pressure flow studies

A good urodynamic investigation is performed interactively with the patient.[3] It should be established how the patient's symptoms relate to what they experienced during the test. There should be continuous observation of the signals as they are collected, and assessment of the plausibility of all signals. Direct inspection of the raw pressure and flow data before, during, and at the end of micturition is essential, because it allows artefacts and untrustworthy data to be recognized and eliminated.[4] The flow pattern in a PFS should be representative of free flow studies in the same patient. An overall study trace is illustrated in Figure 1.

Electronic marking of events is important for subsequent analysis; the position of event markers should be adjustable after the test has finished, and the meaning of any abbreviations used for labels should be clear.[5]

2.5.1 | Pressure recording

Zero pressure is the value recorded when a liquid-filled transducer is open to the environment (either disconnected from any tubes, or when the open end of a connected liquid-filled tube is at the same vertical level as the transducer). "Set zero" or "balance" can then be undertaken, making atmospheric pressure the zero baseline for the test. Intravesical pressure (p_{ves}) or abdominal pressure (p_{abd}) is thus the excess pressure above atmosphere at the hydrostatic level of the symphysis pubis. "Set zero" is not done when catheters are already recording from the patient; this is a common mistake in many urodynamic units.

- ICS standard cystometry is performed using liquid filled catheters, with external transducers at the reference level of the top of the symphysis pubis.[2,3,6] To achieve this, most urodynamic machines have a movable platform for the transducers, so they can easily be placed at the same height from the ground as the patient's symphysis.
- Use the thinnest possible transurethral double or triple lumen catheter or a suprapubic catheter. Two-catheter techniques (separate filling and pressure recording catheters) are an acceptable alternative.[2]
- Fix the catheters as close as possible to the anus and urethral meatus with tape, without blocking the urinary meatus.

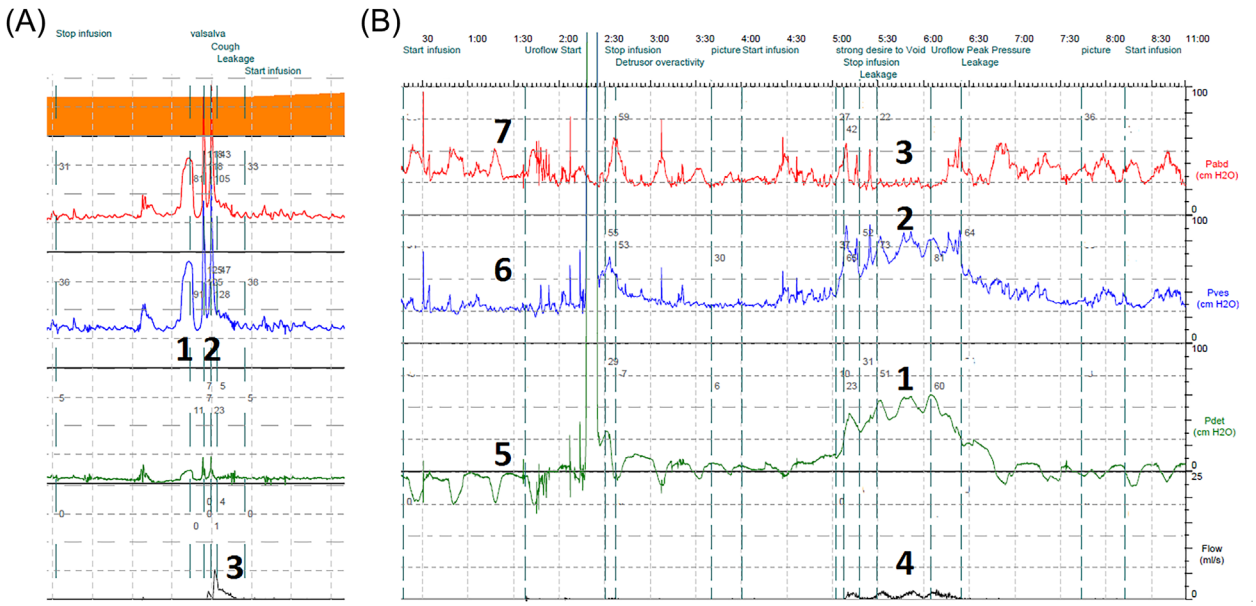

FIGURE 2 Urodynamic observations during filling cystometry. A, USI; the filling pump is stopped, and the patient is asked to do a Valsalva manoeuvre (1) and to do a sequence of 2 or 3 good coughs (2). This patient leaked with the coughs (3), and no DO was present, so the urodynamic observation of USI was documented. B, DO is the presence of a bladder contraction during filling (1), which may be spontaneous or provoked. It is essential to review all the lines in the trace before reporting DO, to confirm there is a bladder contraction (2) and minimal abdominal activity (3; though a small abdominal contraction might be seen if the patient tries to prevent leakage by contracting their pelvic floor). In this case, there is also incontinence (4), so the urodynamic observation here is DO incontinence (DOI). In the same trace, there are also fluctuations in the calculated detrusor pressure (5) which might be misinterpreted as DO. However, these are below the baseline, and there is no change in bladder pressure associated with them (6). Instead, there are phasic pressure changes visible in the abdominal pressure trace (7), indicating the presence of rectal contractions. Practitioners need to recognise that a true change in abdominal pressure shows up in both p_{ves} and p_{abd}; a phasic change in one line which is absent in the other indicates a contraction of the organ containing the catheter tip (bladder or rectum, respectively)

- Rectal placement of a fully liquid filled open catheter, or punctured balloon catheter, to measure p_{abd} is ICS standard. Vaginal or stoma placement is used only if rectal placement is impossible.

Prevention of liquid leaks and air bubbles in the pressure tubing system is needed throughout testing, and should be corrected when identified.[3] Coughs or other abdominal pressure rises are used to ensure that the abdominal and intravesical pressure signals respond equally (see Figure 3).

2.5.2 | Cystometry

Filling cystometry is done in the upright/vertical position (standing or normally seated) whenever physically possible. Detection of detrusor overactivity (DO) and urodynamic stress incontinence (USI) are influenced by the position of the patient; sitting or standing has a higher sensitivity.[2]

2.5.3 | Filling rate

Maximum physiological filling rate is estimated by body weight in kg divided by four,[6] thus typically in the range of 20-30 mL/min. More rapid filling is referred to as non-physiological filling rate.[3]

For a balance between a filling rate that is slow enough to be representative and fast enough to complete the cystometry efficiently, consider a filling rate in mL/min of roughly 10% of the largest voided volume (reported on a FVC; and allowing for PVR).[2]

Diuresis adds bladder volume that is not recorded by the urodynamics system, but that is relevant for interpretation of the results. Cystometric capacity is most reliably determined by calculation of voided volume plus PVR immediately after PFS.[3]

2.5.4 | Sensations

Three sensation parameters are recorded[6]: first sensation of filling (FSF), first desire to void (FDV), and strong desire to void (SDV). The patient also may report sensation(s) suggesting "urgency," which can be marked specifically. When indicating the volumes at which these sensations occurred, the report should make allowance for the fact that the volume instilled into the bladder by the machine is not necessarily the actual liquid volume in the bladder (eg, if the bladder was not empty at the start of the filling cystometry, or if the patient is experiencing diuresis).

1. FSF: "Tell me the moment when you perceive that your bladder is not empty anymore."[2]
2. FDV: "Tell me when you have the sensation that normally tells you to go to the toilet, without any hurry, at the next convenient moment."[6]
3. SDV: "The moment that you would definitely visit the nearest toilet to pass urine." There should be no pain or any fear of losing urine.

The end of filling should relate to a "strong but not uncomfortable need to void," indicated by SDV on the urodynamic graph. A specific marker to indicate permission to void must be used if there is a delay between halting the pump and permission to void. If another reason is chosen for concluding filling, this should be indicated.

Incontinence, fear of leakage, pain, or other signs or symptoms during the test should be specifically marked on the urodynamic graph.

2.5.5 | Provocation

Urodynamic stress test[2] (Figure 2) is used for any physical effort of the person tested, to elevate abdominal pressure during cystometry, with the aim of examining USI. The exact approach to stress testing during urodynamics has not been standardized. Thus, the provocation method, pressure measuring catheter (size) and method, the leak detection method, and the intravesical volume(s) may be reported.

Leak point pressure (LPP)[2] is the pressure (spontaneous or provoked) that has caused fluid to be expelled from the bladder at the moment that it is visible outside the urethra. No ICS (or commonly agreed) standard technique or protocol is available and a variety of terms and techniques are used.

DO (Figure 2) is characterised by involuntary detrusor contractions during the filling phase which may be spontaneous or provoked.[6] Cough-associated DO[2]: Reported when the onset of the DO (with or without leakage) occurs immediately following the cough pressure peak. Cough-associated DO incontinence is a form of DO and must not be confused with USI.

2.5.6 | Pressure-flow studies

The relevance of instruction, position, and privacy while undertaking PFS is equal to uroflowmetry. PFS is done comfortably seated (women, some men) or standing if that is the preferred position (men). Pressure-flow analysis is only validated for voluntarily initiated micturitions and not for incontinence.

