Assessment of lower urinary tract symptoms

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Abstract

Lower urinary tract symptoms (LUTS) encompass a range of symptoms commonly experienced by both men and women, and encountered by a wide range of healthcare practitioners (HCPs). This review summarizes the basic terminology and assessment that HCPs should be aware of, regardless of their professional discipline. Apart from emphasizing the need for standardization in terminology, there is a need to avoid misleading terms that suggest a causative mechanism until the mechanism has been identified by investigation. HCPs should also avoid arbitrary thresholds for judging severity of symptoms. The use of algorithms from evidence-based guidelines limits variation in management and avoids unnecessary investigations. However, a tailored approach is useful in understanding the underlying pathophysiology in individual patients. As symptoms are unreliable in predicting the underlying mechanism, a useful approach is to try and develop a urodynamic diagnosis mindful of the normal physiology of the lower urinary tract as the practitioner works through the symptoms, signs and appropriate urodynamic investigations, and use such investigations in a logical manner tailored to the individual to either support or refute assumptions and arrive at a working diagnosis.

Keywords Incontinence; lower urinary tract symptoms; LUTS; nocturia; overactive bladder

Introduction

The term 'lower urinary tract symptoms' (LUTS) refers to a symptom complex highly prevalent in both males and females, and are encountered by a wide range of healthcare practitioners (HCPs), including doctors, nurses and allied professionals working in surgical, medical, gynaecology, geriatrics, neurology, and primary care. LUTS have multiple aetiologies within and without the lower urinary tract.

The assessment of lower urinary tract dysfunction (LUTD) requires characterization of lower urinary tract function by symptoms, signs and urodynamic observations. It is important not to use terminology that presumes an underlying aetiology, because it is well-recognized that symptoms do not correlate well to the underlying pathophysiology and LUTS may originate from causes outside the urinary tract. In males, terms such as 'prostatism', 'obstructive' or 'prostate symptom score' incorrectly imply a prostatic origin to the problem, and introduced bias in the doctor's and patient's mind regarding the treatment required. For example, a slow urinary stream may be a result of either prostatic obstruction or detrusor underactivity. The word 'irritative' is incorrect because storage LUTS usually do not arise from 'irritation', and the phrase 'weak bladder' is nonsensical as it does not describe a symptom or denote any 'weakness'. Consequently, such words have been abandoned and should no longer be used.

HCPs should also resist the temptation to ascribe arbitrary thresholds to distinguish between what is normal and abnormal. The symptom of 'increased daytime frequency of micturition' is related by the patient who feels that he or she is voiding too often by day, and not defined by an arbitrary numeric threshold, as there is considerable variation of micturition frequency between individuals which is influenced by fluid intake, medication and other factors, and may vary from day to day. Similarly, if a person wakes once a night to void it is identified as nocturia, even if it does not cause any bother, and irrespective of how common the condition is. Another term that often causes confusion is 'overactive'. The 'overactive bladder' (OAB) applies to a symptom complex, central to which is the complaint of urgency. 'Detrusor overactivity', on the other hand, refers to a urodynamic observation during the filling phase of the study which is usually, but not always, associated with the symptom of urgency. An important principle in the evaluation of LUTS is to establish the degree of bother and its impact on the quality of life on the individual. Generally, symptoms such as urgency, nocturia and post-micturition dribble are more bothersome than a poor urinary flow. Treatment is directed towards the most bothersome symptoms, even if they are less frequent.

