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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

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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.

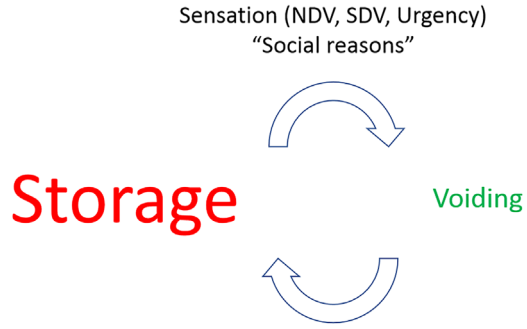


FIGURE 1 The micturition cycle as anchor for categorizing LUTS. Each individual person stores urine until they make an active decision to switch to voiding in response to a sensation or a social reason (eg, anticipation that toilets will be difficult to access in the foreseeable future as a result of 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.

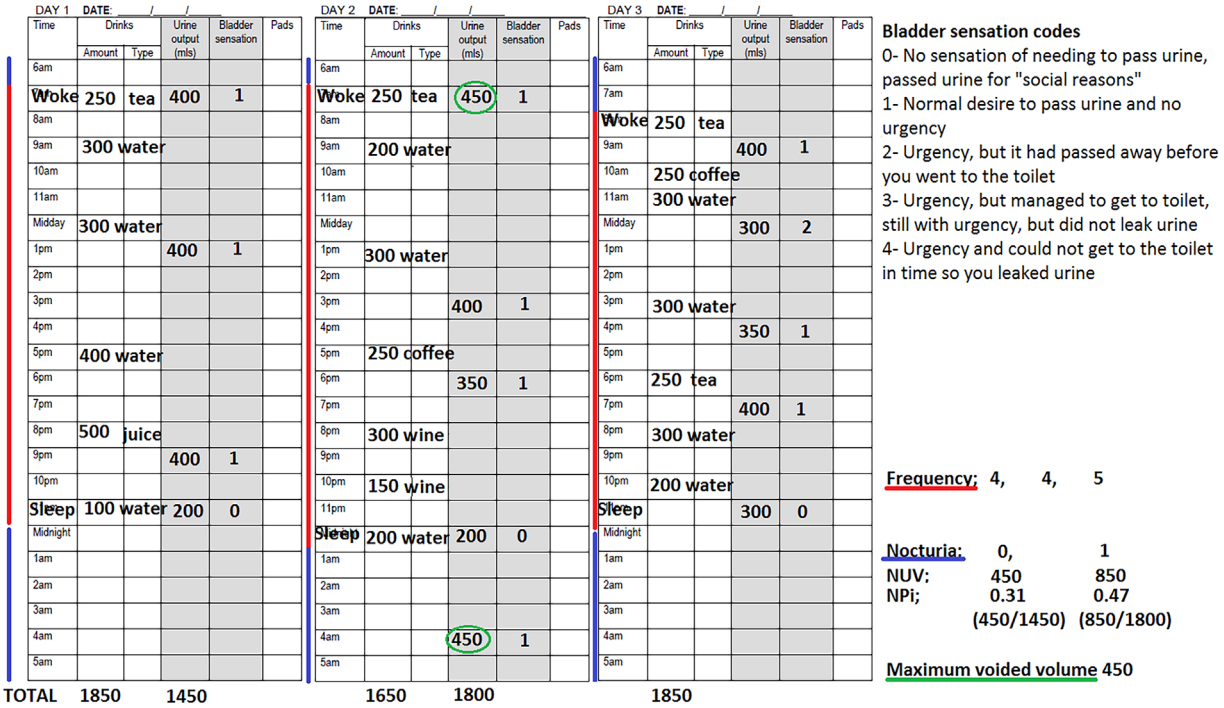
Three-day recordings are generally used in clinical practice. Any of these charts make it possible to identify 24-h frequency of voiding; provided the waking and sleeping times are marked, this can be broken down into the daytime frequency and nocturia (Figure 2). The sign of nocturia is the number of 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.



DAY 1 DATE: ___/___/___

Time	Drinks Amount	Drinks Type	Urine output (mls)	Bladder sensation	Pads
6am					
Woke	250	tea	400	1	
8am					
9am	300	water			
10am					
11am					
Midday	300	water			
1pm			400	1	
2pm					
3pm					
4pm					
5pm	400	water			
6pm					
7pm					
8pm	500	juice			
9pm			400	1	
10pm					
Sleep	100	water	200	0	
Midnight					
1am					
2am					
3am					
4am					
5am					
TOTAL	1850		1450		