- PFS begins immediately after permission to void and ends when the detrusor pressure has returned to the baseline

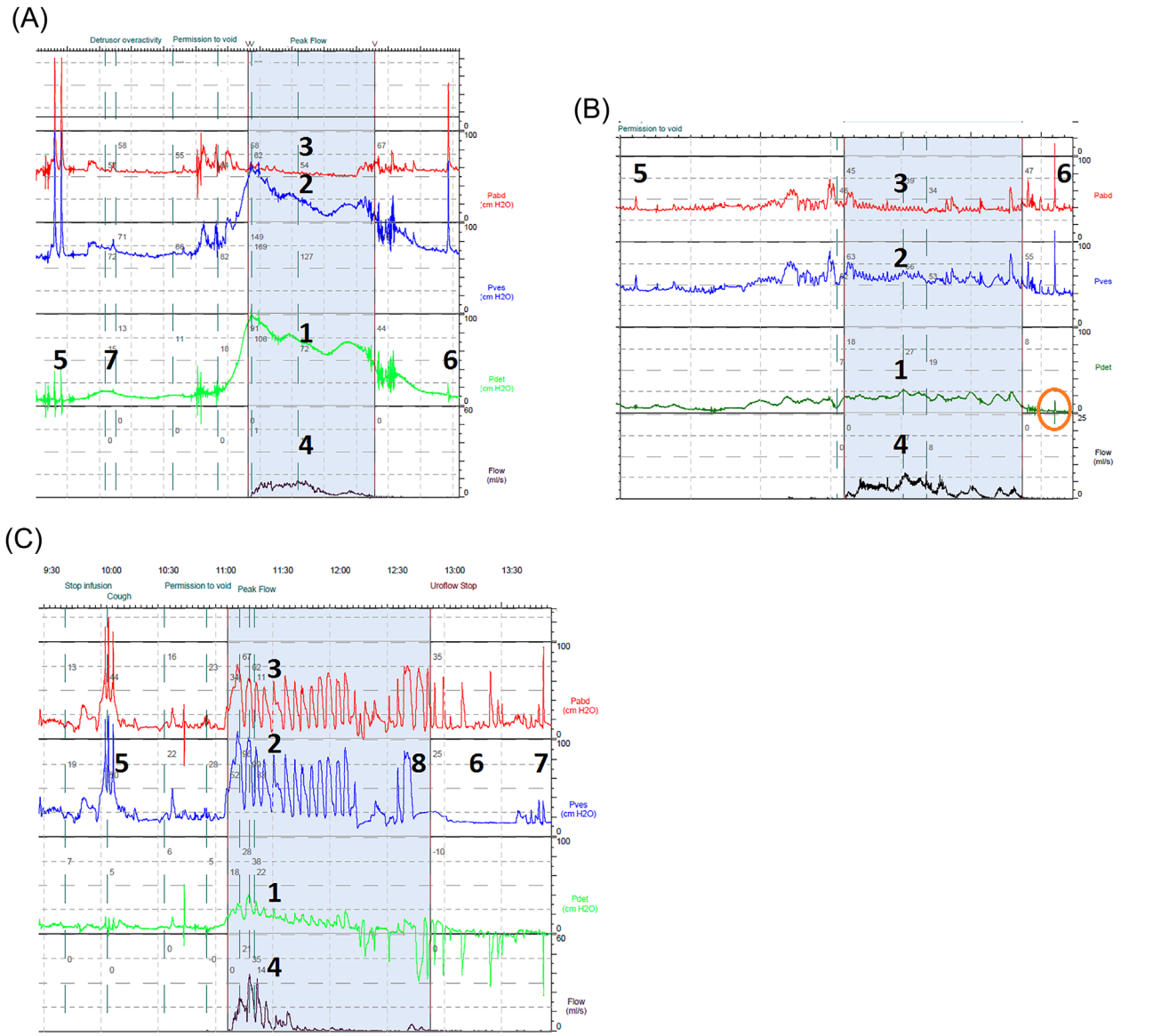

FIGURE 3 Urodynamic observations during PFS.[4] A, Bladder outlet obstruction (BOO) is indicated by a high pressure generated yet only a slow stream. It is ascertained by evaluating the detrusor pressure ($P_{detQmax}$; 1) at the time of maximum flow rate (Q_{max}: 4). It is important to check that the detrusor pressure reflects the bladder pressure (2), rather than a drop in the abdominal pressure (3). In this male case, Q_{max} was 8, $P_{detQmax}$ was 72, and there was no drop in abdominal pressure, so the bladder outlet obstruction index ($P_{detQmax}$-2Q_{max}) was 56, that is, BOO was present. Fidelity of pressure recording must always be checked by asking patient to cough before (5) and after (6) voiding to be sure both P_{ves} and P_{abd} detect the pressure spike equally. This patient also had DO (7). B, Detrusor underactivity (DUA); Detrusor underactivity is defined as a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within a normal time span.[6] In this case, detrusor pressure is low (1) and Q_{max} (4) is slow, with a weak bladder contraction (2) and no change in p_{abd} (3). There is a marked delay between permission to void (5) and start of flow. Cough subtraction before (5) and after (6) the void are good. At 6, the cough subtraction (orange circle) shows a biphasic artefact, meaning a slight deflection upwards and an equal deflection downwards: this is acceptable, and is a consequence of the slight discrepancy in the exact moment the impulse reaches the respective transducer for the two measured pressures (p_{ves} and p_{abd}). C, Straining is sometimes done by a patient to try and help initiate or sustain voiding, or to speed it up. In this case, there is a small detrusor contraction during voiding (1), but at the same time there are marked strains indicated by the intermittent peaks in vesical (2) and abdominal (3) pressure. Caution is needed to decide the corrected value of Q_{max} (4), as it should not be taken during a strain. The cough subtraction before voiding is fine (5), but not so after voiding (6), where this is a spike elicited by coughing only in the p_{abd} trace. A reduced signal is seen in the p_{ves} at (7), explaining the poor post void cough subtraction. The last moment of proper vesical pressure recording is at (8), and since this is after the completion of flow, the PFS can be considered meaningful

value and/or the flowrate to zero and/or the patient considers the micturition completed.

- Use the shortest possible meatus-to-flowmeter distance, raising the flowmeter to suit the individual patient. Correction for delay between pressure and flow recording may be needed.
- Cough checking of catheter response is always required after pressure-flow.