A fundamental concept to grasp is that the lower urinary tract comprises of a functional unit which is comprised of the bladder, bladder neck, prostate (in males), the sphincter mechanism controlling the outlet of the bladder, and the urethra. This is subject to a complex interplay of pathophysiological influences that include prostatic disorders, bladder dysfunction, neuromuscular dysfunction, medication, fluid intake, infection, and extra-urinary tract pathology such as diabetes, cardiac, renal and neurologic disorders.[1]

It is useful to revisit and establish the correct meanings of various terms that have in the past, and still do, caused much confusion:

'**Benign prostatic hyperplasia**' (BPH) refers to histologically confirmed hyperplasia of the prostate. This cannot be diagnosed by the finding of an enlarged prostate on digital rectal examination (DRE) or on ultrasound scanning. The characteristic histological changes of BPH are extremely common and found in 80% of men aged >80 years.[2] The prevalence of BPH increases with age and while it is often associated with symptoms, only 25–50% of men with BPH have LUTS.[1]

'**Benign prostatic enlargement**' (BPE) refers to an increase in size of the prostate gland. This is what should be documented after a DRE or a scan. Only about 50% of men with BPH have BPE, many remain undetected through life.

'**Bladder outlet obstruction**' (BOO) is diagnosed in the pressure-flow or voiding phase of a urodynamic study, typically characterized by increased detrusor pressure and a reduced urine flow rate. The term BOO should not be used otherwise, particularly from voiding symptoms or the finding of an 'obstructive appearance of the prostate on cystoscopy'; such use of the term is inaccurate.

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'**Lower urinary tract symptoms suggestive of BOO**' is a term often used to describe a male with predominantly voiding symptoms with an enlarged prostate on DRE. Ideally this should not be used without urodynamic confirmation of BOO as approximately 50% of men with LUTS do not have BOO, but is frequently used as a working diagnosis.

'**Overactive bladder**' (OAB) is defined as urinary urgency, with or without urgency urinary incontinence, usually with increased daytime frequency and nocturia, in the absence of a urinary tract infection or other obvious pathology. Note that this definition applies to both males and females.

'**Detrusor overactivity**' (DO) is a urodynamic finding of involuntary detrusor contractions during the filling phase of the bladder. It is found in some but not all individuals who present with OAB and may be associated with BOO.

In males, LUTS attributable to an enlarged prostate is a very common problem affecting the ageing male, of which BPH represents only one of several possible causes. The prevalence of LUTS in Europe increases from 14% in men in their 4th decade to >40% in their 6th decade. Assuming an overall prevalence of LUTS of 30%, this would mean that approximately 4 million men aged >40 years have LUTS in the UK.[2] Bothersome LUTS can occur in up to 30% of men over the age of 65 years.[1] The overlap between LUTS, BOO and BPE is illustrated in Hald's rings (Figure 1).

Assessment algorithms and guidelines

There are several clinical practice guidelines (CPGs) with regard to the evaluation of LUTS, including those published by the European Association of Urology (EAU), American Urological Association (AUA), the National Institute for Health and Care Excellence (NICE), and various national and regional guidelines. The aim of these is to provide an evidence-based framework on which clinicians can base their practice, putting into context the circumstances of the individual patient. Although based on similar evidence, there are some variations in the recommendations for the use of diagnostic tests for LUTS. Figure 2 represents the 2019 algorithm published by the EAU, used widely by urologists in the UK.

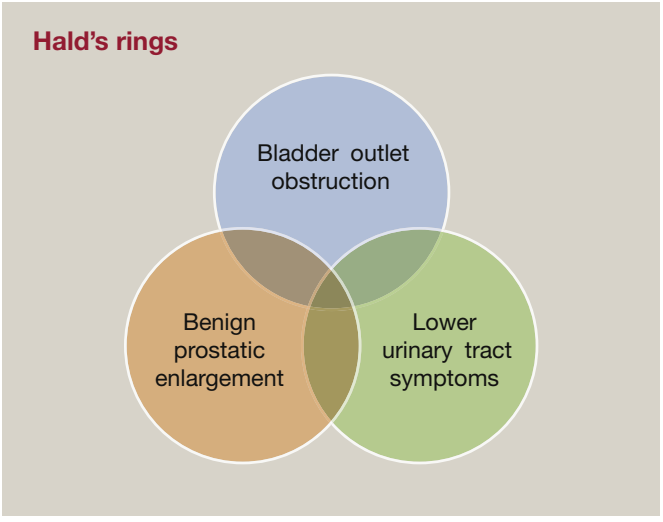

Figure 1

A review of CPGs concluded that high-quality guidelines have found the evidence base for many diagnostic tests to be not as strong, but nevertheless useful and without which important information may be missed.[3] This highlights the need for clear thinking and logical decision making by considering the evidence for each diagnostic test and how it may help the patient in the context of the following goals of LUTS assessment:

- To identify the underlying cause of the symptoms.
- To ascertain if treatment is necessary.
- To determine the optimal management option.
- To assess the risk of disease progression.
- To monitor previously instituted management.

Central to this are the wishes and needs of the patient. NICE guidelines recommendations for the diagnosis of LUTS are categorized into initial assessment and specialist assessment. The former is designed to be carried out by any HCP in any setting (e.g. in the community) without specialist training in the management of male LUTS. The initial assessment should include the following:

- history including that of sexual function
- physical examination
- assessment of general medical history including associated comorbidities and current medication
- a symptom score questionnaire to assess quality of life and bother
- urinary frequency volume chart
- urinalysis
- serum prostate specific antigen (PSA) if appropriate and would change management, after provision of detailed information and obtaining informed consent
- blood tests for renal function in specific situations

Tests such as urodynamics, cystoscopy and renal tract imaging are considered specialist assessments.

Symptoms and terminology

It is often quoted that 'the bladder is an unreliable witness'. Bearing that in mind, symptoms are the obvious fundamental starting point for arriving at a clinical diagnosis, to establish their effect on quality of life, and direct appropriate management accordingly. Symptoms are subjective and indicate a disorder as perceived by the patient, carer or partner, and the impact of symptoms on quality of life and bother is important to establish. The patient's perception should be faithfully reproduced by the HCP who should be conversant with the correct terminology. Attention to detail is important to get it right from the start. The use of standard terminology enables understanding of the reported symptoms by the clinician, leads to correct recommendations of the appropriate management option, and for clarity in research trials across the world. To appreciate the importance of standardization of terminology, it is worth remembering that standardization is present in many aspects of our daily life: for example, we are able to fill up our cars with the same grade of petrol when we travel between countries, understand uniform systems of weights and measures worldwide, or use a credit card with a 'visa' logo to make purchases on holiday.

LUTS comprise of storage, voiding and post-micturition symptoms (Table 1) which correspond to the phases of the