DAY 2 DATE: ___/___/___

Time	Drinks Amount	Drinks Type	Urine output (mls)	Bladder sensation	Pads
6am					
Woke	250	tea	450	1	
8am					
9am	200	water			
10am					
11am					
Midday					
1pm	300	water			
2pm					
3pm			400	1	
4pm					
5pm	250	coffee			
6pm			350	1	
7pm					
8pm	300	wine			
9pm					
10pm	150	wine			
11pm					
Sleep	200	water	200	0	
Midnight					
1am					
2am					
3am					
4am			450	1	
5am					
TOTAL	1650		1800		

DAY 3 DATE: ___/___/___

Time	Drinks Amount	Drinks Type	Urine output (mls)	Bladder sensation	Pads
6am					
7am					
Woke	250	tea			
9am			400	1	
10am	250	coffee			
11am	300	water			
Midday			300	2	
1pm					
2pm					
3pm	300	water			
4pm			350	1	
5pm					
6pm	250	tea			
7pm			400	1	
8pm	300	water			
9pm					
10pm	200	water			
Sleep			300	0	
Midnight					
1am					
2am					
3am					
4am					
5am					
TOTAL	1850				

Bladder sensation codes
0- No sensation of needing to pass urine, passed urine for "social reasons"
1- Normal desire to pass urine and no urgency
2- Urgency, but it had passed away before you went to the toilet
3- Urgency, but managed to get to toilet, still with urgency, but did not leak urine
4- Urgency and could not get to the toilet in time so you leaked urine

Frequency: 4, 4, 5

Nocturia: 0, 1
NUV: 450 850
NPi; 0.31 0.47
(450/1450) (850/1800)

Maximum voided volume 450

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

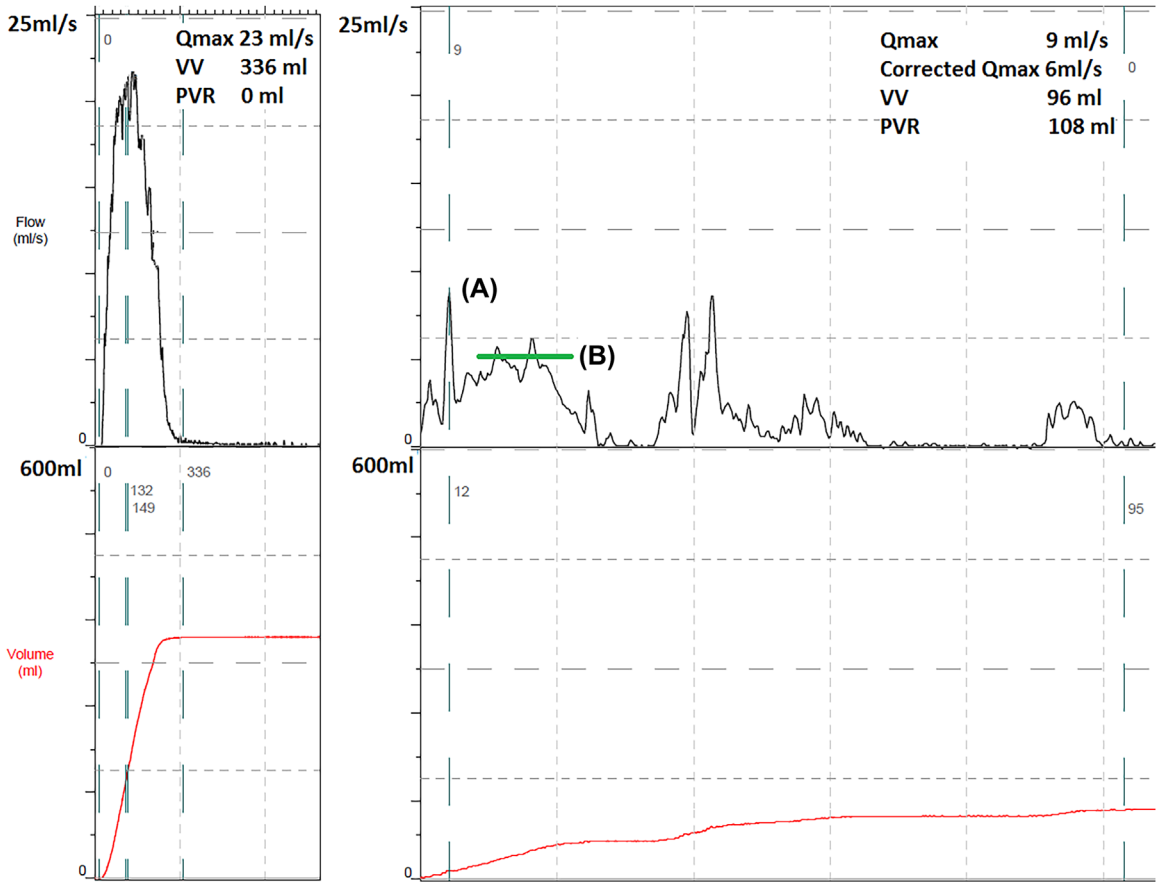


FIGURE 3 Uroflowmetry (free flow rate testing). On the left is a normal flow rate test for a women. It shows a continuous flow, with a good maximum flow rate (Qmax) and complete emptying, with a suitable VV. On the right is an abnormal test suggesting voiding dysfunction. The pattern of flow is interrupted. 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