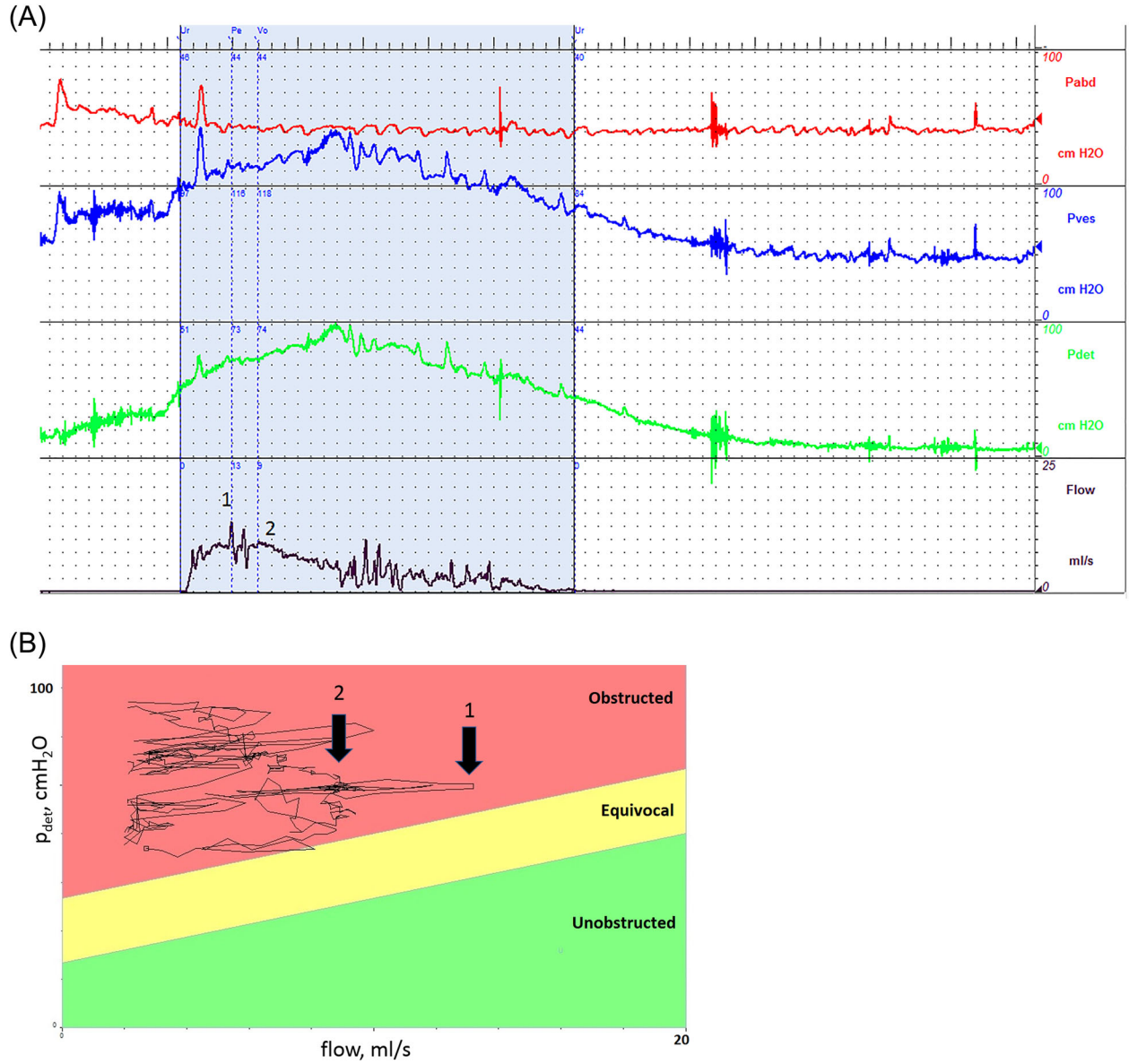

FIGURE 4 Calculating the bladder outlet obstruction index (BOOI) and bladder contractility index (BCI), for describing PFS in men (no equivalent parameters have been identified as yet for women). A, Pressure flow study for a man with voiding LUTS. The machine placed the maximum flow rate at point 1. However, this was on the tip of an unnatural spike, so the urodynamicist checked the shape of the flow trace, and considered that point 2 reflected the flow of the patient's urine most faithfully. Thus, this was considered the corrected maximum flow rate (Q_{max}), with a value of 9 mL/s. p_{det} at this point ($p_{detQmax}$) was 74. From the equation BOOI = $p_{detQmax}$-2.Q_{max}, the value for this patient was 74 – 18 = 56. Any value of BOOI above 40 in a man (with a prostate) indicates obstruction. From the equation BCI = $p_{detQmax}$ + 5.Q_{max}, the value of BCI for this patient was 74 + 45 = 119. Any value of BCI above 100 in a man (also with a prostate) indicates normal contractility. B, The ICS recommends that the PFS is plotted graphically on a PQ plot. On the P/Q plot, "1" shows the artefactual peak due to the flow spike. The P/Q plot allows the investigator to see how the artefact almost changes the diagnosis, by nearly crossing one of the lines on the nomogram. "2" shows the corrected position, away from the flow spike and clearly in the obstructed region. Failure of machine software using current technology to identify artefacts, like that shown at 1, means that traces must be checked for plausibility, since otherwise obstruction and contractility may be wrongly derived from the pressure flow study, leading to inappropriate treatment decisions for the patient

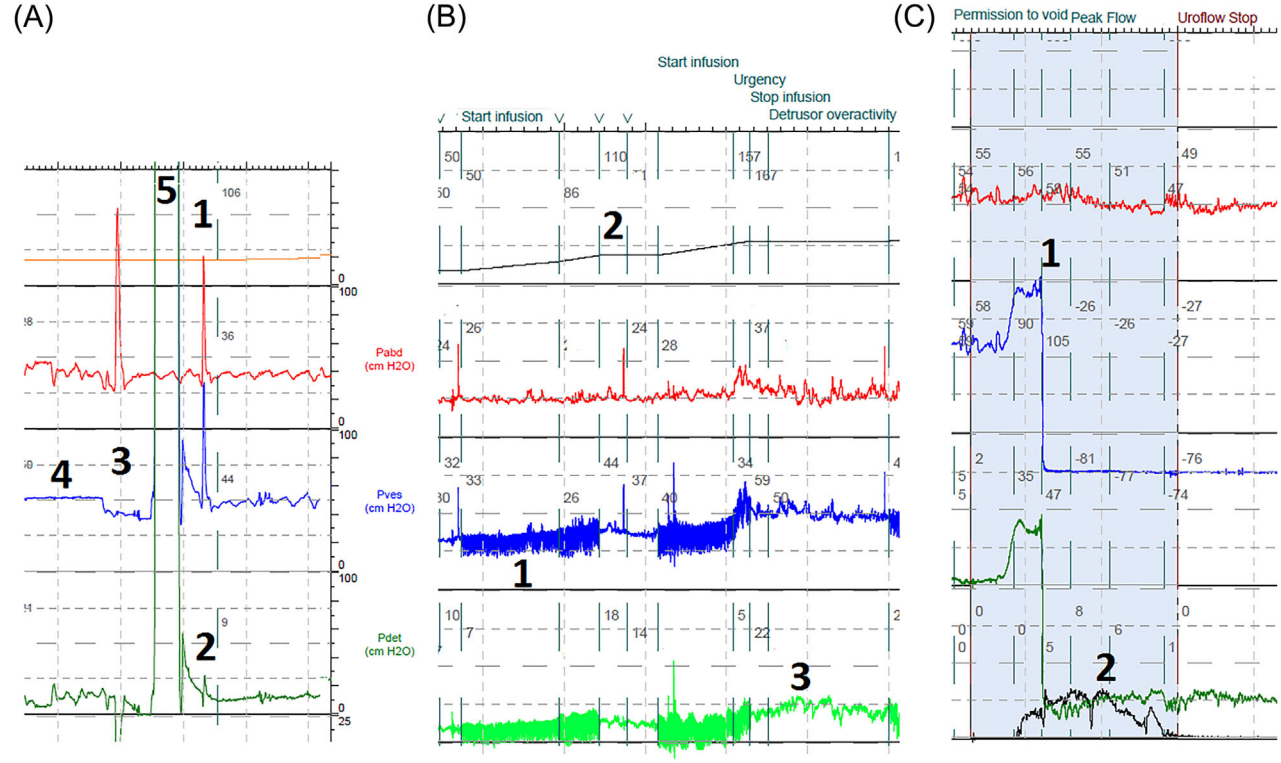

FIGURE 5 Artefacts that can cause difficulty with identifying representative information and misinterpretation of urodynamic findings. A, A cough pressure peak (1) is recognizable during post-test evaluation as a phasic positive pressure change observed in p_{ves} and in p_{abd}. With liquid-filled catheters, it is usual that the bladder line is of smaller diameter than the abdominal line, so complete cancellation of a cough in the detrusor trace is unlikely. Thus, a symmetric biphasic wave on the detrusor trace (2) is acceptable. Poor pressure transmission is suggested when the cough pressure peak signals on p_{ves} and p_{abd} are not nearly equal, or one of them is absent, as illustrated at 3. This follows a phase of "dead signal," meaning that it is not showing small pressure fluctuations and is not adequately responding on straining, patient movements, or coughing (4). Flushing the vesical pressure line (5) is a common approach to solving a dead signal or poor pressure transmission, and should be verified with a subsequent cough test, as illustrated. B, Pump vibrations: visible as stable frequency oscillations of small but constant amplitude if a dual-lumen is used, or if the filling tube touches the pressure connecting tube and the pump is switched on (1), clearly identified as they stop when the pump is off (2). This patient was observed to have DO (3; pump turned off at this time). C, Expelled catheter: this is observed as a sudden drop in either p_{ves} or p_{abd}, usually below zero (1). In this case, the vesical catheter was expelled before Q_{max} (2) in a pressure flow study, which means it is not possible to interpret the pressure-flow relationship at this key point during voiding. If this hinders answering the urodynamic question, the test will have to be repeated

Normal voiding function: Flow rate (and pressure rise) are within normal limits; flow begins more or less directly after permission to void, and ends with an empty bladder.

"Situational inability to void" or "Situational inability to void as usual"[2]; when the person performing the test, communicating with the patient, feels the attempted voiding has not been representative.

Bladder outflow obstruction (BOO) (Figure 3) is defined as a (specified) cut-off of bladder outflow resistance based on the pressure/flow relation (ratio) that is considered clinically relevant.[2]

A slow stream may be caused by BOO or detrusor underactivity (Figure 3). Presentation of pressure-flow studies should be with a plot of the flow rate (delay corrected) rate on the X-axis and the synchronous detrusor pressure on the Y-axis, in addition to the time-based graphs.[2] The ICS pressure flow nomogram can be used to present this data for male patients, for whom BOO can be quantified with the BOO Index, and underactivity with the bladder contractility index[14] (Figure 4). While these indices are often stated by the urodynamic software, the urodynamicist is duty-bound to check the plausibility of the results, as the machine may wrongly identify an artefact as the Q_{max}, and give entirely wrong results with potentially disastrous consequences for the patient.

2.5.7 | Repeat testing

- When an error or artefact is observed, the person performing the test should act accordingly, and prevent continuation in case of an error.
- Do not routinely undertake immediate repetition of invasive urodynamics "for confirmation" if the test was

technically adequate and representative, and has answered the clinical question.
- Immediate repetition of the test is appropriate when doubt exists as to whether the test has answered the clinical question.
- Repetition of a urodynamic test subsequently is needed when technical errors and artefacts have been observed at post-test analysis.

Artefacts such as a signal which is non-responding (dead), has stepwise changes in pressure, or has negative pressures, often can be corrected only with speculation about the underlying causes. Studies with such artefacts should be repeated. A few common artefacts can be accepted, for example, rectal activity, biphasic spikes at cough tests (Figure 3B), or insufficient p_{abd} response during straining.

The urodynamic findings and the interpretation of the results should be documented immediately, that is, before the patient has left the urodynamic laboratory. Doing so allows for a second test if required.

2.6 | Technical and clinical quality control

The following three criteria form the minimum recommendations for ensuring quality control of pressure recordings:

1. Resting values for abdominal, intravesical, and detrusor pressure are in a typical range (see below);
2. The abdominal and intravesical pressure signals are "live," with minor variations caused by breathing or talking being similar for both signals; these variations should not appear in p_{det};
3. Coughs or other abdominal pressure rises are used throughout, including before and after voiding, to ensure that the abdominal and intravesical pressure signals respond equally. This is because pressure recording quality can deteriorate quickly during a test, and wrong conclusions might be drawn if not identified quickly. Since the test is used to recommend treatment options, possibly including surgery, the consequence of a wrong conclusion can be detrimental for the patient.