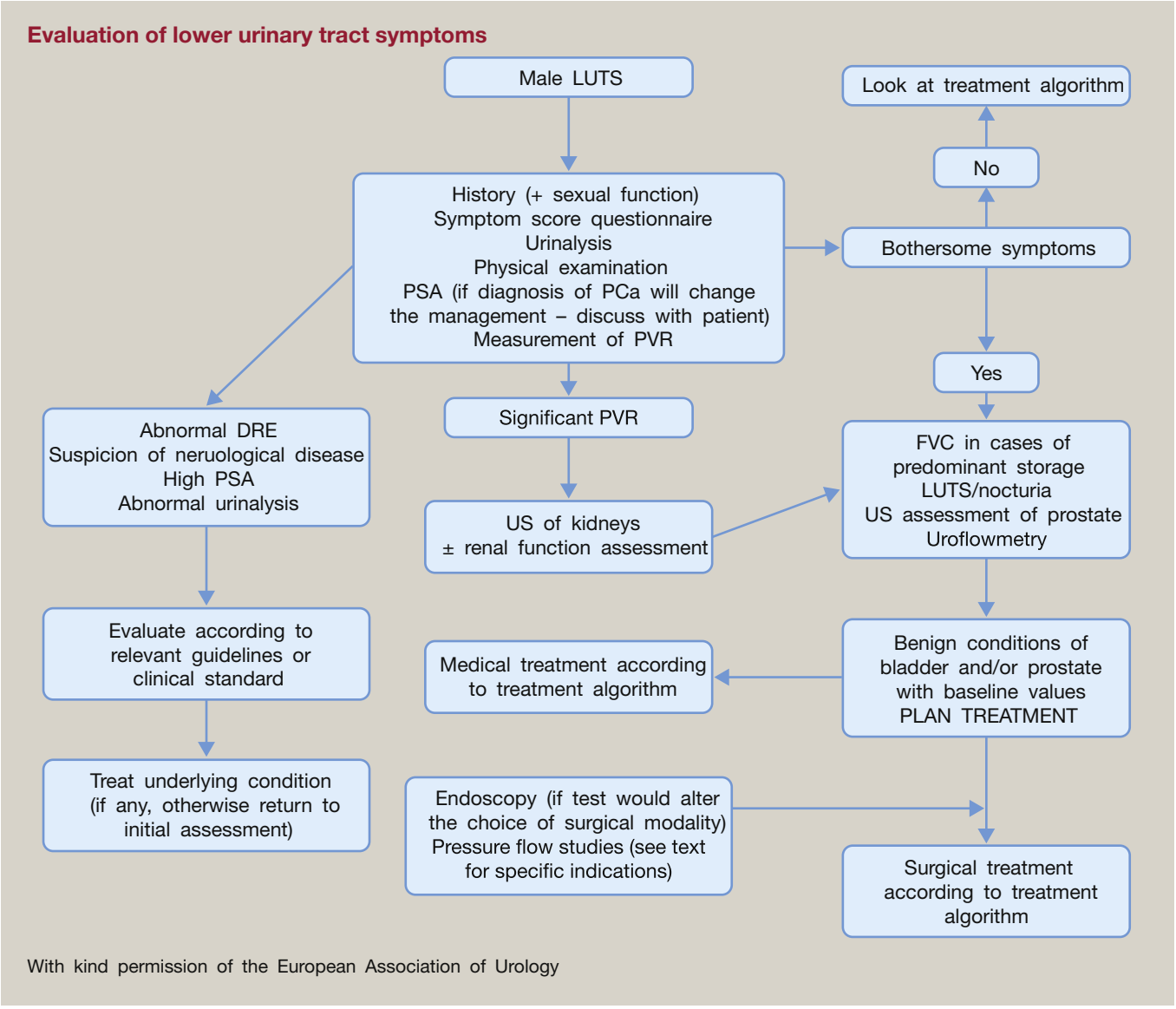

Figure 2

micturition cycle. It is useful to remember this table when taking a history of LUTS.

These symptoms are defined as below.[4,5] As explained above, careful note should be made of the proper wording of each. Often patients find it difficult to express their complaints and so the clinician may need to clarify exactly what is being meant.

Storage LUTS

Increased daytime frequency (IDF): The complaint by the patient who considers that he/she voids too often by day. Note that there is no numeric threshold for what is considered 'normal'.

Nocturia: Complaint of interruption of sleep one or more times because of the need to micturate. Each void is preceded and followed by sleep. Note that the word 'night' is not mentioned in more recent definitions to refer to sleep patterns rather than the time of day, such as in a night shift worker who would normally sleep through the day. Similarly, the definition of IDF applies to the night if that person stays up at night and feels that he/she voids too often during waking hours. (See also Nocturia on pages 388–392 of this issue.)

Urgency: Complaint of a sudden compelling desire to pass urine which is difficult to defer. Note that 'urge' or 'strong desire to void' are considered descriptions of a normal physiological sensation whereas 'urgency' refers to a distinct symptom.

Urgency urinary incontinence: Complaint of involuntary loss of urine associated with urgency. The urgency may immediately precede or accompany the urinary leakage. Note that this is a reported symptom, and may not be demonstrable in a clinical situation such as at outpatients or even on urodynamics.