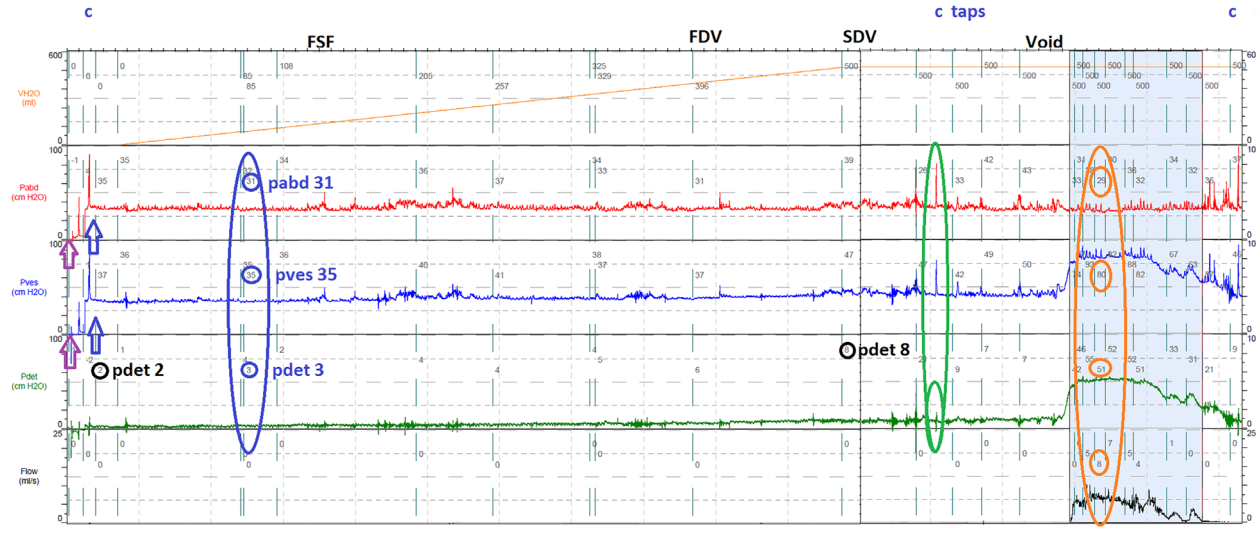


FIGURE 4 Pressure measurement. The record shows continuous tracings of two measured pressures; the abdominal pressure p_{abd} in red, and the vesical bladder pressure p_{ves} in blue. These are continuously subtracted (p_{ves}-p_{abd}) to give the detrusor p_{det}, in green. Also shown are the volume 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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REFERENCES

1. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. *Neurourol Urodyn*. 2002;21:167–178.
2. Hashim H, Drake MJ. Basic concepts in nocturia, based on International Continence Society standards in nocturnal lower urinary tract function. *Neurourol Urodyn*. 2018;37:S20–S24.
3. Chapple CR. Terminology report from the International Continence Society (ICS) working group on underactive bladder (UAB). *Neurourol Urodyn*. 2018;In press.
4. Haylen BT, de Ridder D, Freeman RM, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Neurourol Urodyn*. 2010;29:4–20.
5. Cornu JN, Abrams P, Chapple CR, et al. A contemporary assessment of nocturia: definition, epidemiology, pathophysiology,

and management—a systematic review and meta-analysis. *Eur Urol*. 2012;62:877–890.
6. Drake MJ. Do we need a new definition of the overactive bladder syndrome? ICI-RS 2013. *Neurourol Urodyn*. 2014;33:622–624.
7. Gajewski JB, Schurch B, Hamid R, et al. An International Continence Society (ICS) report on the terminology for adult neurogenic lower urinary tract dysfunction (ANLUTD). *Neurourol Urodyn*. 2018;37:1152–1161.
8. Abrams P. Bladder outlet obstruction index, bladder contractility index and bladder voiding efficiency: three simple indices to define bladder voiding function. *BJU Int*. 1999;84:14–15.
9. Drake MJ, Doumouchtsis SK, Hashim H, Gammie A. Fundamentals of urodynamic practice, based on international continence society good urodynamic practices recommendations. *Neurourol Urodyn*. 2018;37:S44–S49.
10. Bright E, Cotterill N, Drake M, Abrams P. Developing and validating the International Consultation on Incontinence Questionnaire bladder diary. *Eur Urol*. 2014;66:294–300.

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