Initial resting pressure[2] is the p_{ves} and the p_{abd} pressure at the beginning of the cystometry. Typical ranges for p_{ves} and p_{abd} are: supine 5-20 cmH_2O; sitting 15-40 cmH_2O; standing 30-50 cmH_2O.[3] Usually both recorded pressures are almost identical (and they must not be zero: see Figure 1), so that the initial p_{det} is is between −5 and +5 cmH_2O in the majority.[15] Gentle flushing of both catheter channels and/or filling 20-30 mL into the bladder may be needed before the initial resting pressures are registered.

The use of rectal transducers assumes they measure resting abdominal pressure, but they can also measure rectal contractions,[5] seen as positive waves on p_{abd} and reflected as negative p_{det} waves. If either detrusor or rectal contractions occur, the recorded pressures in p_{ves} and in p_{abd} will differ. The relation between signal changes and patient sensation/activity are checked for plausibility and documented during the test.

2.6.1 | Features, artefacts, and errors

Patient movement, external manipulation of the catheter and other influences cause signal patterns that should be recognized during the test and at (re-) evaluation of graphs.

- Position change[2]: A change in patient position, either active or passive (eg, tilting), is visible on the cystometry trace by a lasting change of equal magnitude in both p_{ves} and p_{abd}.

A position change should be followed by adjustment of the external pressure sensors height to the new level of the pubic symphysis, so that the physiological p_{ves} and p_{abd} are observed again; p_{det} should be unaffected.

- Rectal contractions: temporary phasic increases visible in the p_{abd} trace, without synchronous change in p_{ves}, resulting in negative deflections of p_{det} (Figure 2B).
- Dropped p_{abd} at void: during the voiding time, p_{abd} decreases below the previous resting pressure (as a consequence of pelvic [and abdominal] muscle relaxation). This will artefactually increase p_{det}, and so affect the pressure-flow analysis result.
- Straining: observable as a temporary increase in both p_{ves} and p_{abd} pressure.
- After-contraction: a continued or new detrusor pressure rise immediately after flow ends. It is important to note if this occurs with the complete emptying of the bladder. This may be the reason why some patients feel they have an urgency sensation at the end of voiding.

Artefacts affect interpretation of urodynamic findings (Figure 5), and could lead to mis-diagnosis in severe examples. Step-wise or prolonged constant slope pressure changes imply a non-physiological cause (eg, movement, blockage or disconnection, or leakage of a catheter), which should be resolved.[3] A detailed review of urodynamic artefacts has been published.[8]

2.6.2 | Post-test analysis

Once a test is completed, it should be scrutinized to confirm technical quality and exclude the possibility that artefacts have influenced key observations. Liquid leaks and air

TABLE 1 Checklist for fundamentals of urodynamic practices

Question	What is the urodynamic question? Will patient management change as a result? Does the bladder diary/symptom score affect these? Does the patient's report match the above?
Setup	
Calibrate	Check that the equipment is registering pressure and volume accurately
Prepare	Fill the domes and tubes with water, and mount them on the transducers
	Catheterise the patient, connect tubes and flush with water
	Level transducers with symphysis pubis bone
Quality	
Zero to atmosphere	Ensure taps are closed to patient, and open to air when zero is pressed.
Check resting pressures are normal	Supine: p_{abd} and p_{ves} 5-20 cmH_2O Seated: p_{abd} and p_{ves} 15-40 cmH_2O Standing: p_{abd} and p_{ves} 30-50 cmH_2O for all positions, p_{det} −5-+5 cmH_2O
Continuous monitoring	Check regularly that pressure transmission is equal on both lines, for example, coughs, blowing
	Check that live patient signal is present throughout
	Check that baseline pressures do not drift
	Troubleshoot above during the test, temporarily stopping recording/filling if necessary
	Stop or reduce fill rate if urgency is excessive, or compliance poor
	Change patent position as required (eg, discomfort, stress testing)
	Consider repeating test if urodynamic question not answered
Interpretation	Place markers on the trace frequently, for example, sensation, patient position, stress tests, permission to void
	Adjust positions of markers after completion of test if needed
	Take a when interpreting, for example, rectal contractions, knocking of flowmeter
Report	Bladder during filling Urethra during filling Bladder during voiding Urethra during voiding Reproduction of symptoms Management plan

bubbles in the pressure tubing system should be recognized and reported during post-test analysis, if not identified during the procedure, to prevent mis-diagnosis.[8]

Post-processing automated analysis is an optional extra in urodynamic equipment, and established nomograms and calculated parameters may also be provided. Such analysis could be affected by artefacts (eg, Q_{max} caused by knocking the flow meter, p_{max} from cough),[5] and the urodynamicist must check the trace to be certain that misinterpretation does not result. The user should have the ability to check the values for feasibility and change the relevant ones if necessary. Software should not filter or remove artefacts, but should be able to ignore them for analysis.

2.7 | The urodynamics report

Bladder storage function should be described according to bladder sensation, detrusor activity, bladder compliance, and bladder capacity.[6] The urethral closure mechanism during storage may be competent or incompetent. Voiding is described in terms of detrusor and urethral function and assessed by measuring urine flow rate and voiding pressures. An "ICS standard urodynamic (time based) graph" and an "ICS standard pressure-flow plot" are required elements in the ICS standard urodynamics report.

- Reporting includes the following elements (summarized from GUP2016 [2]):

a Overall judgement of the technical quality, clinical reliability, representativeness, and methods of assessment.
b Uroflowmetry: voiding position, Q_{max}, voided volume, PVR.
c Introduction of catheters: sensation, muscular defence, obstruction(s).
d Patient position(s) during cystometry and PFS.
e Patient's ability to report filling sensations and/or urgency and/or urine loss.
f Method of urodynamic stress test and accessory tests (if applicable).
g Diagnoses: filling sensation (with volumes); cystometry; PFS (bladder outflow function, detrusor contraction).

All results and observations should be carefully reported. It is good clinical practice to integrate the urodynamic test results with the history, examinations, and other tests.

Table 1 gives a proposed checklist for Fundamentals of Urodynamic Practice.

3 | CONCLUSIONS

A good study is one that is easy to read and one from which any experienced urodynamicist will abstract the same

results and come to the same conclusions (GUP2002). Adherence to the fundamentals of the ICS standards, as synthesized in this review, will enable urodynamic units to ensure the quality of urodynamic studies and compare findings with other units.

CONFLICT OF INTEREST

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SOUNDING BOARD

WILEY Neurourology Urodynamics ICS SUFU

Basics of videourodynamics for adult patients with lower urinary tract dysfunction

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Aims: Videourodynamics is the addition of imaging to invasive urodynamics and one of the methods to ensure objective diagnosis in persons with signs or symptoms of lower urinary tract dysfunction. This manuscript has the aim to outline the basics of the practice of videourodynamics and to elementary explain interpretation of the results.

Methods: Literature sources and expert opinion were arranged to provide the reader with an introductory overview of current knowledge.

Results: Videourodynamics was—like most diagnostics in health care—introduced on the basis of plausibility and expert conviction but has stood the test of time. Videourodynamics has, especially in patients with congenital or acquired neurogenic dysfunction of the lower urinary tract, undisputedly although not precisely quantifiable, added to (lower urinary tract) health care quality.

Conclusion: The manuscript summarizes the basic elements of indication, practice, and interpretation of videourodynamics.

KEYWORDS
meningomyelocele, neurogenic lower urinary tract dysfunction, practice recommendations, spinal cord injury, videourodynamics

1 | DEFINITION

The ICS good urodynamic practice[1] states that standard invasive urodynamics may be combined with imaging. Invasive urodynamics performed with contrast fluid as the filling medium is termed videourodynamics: X-ray (image amplifier) pictures or cine-loops are made at relevant moments.[1] This report states that the contrast medium should be specified and the total patient radiation dose should be reported. Videourodynamics is not further discussed in the good urodynamic practices document and we provide the basic principles of this technique in this manuscript, with the goal to briefly introduce the practice and technique as well as the clinical purpose and application of the test to the not-expert.

2 | REQUIREMENTS

In addition to the standard urodynamic (UDS) set-up,[1] videourodynamics (VUDS) requires that the bladder is filled with (iodine) contrast fluid. The technique of VUDS has been introduced in the early seventies of last century[2,3] and the technique as was introduced in those early days has remained throughout the years.[4,5] All publications that explain the principles are expert opinion driven and all clinical studies, describing the application of the technique are single center retrospective reviews. We have extracted practical elements from a few reviews and instructional manuscripts.[6,7]

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

Diverse brands and types of contrast fluid are available. In general it is reasonable to use the contrast that is used on the radiology department to perform cysto-urethrography. As an example, the American College of Radiology provides a detailed description of the technique[8] and links, to documents that list available contrast agents. Recent studies about the type of contrast media and the quality of imaging are rare but earlier fundamental research demonstrates that very dense medium may obscure details.[9] Contrast agents have a different density compared to that of urine and or saline, which are usually applied for urodynamic measurements. The difference in weight requires specific calibration of the UDS equipment; the infusion pump and the flow meter, to ensure the machine does not overestimate volumes, because of the larger relative weight of the fluid.

A fixed X-ray unit that can move from 90° to 180° (allowing an antero-posterior, lateral as well as an oblique view), or a C-arm can provide for imaging in a fluoroscopy-proof room. Modern image intensifier, flat-panel and digital radiology equipped systems significantly reduce radiation dose when compared to the "old" x-ray film. Fluoroscopy rooms (also for VUDS) require shielded walls, shielded door(s) and usually have an x-ray glass control window. Shielding must be calculated by a physicist or radiation expert and is based on the specific imaging equipment utilized. The shielding typically will involve several different lead thicknesses depending upon primary beam and secondary scatter radiation fields, surrounding occupancy factors and other considerations. The patient and the medical team involved should be adequately protected and wear dosimeters.