Voiding LUTS

Hesitancy: Complaint of a difficulty or delay in initiating micturition.

Classification of LUTS

Storage symptoms	Voiding symptoms	Post-micturition symptoms
Increased daytime frequency	Hesitancy	Sensation of incomplete emptying
Urgency	Intermittency	Post-micturition dribbling
Urinary incontinence associated with urgency	Straining	
Nocturia	Weak or slow stream	
	Split stream or spraying	
	Terminal dribble	

Table 1

Intermittency: When the individual describes urine flow which stops and starts, on one or more occasions, during micturition. Note the difference from post-micturition dribble.

Straining: Describes the need to make an intense muscular effort (by abdominal straining, Valsalva or suprapubic pressure) to either initiate, maintain or improve the urinary stream.

Slow stream: This is reported as the person's own perception of reduced urine flow, usually compared to previous performance or in comparison to others.

Splitting or spraying: The complaint that the urinary stream sprays or splits rather than a single discrete stream.

Terminal dribble: When the individual describes a prolonged final part of micturition, when the flow has slowed to a trickle/dribble.

Post-micturition LUTS

Feeling of incomplete emptying: Complaint that the bladder does not feel empty after micturition.

Post-micturition dribble: When the individual describes the involuntary loss of urine immediately after having finished passing urine, usually after rising from or leaving the toilet.

Sexual symptoms

There is a well-recognized association between LUTS and male sexual function, and this may reflect shared underlying pathophysiologic processes, medication intake, lifestyle choices and psychosocial factors.

Impotence: Inability to achieve or maintain an erection sufficient for intercourse.

Decreased libido: loss of or reduced sexual desire. This may be indicative of androgen deficiency from either pituitary or testicular dysfunction, and should prompt examination of the testicles and a blood test to measure serum testosterone levels. If abnormal, further blood tests for serum gonadotropins and prolactin may be required.

Failure to ejaculate: this symptom, if present, should prompt a search for an underlying cause such as current medication, previous bladder neck and prostatic surgery, diabetes, androgen deficiency and sympathetic denervation (e.g. sympathectomy, retroperitoneal lymph node dissection).

Anorgasmia: Failure to orgasm: this may occur from psychogenic causes, medications, or diabetic peripheral neuropathy.

Premature ejaculation: Occurs when a man ejaculates sooner than he or his partner would like during sexual intercourse. This is usually described as an inability to delay ejaculation for more than one minute after penetration. This may be lifelong or primary, or acquired and secondary.

Haemospermia: This most commonly results from non-specific inflammation of the prostate and/or seminal vesicles, and is usually self-limiting. A genital and digital rectal examination and measurement of serum prostate specific antigen (PSA) is recommended.

It is useful to try and establish a timeline for symptoms, even though it may be difficult to be precise. Remember, symptoms may change with time as well.

Evaluation of comorbidities, medication and lifestyle

There should be a thorough evaluation of comorbidities for each individual patient. A list of all current medication should be obtained, and the patient should be asked if he/she takes any over the counter medication.

Renal, cardiac and liver failure may be associated with LUTS consequent to fluid retention and altered fluid balance. Certain medications such as diuretics may have a direct effect on lower urinary tract function.

Excessive fluid intake, or consumption of alcohol, caffeinated or aerated drinks have all been associated with LUTS, by at least exacerbating them. Chronic alcoholism may affect the urinary tract by resultant autonomic and peripheral neuropathy as well as various endocrine dysfunctions.

Previous history of surgery, particularly to the urinary tract, may be relevant. An example is a recurrence of a previously treated urethral stricture.

Symptom scores

The use of a validated symptom score questionnaire is helpful for the quantification of the degree of bother from LUTS. There are several questionnaires available which are sensitive to changes in symptom severity and can therefore be used to monitor treatment[6]

International Prostate Symptom Score (IPSS)

Name: _____ Date: _____

	Not at all	Less than 1 in 5 times	Less than half the time	About half the time	More than half the time	Almost always	**Your score**
Incomplete emptying Over the past month, how often have you had a sensation of not emptying your bladder completely after you finish urinating?	0	1	2	3	4	5	
Frequency Over the past month, how often have you had to urinate again less than two hours after you finished urinating?	0	1	2	3	4	5	
Intermittency Over the past month, how often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5	
Urgency Over the past month, how difficult have you found it to postpone urination?	0	1	2	3	4	5	
Weak stream Over the past month, how often have you had a weak urinary stream?	0	1	2	3	4	5	
Straining Over the past month, how often have you had to push or strain to begin urination?	0	1	2	3	4	5	

	None	1 time	2 times	3 times	4 times	5 times or more	**Your score**
Nocturia Over the past month, how many times did you most typically get up to urinate from the time you went to bed until the time you got up in the morning?	0	1	2	3	4	5	

Total IPSS score	

Quality of life due to urinary symptoms	Delighted	Pleased	Mostly satisfied	Mixed – equally satisfied/ dissatisfied	Mostly dissatisfied	Unhappy	Terrible
If you were to spend the rest of your life with your urinary condition the way it is now, how would you feel about that?	0	1	2	3	4	5	

Figure 3 International Prostate Symptom Score (IPSS)

However, they are not essential[1] and may be time consuming as well as not add much more to a detailed history.

The International Prostate Symptom Score (IPSS) has been in common usage worldwide since it was devised in 1992 (Figure 3). It is, however, non-specific and weighted towards voiding symptoms as opposed to storage and post-micturition symptoms which makes it less desirable. Consequently, others have been devised to include assessments for OAB, incontinence, nocturia, post-micturition symptoms and measurements of bother for each LUTS (Table 2). The IPSS has only one overall Quality of Life question.

Symptom scores serve as an adjunct to history taking and are not an end to themselves; clinicians should be aware of their specific limitations.

Frequency volume charts and bladder diaries

Recording of voiding function during the normal daily life of an individual is a very important tool in the assessment of LUTS (Figure 4). They are particularly useful in the assessment of storage LUTS and nocturia. There are different mechanisms for nocturia and bladder diaries are therefore helpful for differentiating between these.

A number of different diaries are available but the two most useful forms in clinical practice are:

- **Frequency/volume chart (FVC)**: records the time and volume of each micturition.
- **Bladder diary**: records the time and volume of each micturition and additional information specific to the question being asked for that individual, such as fluid intake, pad usage, incontinence episodes, urgency episodes and degree of urgency.

Paper diaries are most commonly used, although electronic versions are available. The patient is requested to record the above information as timed events on the chart. The voided volume measurement is made using a graduated container (e.g. jug). They are also asked to record the time of going to sleep and waking. The diary is usually recorded by the patient over a three-day period and interpreted by the clinician at the review appointment.

Some of the common findings from bladder diaries/FVCs include:

- Normal voided volumes and frequency.
- Increased nocturnal production of urine, or **nocturnal polyuria** is present when an increased proportion of urine output occurs at night, defined as night-time output of >20 −35% of the 24-hour total output (age and sex dependent).
- **Polyuria** is the production of >2.8 litres in 24 hours in adults.
- Increased frequency of micturition with urgency and reduced voided volumes is typical of overactive bladder.
- A high fluid intake, or consumption of fluids associated with urgency or frequency, such as caffeinated or aerated soft drinks.

Voiding diaries have limited use in patients who are non-compliant, those with cognitive impairment, children and those performing intermittent self-catheterization.