VUDS should be performed in the patient's natural position, if possible. This will require a radiolucent toilet seat to allow fluoroscopy of voiding in a sitting position. A standing position should also be available to enable (stress) evaluation of urinary incontinence in men and women and or voiding in the standing position. Many patients, however, especially those with neurogenic dysfunction of the lower urinary tract (LUT) never void and or are unable to sit or stand. For those patients it should be considered, or preferred, to perform UDS in supine position. Both in seated as well as in supine position the relevant elements of the system should be upholstered adequately to prevent skin damage, especially again, for the patients with loss of sensation and LUT dysfunction.

VUDS software combining the X-ray images with the UDS trace, and presenting the data either on a split screen or by superposition, is widely commercially available although the precise association of the images with synchronous pressures is rarely reported.

Radiation exposure should be As Low As Reasonably Achievable (ALARA) without sacrificing diagnostic accuracy, and the radiation time and dose should always be reported, making patient dose monitoring essential.[1] Urodynamicists that wish to perform VUDS, as well as physicians should be well-trained to ensure that video-monitoring is performed adequately. Snapshots at clinically relevant moments (eg, during provocative measures or bladder pressure rises) are usually sufficient and long cine-loops are rarely relevant. The radiation field should be limited to the anatomical region of interest (sparing the gonads if possible). Pulsed digitally enhanced or low-dose setting continuous fluoroscopy with spectral beam filtration, optimal selection of the tube current and high voltage by an automatic brightness control system should be used to reduce radiation exposure. Certainly regular servicing as per local maintenance plan is important. A relatively low effective dose is achievable, as was demonstrated in a cohort with historical controls. A mean fluoroscopic time of around 60 s for VUDS including filling, stress testing, and voiding observations has been possible.[10] Plausibly, observations done do not often need reconfirmation (with repeated images), and a few snapshots at critical moments are conceivably sensitive to observe anatomical abnormalities in combination with the (dys) function of the LUT. Regrettably not much scientific evidence is published, regarding this.

3 | VIDEO-URODYNAMIC FINDINGS

The possible findings during VUDS are listed in Table 1. The key to VUDS is to adequately relate the anatomical findings (see Figures 1-4) to the urodynamic observations.

For example, a critical part in the follow-up and management of patients with neurogenic dysfunction (NLUTD) is to ensure low-pressure urine storage, thereby protecting the upper urinary tract (UUT). An unsafe bladder, prone to cause UUT damage, was defined in adult patients with spinal dysraphism as a bladder with a high end filling pressure (>40 cmH_2O), poor compliance (<10 mL/cmH_2O) and high detrusor leak point pressure (>40 cmH_2O)[11] criteria that can be deducted from conventional UDS.[12] High bladder pressures during the storage phase can, however, cause vesico-ureteral reflux (VUR) (eg, Figure 4). Secondary, this VUR can create a pop-off of bladder pressure as (one of) the UUT(s) now absorbs the pressure. This may lead to overestimation of bladder compliance. Therefore, VUDS have a clear advantage over conventional UDS when hydronephrosis was documented in the patient or when VUR is suspected or known by other means. VUR can be related to bladder function; passive VUR at low intravesical pressures, for example, due to an insufficient ureteric orifice as is frequently existing in congenital ureteral anomalies, for example, doubling versus active VUR occurring during

TABLE 1 Video-urodynamic observations in relation during anatomical site and urodynamic phase

Anatomical site	Video-urodynamic finding
Ureters and renal pelvis	Vesico-ureteral reflux + grade
Bladder	Trabeculation Diverticula Christmas tree appearance Postvoid residual (+ quantification) Vesico-vaginal fistula Filling "defect" (eg, prostate median lobe, bladder tumor, bladder stone)
Bladder base	Cystocoele + grade (at rest, during stress testing, and during voiding)
Bladder neck	Filling: Bladder neck incompetence (during stress testing) Filling: Bladder neck opening during detrusor overactivity contractions Voiding: Bladder neck dysfunction or dyssynergia Voiding: Bladder neck fibrosis
Urethra	Urinary incontinence Urethral stricture Urethral diverticula Urethrovaginal fistula (Neurogenic) detrusor—(external urethral) sphincter dyssynergia

elevated pressure as a consequence of reduced compliance or synchronous with a detrusor contraction during filling or during—high pressure—dyssynergic voiding. It is important to note that in patients with spinal dysraphism, anatomical abnormalities of the LUT are more prevalent than in patients with acquired NLUTD due to the abnormal muscle functional as well as anatomical development of the LUT and pelvic floor even before birth, as a consequence of the lack of (early) normal innervation.

Abnormalities in the shape or outline of the bladder should be related to the functional and the cystometric capacity. Bladder diverticula, for example, can serve as a pressure sink or can be responsible for postvoid residual (eg, Figure 3).

VUDS can also aid in the diagnosis of urinary incontinence. Male (post-prostatectomy) PRP-UI has been suggested as an indication for VUDS on the basis of expert conviction.[13,14] Whether VUDS is of advantage in uncomplicated PRP-UI; men without any other urological history or (neuro-) urological co-morbidity, than UDS has not been assessed yet. In women with recurrent signs and symptoms of UI on the other hand, VUDS can aid in the evaluation and may guide the management, but this also has not been evaluated prospectively with regard to improvement in management selection and or outcome. Therefore, the added value of fluoroscopy to UDS in women with recurrent UI after initial (surgical) intervention has yet to be determined. In NLUTD, VUDS can also be used to determine detrusor leak point pressure; it is possible to observe contrast fluid entering the urethra via the X-ray; however, all leak points are designed or calibrated with externally visible leakage.

In young men with non-neurogenic LUTS, a single center report suggests that VUDS can offer guidance in diagnosing

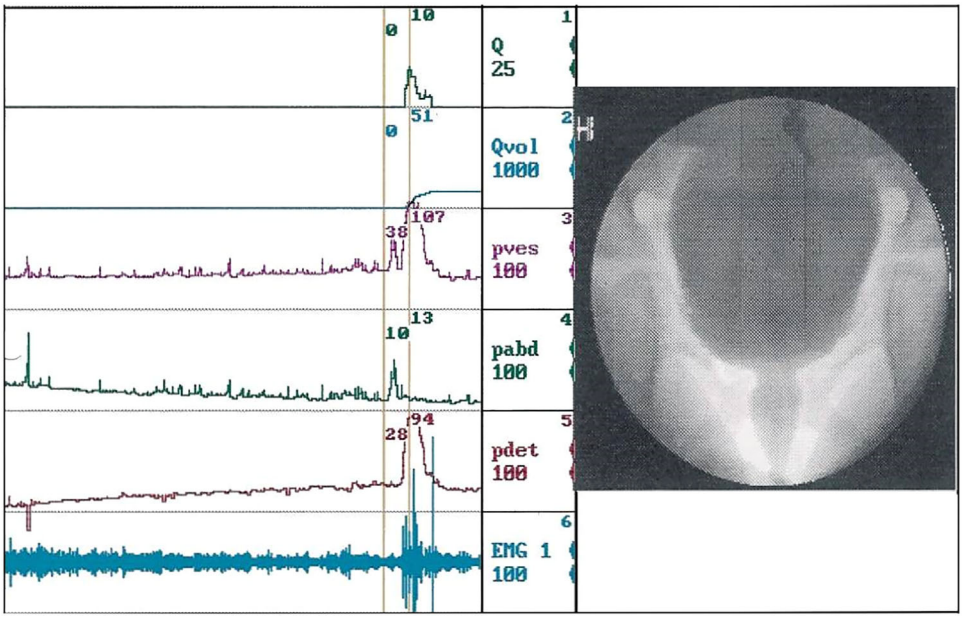

FIGURE 1 Voiding phase of VUDS bladder contour has normal appearance and bladder neck and prostatic urethra are clearly visible. Pressure flow analysis demonstrate that this patient has a normal contraction (BCI 144) and a bladder outflow obstruction grade 4 (or ICS-BOOI: 74)

FIGURE 2 Cystogram showing trabeculation over the entire bladder

the location or cause of bladder outflow obstruction (BOO): bladder neck dysfunction versus bladder neck fibrosis[15] versus urethral stricture. Some reports also suggest that VUDS can be useful for women with voiding difficulties to distinguish the effect of pelvic organ prolapse or dyssynergia in women with consistent intermittent or fluctuating flow,[16,17] however, the precise predictive value of observations with the video-part of the study are poorly described and difficult to reproduce.

Other indications for VUDS are listed in Table 2. In general, fluoroscopy can be added to the urodynamic evaluation if there is suspicion of an anatomical anomaly contributing to the patient's LUTD or when a relevant neurological disease is causing the dysfunction and an anatomical cause or consequences are expected.