Symptom scores for LUTS

Instrument	Number of questions
International Prostate Symptom Score (IPSS)	7 + 1 QoL
International Consultation on Incontinence Questionnaire (ICIQ-MLUTS)	13
Danish Prostate Symptom Score (DAN-PSS)	12
Urgency Perception Scale	1
King's Health Questionnaire Assessment	7

Table 2

Physical examination

Examination of every patient should be undertaken in the presence of a chaperone. Detailed explanation of the nature of the examination should be provided, and verbal consent obtained. The identity of the chaperone should be documented in the notes. The provision of a chaperone is of medicolegal importance, and gives patients reassurance during what is a very intimate examination.

Examination technique should be systematic, thorough and include the following:

General examination: This is undertaken to detect the presence of systemic conditions. In particular, look for signs of fluid retention such as dependent oedema.

Abdominal examination: Performed by inspection, palpation and percussion. Urinary retention (which may be of the chronic painless variety) must be ruled out. Remember the palpable bladder is a smooth mass-like structure arising out of the bony pelvis that is dull on percussion. The bladder needs to contain at least 250 ml of urine to be palpable, but detecting a full bladder may be difficult in obese patients.

Genital examination: Examination of the scrotum, testicles and the cord structures are a standard part of abdominal examination. The epididymis may be the source of a chronic infection which may underlie LUTS, and tenderness in the area may be an important clue.

Digital rectal examination (DRE): A DRE is essential for assessment of the prostate. This is usually preformed with the patient in the left lateral position with the buttocks positioned at the edge of the table and the hips and knees flexed, although supine and standing positions are sometimes used. A lubricated gloved index finger is used, which is inserted slowly to allow the external anal sphincter to relax upon applying gentle pressure. The prostate is palpable anteriorly. Key points to note on DRE are:

- Consistency of the prostate gland.
- Presence of any nodules or hard irregular areas (often described as 'woody').
- Is the median sulcus palpable?
- Are the prostatic lobes symmetrical?
- Is the prostate tender on palpation? As a DRE is generally uncomfortable, ask the patient if there is specific tenderness at the tip of the palpating finger.

- Prostate size: this is notoriously inconsistent but has an important correlation with serum PSA levels and the risk of disease progression in men with LUTS (see under PSA test, below).
- Is the rectal mucosal normal?
- Are there any rectal tumours or other pelvic masses?
- Note the presence of faecal loading or impaction. This may be a cause of LUTS and incontinence, particularly in the neurologically impaired patient and in children.
- Is there blood on the gloved finger noted at the end of the examination?

Focused neurological examination: This is particularly applicable when possible neurogenic lower urinary tract or pelvic floor dysfunction is suspected. Particular note should be made of neurological signs related to S2–S4. Perianal sensation and external anal sphincter tone (at rest) and strength (ask to voluntarily squeeze) provides useful information. Testing genital reflexes such as the bulbocavernosus reflex (BCR) and cremasteric reflex may provide important information. Eliciting the BCR tests the integrity of the spinal cord mediated reflex arc involving S2-S4.

Vaginal examination: Women with LUTS should have an assessment of the pelvic floor, vaginal length and mobility, and pelvic organ prolapse in relation to the normal anatomical landmarks of the pelvis. The perineum should be a part of this assessment, and note made of its position at rest, descent during straining/coughing, and the presence of any scarring. Pale mucosa with loss of normal vaginal rugosity may indicate lack of

Frequency volume chart

Instructions

Before starting to fill in the chart you will need a small plastic measuring jug, with millilitres marked on it. It is best to choose 2 or 3 days when you know you will not be particularly busy (e.g, over a weekend). They do not need to be consecutive days.

Type of drink – please write what sort of drink you had in this column (e.g, tea, coffee, water).

Amount of drink – before you start, and to avoid having to measure every drink you have, please use the jug to measure the volume (amount of liquid it holds) of your usual cup/mug/glass and keep a note of these figures in the table below. Please then enter the appropriate volume in the column opposite when you have a drink. The jug can then be used to measure the volume of urine passed.