4 | GUIDELINES

The evidence supporting VUDS in non-neurogenic LUTS is low grade; sparse, incomplete, and almost exclusively based on expert opinion and single center uncontrolled studies.[18] Data on the effect of VUDS with or without comparison with UDS on management selection and outcomes are also lacking. Nevertheless, the aim of VUDS is to achieve a more accurate diagnosis in these patients and hence improve the therapeutic decision-making, however, usually at the cost

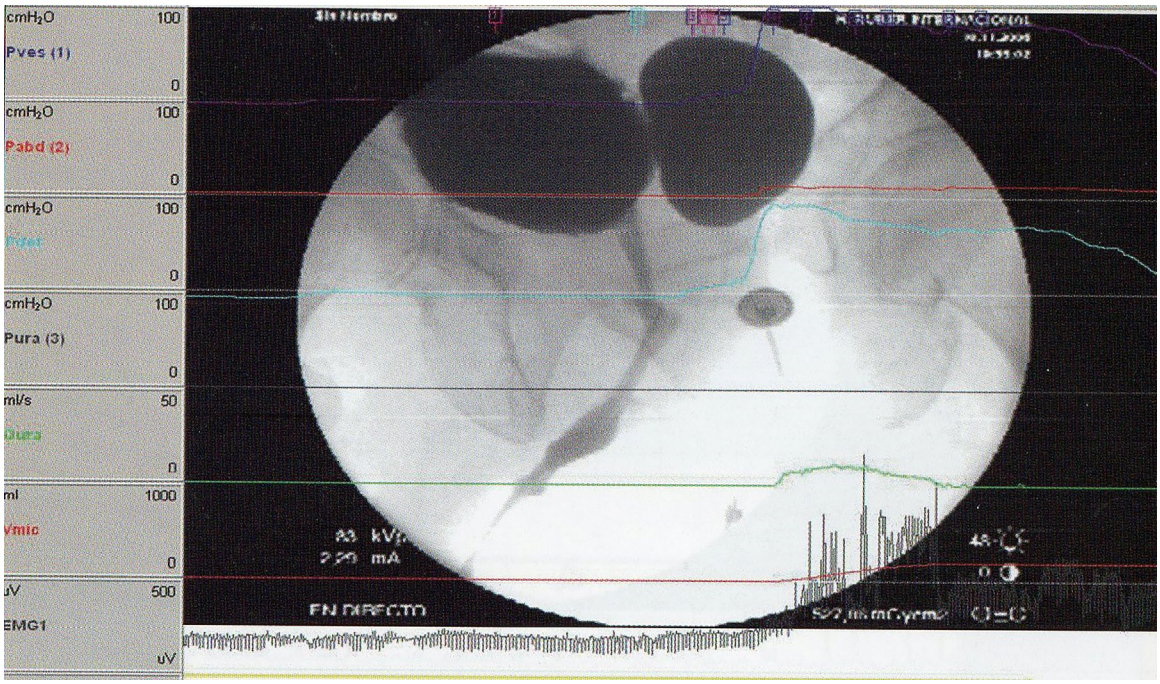

FIGURE 3 A relatively large diverticulum, filled during voiding; normal appearance of urethra, but pressure flow parameters (over-projected: not zeroed to atmosphere as per ICS standard; low flow and relatively high detrusor pressure) indicate bladder outflow obstruction (should be graded on [ICS] pressure flow plot)

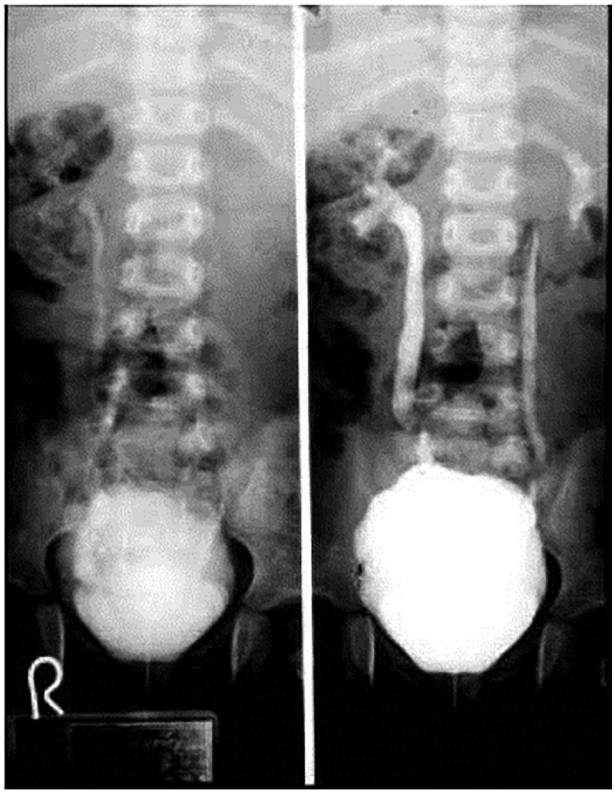

FIGURE 4 Vesico-ureteral reflux initially at the right hand side and subsequently on both sides

TABLE 2 Indications for considering fluoroscopy during the urodynamic evaluation

Neurological findings or history of relevant neurologic disease
(History of) congenital genitourinary anomaly (eg, ectopic ureter, posterior urethral valves, prune-belly syndrome, vesico-ureteral reflux)
Bladder outflow obstruction or urinary retention associated with complex history
History of pelvic radiotherapy or intrapelvic surgery
History of pelvic reconstructive surgery, SUI surgery, urethral stricture repair, POP reconstruction, urethral diverticulectomy
Suspicion of vesico-vaginal or urethro-vaginal fistula
Suspicion of urethral diverticulum
Pre- and post-renal transplant

of patient comfort, making the chance of not representative outcome of studies more likely, especially in patients without neurological disease.

The European Association of Urology (EAU) recommends, based on level 4 evidence, VUDS as the optimum procedure for invasive UDS in neuro-urological patients.[19,20] In male LUTS VUDS are considered applicable if this is needed for the clinician to understand the pathophysiological mechanism of a patient's LUTS although this is also based on experts impressions.[21] The British National Institute for "Health" and Care Excellence (NICE) recommends to offer VUDS to people who are known to have a high risk of renal complications from their LUT function (eg, people with spina bifida, spinal cord injury, or anorectal abnormalities).[22]

The American Urological Association (AUA) and Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction (SUFU) states that, when available, clinicians may perform VUDS in patients with relevant neurologic disease at risk for neurogenic bladder dysfunction, in patients with other neurologic disease and elevated PVR.[23] Clinicians may also perform VUDS in properly selected patients to urodynamically grade and to anatomically localize bladder outflow obstruction, based on this association statement.[23]

5 | CONCLUSION

Medical imaging has developed in a century.[24] Imaging finds its application in healthcare via the evolution of technical

possibilities in combination with plausibility, and expert opinion. Randomized prospective studies that demonstrate the effect of diagnosis with and without imaging, on outcome of management have not been published. The development of videourodynamic evaluation is no exception. It is difficult to precisely delineate the indications for the study, as well as to assess its precise surplus for predictive value of the diagnostic strategy, however, it is undoubtedly plausible and useful to combine reliable objective functional physiological measurements (UDS) with anatomical information of synchronous imaging in a proportion of patients with lower urinary tract dysfunction.

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EDITORIAL COMMENTS

WILEY Neurourology Urodynamics ICS SUFU

Why ICS standardization of lower urinary tract symptoms matters

Why does as a red traffic light mean "STOP" everywhere? Or why are you able to browse the Internet from anywhere over the world? These are just a few examples from our daily life that illustrate the need for standardization and the use of a common and correct terminology.

Standards make the world a safer place. Our health is dependent on standards, going from the definition of safe drinking water, over the quality of medical equipment to the creation of terminology, standards, and guidelines in healthcare.

Standards and terminology define what is being talked about. This is especially necessary in critical communication, but also to ensure the safe diagnosis and treatment of patients. It is important that the term for a symptom, condition or disease has the same meaning for every healthcare professional on this planet. If you hear of a new development at a congress or in publication, you need to understand it fully in order to adopt it properly into your practice. When talking with patients, both of you need to understand what the other is saying. Achieving this is the aspiration of the International Continence Society (ICS) standardizations.[1] They are a series of evidence based pragmatic documents, some of them developed in partnership with other professional bodies, covering the field of lower urinary tract function and dysfunction, and urodynamic assessment.[2–4]

Similar words can have different meanings in different languages, or translation. Notably an English term in another language can change the linguistic meaning or can have different connotations than in the original language. For example many languages do not make a distinction between urinary urge and urinary urgency. The ICS has clearly defined this difference to make it clear that urgency is pathological, as in overactive bladder, and urge is the normal sensation associated with a strong desire to pass urine. So as to be consistent for inclusion of patients in clinical trials on Overactive Bladder Syndrome potentially being run in several countries, correct interpretation of the inclusion and exclusion criteria is essential. For these trials it is of paramount importance to recruit only patients with urgency, and not those describing the normal sensation of urge. Standards help in managing cultural and linguistic diversity and differences. Such terminology efforts are crucial for the advancement of research and clinical practice.

Standards allow sharing of technology and innovation and information. If we would not use a standardized terminology and a set of standards in urodynamics, results from one center would not be interchangeable with those from another center. This would lead to an unnecessary duplication of examinations, when a patient would be referred to another center. Technology is highly dependent on terminology and standardization.[5] Standards also make information retrievable and speed up research. Every book or published article can be found with internet search engines or through library systems, thanks to unique identifiers that have been attributed according to international standards. Just imagine to have go back in time and to be dependent on an old-fashioned librarian and his reference system on little cards, before you could read an interesting article or book. Standards help tremendously in speeding-up research and interaction between researchers.

We strongly encourage all healthcare professionals to engage with the ICS standardizations, so as to push forward the progress in this field. Once it is in universal use, the ICS terminology offers a backbone for communications between professionals and also with patients.

CONFLICTS OF INTEREST

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SOUNDING BOARD

WILEY Neurourology Urodynamics ICS SUFU

Critical steps in developing professional standards for the International Continence Society

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Aims: Standardization on the basis of systematic assessment of evidence has become an indispensable element of modern healthcare. International Continence Society (ICS) has initiated and produced extremely well cited standardization documents. The process of standardization is recently depicted in a published manuscript, to keep up with modern society healthcare demands.

Methods: A narrative review of the ICS history and current state of standardizations for the terms, assessment and the management of patients with lower urinary tract dysfunction.

Results: This article highlights the philosophy and the historical context of standardization and explains the core elements of modern day standardization. The article also demonstrates the scientific relevance of the ICS standards, on the basis of reference-counts.

Conclusion: The history and the relevance of ICS standards are summarized.

KEYWORDS
health care quality, lower urinary tract dysfunction, systematic assessment and diagnosis

1 | INTRODUCTION

The Mars Climate Orbiter was a space probe launched by NASA on December 11, 1998 to study the Martian climate. However, on September 23, 1999, communication with the spacecraft was lost as the spacecraft went into orbital insertion, due to ground-based computer software which produced output in non-SI units of pound (force)-seconds (lbf/s) instead of the SI units of newton-seconds (N/s) specified in the contract between NASA and Lockheed. The spacecraft encountered Mars on a trajectory that brought it too close to the planet, causing it to pass through the upper atmosphere and disintegrate.[1] SI units are standard units of technical measurement, allowing communication about technical issues. Standardization is relevant, in technical science as well as in medical science. Standard terms, classifications and disease and management patterns were sought, in fact since the early days of healthcare, for example, by Hippocrates. Maybe in the more modern society further standardization began in the 16th century, where parish clerks were asked to classify mortality and standard terms were developed with this aim. This can be seen as the later basis for health epidemiological observations. In the beginning of 20th century a standard nomenclature for diseases was developed that progressed into the nowadays International Classification of Diseases (ICD) and Systematized Nomenclature of Medicine (SNOMED, now SNOMED-CT).[2]

Medical societies are established around (clinical-medical) specialisms to improve knowledge and accountability. The Continence Club was established in Exeter (UK) in 1971, renamed to International Continence Society that same year and had the purpose to ". . . provide a link for the interchange of ideas and results for clinicians and physicists interested in

Clinical trial: No.

Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

TABLE 1 "General" (not specific) ICS standardization documents with publication year and between brackets, a double or triple publication are showed

Scopus EXPORT DATE: 15 May 2018 searched quote: "standard* lower urinary tract function"		
Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, Van Kerrebroeck P, Victor A, Wein A. The standardization of terminology of lower urinary tract function: Report from the standardization sub-committee of the international continence society (2002) Neurourology and Urodynamics, 21 (2), pp. 167–178.	2002 (1)	Cited 4360 times.
Bump, RC, Mattiasson, A, Bo, K, Brubaker, LP, DeLancey, JOL, Klarskov, P, Shull, BL, Smith, ARB. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction (1996) American Journal of Obstetrics and Gynecology, 175 (1), pp. 10–17.	"ICS approved"	Cited 2616 times.
Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, Van Kerrebroeck P, Victor A, Wein A.The standardization of terminology in lower urinary tract function: Report from the standardization sub-committee of the International Continence Society (2003) Urology, 61 (1), pp. 37–49.	2002 (2)	Cited 1583 times.
Good Urodynamic Practices: Uroflowmetry, filling cystometry, and pressure-flow studies (2002) Neurourology and Urodynamics, 21 (3), pp. 261–274.		Cited 1006 times.
Abrams P, Blaivas JG, Stanton SL, Andersen JT. The standardization of terminology of lower urinary tract function. The International Continence Society Committee on Standardization of Terminology. (1988) Scandinavian Journal of Urology and Nephrology, Supplement, 114, pp. 5–19.	1988 (1)	Cited 951 times.
Haylen, BT, De Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, Monga A, Petri E, Rizk DE, Sand PK, Schaer GN. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction (2010) International Urogynecology Journal, 21 (1), pp. 5–26.		Cited 771 times.
Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, Van Kerrebroeck P, Victor A, Wein A. The standardization of terminology of lower urinary tract function: Report from the Standardization Sub-committee of the International Continence Society (2002) American journal of obstetrics and gynecology, 187 (1), pp. 116–126.	2002 (3)	Cited 607 times.
Griffiths D, Hofner K, Van Mastrigt R, Rollema HJ, Spangberg A, Gleason D. Standardization of terminology of lower urinary tract function: Pressure-flow studies of voiding, urethral resistance, and urethral obstruction (1997) Neurourology and Urodynamics, 16 (1), pp. 1–18.		Cited 324 times.
Abrams P, Blaivas JG, Stanton SL, Andersen JT. The standardization of terminology of lower urinary tract function recommended by the international continence society (1990) International Urogynecology Journal, 1 (1), pp. 45–58.	1988 (1)	Cited 305 times.
Bates P, Bradley WE, Glen E, Griffiths D, Melchior H, Rowan D, Sterling A, Zinner N, Hald T. The standardization of terminology of lower urinary tract function (1979) Journal of Urology, 121 (5), pp. 551–554..		Cited 233 times
First Report on the Standardization of Terminology of Lower Urinary Tract Function: PRODUCED BY THE INTERNATINAL CONTINENCE SOCIETY, FEBRUARY, 1975 (1976) British Journal of Urology, 48 (1), pp. 39–42.		Cited 215 times.
Austin PF, Bauer SB, Bower W, Chase J, Franco I, Hoebeke P, Rittig Sø, Vande Walle J, Von Gontard A, Wright A, Yang SS, Nevéus T. 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 (2014) Journal of Urology, 191 (6), pp. 1863–1865.		Cited 193 times.
The standardization of terminology of lower urinary tract function (1990) BJOG: An International Journal of Obstetrics & Gynecology, 97, pp. 1–16.		Cited 118 times.
Glen ES, Bradley WE, Melchior H, Rowan D, Sterling AM, Sundin T, Thomas D, Torrens M, Warwick RT, Zinner NR, Chairman TH. Fourth Report on the Standardization of Terminology of Lower Urinary Tract Function: Terminology related to neuromuscular dysfunction of the lower urinary tract: PRODUCED BY THE INTERNATIONAL CONTINENCE SOCIETY (1981) British Journal of Urology, 53 (4), pp. 333–335.		Cited 90 times.
Abrams P, Blaivas JG, Stanton SL, Andersen JT. The standardization of terminology of lower urinary tract function – Produced by the international continence society committee on standardization of terminology (1989) World Journal of Urology, 6 (4), pp. 233–245.	1998-9 (3)	Cited 52 times.
Austin PF, Bauer SB, Bower W, Chase J, Franco I, Hoebeke P, Rittig S, Walle J.V, Von Gontard A, Wright A, Yang SS, Nevéus T. 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 (2016) Neurourology and Urodynamics, 35 (4), pp. 471–481.		Cited 47 times.

(Continues)

TABLE 1 (Continued)

Scopus EXPORT DATE: 15 May 2018 searched quote: "standard* lower urinary tract function"		
Bates CP, Bradley WE, Glen ES, Griffiths D, Melchior H, Rowan D, Sterling A, Hald T. Third Report on the Standardization of Terminology of Lower Urinary Tract Function: Procedures related to the evaluation of micturition: Pressure-flow relationships. Residual urine: PRODUCED BY THE INTERNATIONAL CONTINENCE SOCIETY, FEBRUARY 1977* (1980) British Journal of Urology, 52 (5), pp. 348–350.	1977 (3)	Cited 43 times.
Bates P, Bradley WE, Glen E, Griffiths D, Melchior H, Rowan D, Sterling AM, Zinner N, Hald T. Standardization of terminology of lower urinary tract function First and second reports: International Continence Society (1977) Urology, 9 (2), pp. 237–241.	1977 (4)	Cited 34 times.
Abrams P, Blaivas JG, Stanton SL, Andersen JT, Fowler CJ, Gerstenberg T, Murray K. Sixth report on the standardization of terminology of lower urinary tract function. Procedures related to neurophysiological investigations: electromyography, nerve conduction studies, reflex latencies, evoked potentials and sensory testing. The International Continence Society Committee on Standardization of Terminology, New York, May 1985. (1986) Scandinavian Journal of Urology and Nephrology, 20 (3), pp. 161–164.	1985 (1)	Cited 26 times.
Nevéus T, Von Gontard A, Hoebeke P, Hjälmas K, Bauer S, Bower W, Jørgensen TM, Rittig S, Van De Walle J, Yeung, C-K, Djurhuus JC. The standardization of terminology of lower urinary tract function in children and adolescents: Report from the Standardization Committee of the International Children's Continence Society (ICCS) (2007) Neurourology and Urodynamics, 26 (1), pp. 90–102.		Cited 20 times.
Bates P, Bradley WE, Glen E, Melchior H, Rowan D, Sterling A, Hald T. The standardization of terminology of lower urinary tract function (1976) European Urology, 2 (6), pp. 274–276.		Cited 15 times.
Andersen JT, Blaivas JG, Cardozo L, Thuroff J. Seventh report on the standardization of terminology of lower urinary tract function: Lower urinary tract rehabilitation techniques (1992) Scandinavian Journal of Urology and Nephrology, 26 (2), pp. 99–106.		Cited 14 times.
Abrams P, Blaivas JG, Stanton SL, Andersen JT, Fowler CJ, Gerstenberg T, Murray K. Sixth report on the standardization of terminology of lower urinary tract function – Procedures related to neurophysiological investigations: Electromyography, nerve conduction studies, reflex latencies, evoked potentials and sensory testing (1986) World Journal of Urology, 4 (1), pp. 2–5.	1985-6 (2)	Cited 9 times.
Bates P, Rowan D, Glen E. Second report on the standardization of terminology of lower urinary tract function. Produced by the International Continence Society committee on standardization of terminology Copenhagen, August 1976 (1977) European Urology, 3 (3), pp. 168–170.	1977 (2)	Cited 8 times.
Bates P, Bradley WE, Glen E, Melchior H, Rowan D, Sterling A Hald T. First report on the standardization of terminology of lower urinary tract function: Incontinence, cystometry, urethral closure pressure profile and units of measurement (1977) Urologia Internationalis, 32 (2–3), pp. 81–87.	1977 (1)	Cited 7 times.

The third column shows the number of citations to the specific document as obtained from Scopus.com (May 2018).

urodynamic studies . . . treating related disorders."[3] To this aim, as a logical consequence, ". . . to set it [the new society (ICS)] on the way to becoming a professional body"[3] a "standardization of terminology of lower urinary tract function" was developed and published simultaneously in diverse journals.[4] Terms for urodynamic observations were developed since then and refined, together with improvements in the techniques used to objectively measure lower urinary tract functions, independent from the patients expression of symptoms. New ICS standardization documents have been published in the years that followed.

2 | MATERIAL AND METHODS

A narrative review of the evolution of the process of standardization in healthcare, in general and specific for ICS is presented. Scopus—website counts are used to demonstrate the scientific relevance of the published manuscripts of ICS standards.

3 | RESULTS

2.1 | Standard for standards

Early standards in health care have been eloquence based. A group of renowned experts sat together and developed the text of the standard, on the basis of their knowledge. That actual knowledge failed against big data was demonstrated in the late 1960s. A clinical epidemiological book discussed the complexity of medical decision making, and was the starting point for nowadays clinical epidemiology. Clinical epidemiology became a tool to be the more reliable basis for (more) systematic diagnosis and management.[5] This clinical epidemiology, and systematic reviewing of research data were deployed into evidence based medicine later.[6]

Also early ICS standards have been developed in the "good old boys sat around the table" (GOBSAT)—manner. In 2012, however, the ICS standardization committee has published a standard to deviate from GOBSAT and to introduce—evidence based-(healthcare and) ICS standards.[7] This manuscript highlights also that the ICS standardization committee had modernized itself and became a standardizing steering committee, with the aim to oversee and guide (ad hoc) working groups to deliver new ICS standards. The renewed process and structure of standards production were defined, to ensure careful inclusion of evidence in the standard and to explicitly grade evidence and also indicate expert opinion where evidence is lacking. In summary of the earlier published document, the process consists of a proposal stage, a preparatory stage, a committee stage and an approval stage and has also defined an implementation stage.[7] An idea for a new standard should be proposed to the ICS standardization steering committee who will establish an opinion- and background-balanced working group with a chairperson. The "balance," referred to in the standard[7] includes that the background should as diverse as possible, around the topic of the standardization, not only in opinion and profession but also including partnership of other organizations (outside ICS) when that is deemed potentially rewarding. The working group, when established, searches for relevant evidence and makes summaries of answers for clinical questions associated with the topic of the standard. Terms may also be searched for existence in scientific databases or in the, here above mentioned, international nomenclature—sets, or medical dictionaries, before introduction in the (new) standard.

TABLE 2 The top ranking documents with (clinical OR practice) standard* in the title with the number of citations to the specific document (may 2018) are showed

Scopus EXPORT DATE: 15 May 2018 Search quote: "Standard*"- in Title.	
Standardization of spirometry (2005) European Respiratory Journal, 26 (2), pp. 319–338.	Cited 6495 times.
Standardization of spirometry: 1994 Update (1995) American Journal of Respiratory and Critical Care Medicine, 152 (3), pp. 1107–1136.	Cited 5248 times.
Bone histomorphometry: Standardization of nomenclature, symbols, and units: Report of the asbmr histomorphometry nomenclature committee (1987) Journal of Bone and Mineral Research, 2 (6), pp. 595–610.	Cited 4397 times.
The standardization of terminology of lower urinary tract function: Report from the standardization sub-committee of the international continence society (2002) Neurourology and Urodynamics, 21 (2), pp. 167–178.	**Cited 4360 times.**
The consortium to establish a registry for Alzheimer's disease (CERAD). Part II. Standardization of the neuropathologic assessment of Alzheimer's disease(1991) Neurology, 41 (4), pp. 479–486.	Cited 3495 times.
The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction (1996) American Journal of Obstetrics and Gynecology, 175 (1), pp. 10-17	Cited 2616 times.
Lung volumes and forced ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. (1993) The European respiratory journal. Supplement, 16, pp. 5-40	Cited 2523 times.
Standard of spirometry- 1987 update. Statement of the American Thoracic Society. (1987) The American review of respiratory disease, 136 (5), pp. 1285–1298.	Cited 2070 times.
Design and standardization of PCR primers and protocols for detection of clonal immunoglobulin and T cell receptor gene recombinations in suspect lymphoproliferations: Report of the BIOMED 2 concerted action BMH4- CT98-3936 (2003) Leukemia, 17 (12), pp. 2257–2317.	Cited 1834 times.
The standardization of terminology in lower urinary tract function: Report from the standardization sub- committee of the International Continence Society (2003) Urology, 61 (1), pp. 37–49.	**Cited 1583 times.**
A Specific Laboratory Test for the Diagnosis of Melancholia: Standardization, Validation, and Clinical Utility (1981) Archives of General Psychiatry, 38 (1), pp. 15-22	Cited 1579 times.
Revised Recommendations of the International Working Group for diagnosis, standardization of response criteria, treatment outcomes, and reporting standards for therapeutic trials in acute myeloid leukemia (2003) Journal of Clinical Oncology, 21 (24), pp. 4642–4649.	Cited 1471 times.
Standardization of uveitis nomenclature for reporting clinical data. Results of the first international workshop (2005) American Journal of Ophthalmology, 140 (3), pp. 509-516	Cited 1435 times.
A working formulation for the standardization of nomenclature in the diagnosis of heart and lung rejection: Heart rejection study group (1990) Journal of Heart Transplantation, 9 (6), pp. 587-592	Cited 1301 times.

When the number of citations to the three versions of the 2002 document are added (4360 + 1583 + 607), 3th not shown, see Table 1), the total of 6650 would rank this document number 1 clinical standard in healthcare. Note also that the number 6 document is an "ICS-collaboration-endorsed" standard.

Objective evidence for management in new standard should be systematically gathered with structured searches of literature and Oxford grading. Theoretically a Delphi process would be applicable for sub-topics where evidence is lacking, however, this procedure is not without pitfalls, for example, has the danger of devaluating to the "old GOBSAT" manner,[8,9] by overestimation of the experts knowledge[8] and underestimation of the existence of evidence. Potential other pitfalls are, for example, imposing preconceptions of a problem and not allowing for the contribution of other related perspectives; poor techniques of summarizing and presenting the group responses; not exploring disagreements and; underestimating the demanding nature of a Delphi.[8] A recent systematic review of reports based on the Delphi method found substantial variation in quality as consequence of lack of rigorousness of the application of the process.[9] Ultimately the (new) standard terms are selected on the basis of arguments made transparent. Sensitive and systematic searching for existing evidence prevents reinvention of knowledge and has to provide the evidence base for the practice recommendations or for the terms. Finally the members and board of the ICS will see the draft standard and control, for process and structure, but also for missed evidence that may change the recommendations. Details of this process are given in the original publication but essentially the draft document is made available for all ICS members via the ICS website, and is also submitted to internal invited peer review and or discussed during an annual society meeting. The finally approved standard is published and, for example, relevant committees can take out relevant elements and make these into educational modules to be published as presentation on the ICS website to enhance implementation of standard good practice and terms by education.

3.2 | Scientific relevance

The International Continence Society has produced one of the most cited standards in healthcare.[10] Table 1 shows the number of citations for the most "general" ICS standards on the basis of the counts given in Scopus.com website on May 15, 2018. Table 2 shows that the number of citations to the 2002 standardization document exceeds all documents with "practice guideline" or "practice standard" in the title when the three versions of the 2002 document (see Table 1) are grouped. (source: scopus.com). The references total of 6650 contains that the document is referred to every single day since its publication.

4 | DISCUSSION

The modern era standards should aim at that level and be the basis for good practice. ICS is still leading in the development of careful objective assessment of lower urinary tract dysfunction as has been aimed in 1971. Objective assessment of dysfunction meets patients expectations also (or especially?) to date.[11] Modern era healthcare, however, also demands, more than in the early days of ICS, that patients quality of life and well-being are taken into account and that minimal or not invasive management is recommended to them, where possible. Not only terms and techniques for objective assessment and diagnosis should be renewed, in an evidence based fashion, also the assessment of the patients well-being deserves evidence based standardization. Furthermore standards for management may lead the way to improvements. The ICS standard for standardization may become the basis for systematic evidence based documents to enforce the International Consultation on Incontinence management recommendations[12] and may also expand to management of lower urinary tract dysfunctions without urinary incontinence.

5 | CONCLUSION

Standardization prevents miscommunication and therefore mismanagement, also in healthcare. ICS started with standardization, based on scientific progress and development and has continued this, in the lead, for almost 50 years. ICS Standardization is now standardized within the framework of Evidence Based Medicine and apart from further standardization of urodynamic assessment and evidence based objective pelvic floor muscle function evaluation standardization of quality of life assessment as well as standards for management may be future goals.

CONFLICT OF INTEREST

No.

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