Amount of urine passed – every time you pass urine, measure the amount in the measuring jug and record the amount in mls (millilitres). It is important to record the amount of urine passed during the night time as well as the day time and enter it in the appropriate column.

Wet/pads changed – please write **wet** every time you are wet and **pad** every time you changed a pad in the corresponding column, if this applies to you.

Please also note on the chart at what hour you woke up (by writing **woke**) and when you went to bed (by writing **bed**).

Complete the chart for 3 full days and bring it to your next appointment.

Thank you

	Average volume in mls	Record your usual cup/mug volumes here
Cup	150	
Glass	175	
Mug	250	
Pint	550	

Example	Day 1			
Time	**Type of drink**	**Amount of drink**	**Amount of urine**	**Wet/pad changed**
6.00am				
7.00am	*woke*			
8.00am	*tea*	*250*		
9.00am			*240*	
10.00am	*coffee*	*250*		
11.00am			*180*	
12 noon				
1.00pm	*water*	*175*		
2.00pm				
3.00pm			*320*	
4.00pm	*tea*	*250*		
5.00pm				
6.00pm				
7.00pm			*280*	*pad*
8.00pm	*wine*	*175*		
9.00pm				
10.00pm	*coffee*	*150*	*130*	
11.00pm	*bed*			
12 midnight				
1.00am				
2.00am				
3.00am			*170*	
4.00am				
5.00am				

Figure 4

mucosal oestrogenization. Pelvic pain or the presence of a vaginal discharge may indicate a vaginal or pelvic infection.

Urinary incontinence, when observed rather than reported as a symptom, is a sign; it is the observation of urinary leakage during examination. It may occur involuntarily during coughing or straining down (**stress urinary incontinence**) or observed to be leaking through channels other than the urethra, such as a fistula (**extra-anatomic urinary incontinence**).

Pelvic organ prolapse (POP) is the descent of the one or more 'compartments': anterior vaginal wall (e.g. **cystocoele**), posterior vaginal wall (e.g. **rectocoele**) or apex (e.g. **uterine prolapse** or the cuff/vault after a hysterectomy). POP is correlated with POP symptoms and anatomically its relationship to the level of the hymen.

Pelvic floor muscle function can be assessed by noting the tone at rest, and the strength of a voluntary contraction. Although grading system exist, most often this is recorded subjectively as strong, weak, or absent.

Urinalysis

A sample for urinalysis is typically obtained from a mid-stream specimen of urine (MSU). The patient should be instructed on how to try and reduce contamination by skin organisms (retract foreskin or part labia and clean the external urethral meatus) and to collect the sample in a sterile pot provided. The initial part of the flow is avoided to obtain a mid-stream sample. On occasion, urine sampling has to be obtained by clean catheterization. A MSU is not always appropriate, such as for suspected urethral or prostatic infections where initial and terminal urine samples are required. Three early morning samples of urine are recommended for the detection of urinary tuberculosis.

Urine samples are tested by dipstick biochemical analysis (at outpatients or in the community; Figure 5**)** or formal microscopy and culture of centrifuged urine (in the microbiology laboratory).

LUTS may be caused by pathology such as infection, stones, diabetes, bladder cancer and renal disease. Urinalysis provides clues towards such conditions, which are described as 'red flags' and so must be ruled out.

Urine dipstick analysis commonly detects the parameters shown in Table 3.

Figure 5 Dipstick urinalysis.

Parameters identified on dipstick urinalysis

Parameter detected	Remarks
Blood	Free red blood cells, haemoglobinuria and myoglobinuria may give positive results
Protein	
Glucose	Levodopa may give false positive result
Ketones	
Urobilinogen and bilirubin	
White blood cells	Contamination may give a positive result
Nitrites	Oxidizing agents, hypochlorite solutions and bacterial peroxidases may give false positive result
Leucocyte esterase	
Specific gravity	
pH	

Table 3

Prostate specific antigen (PSA) test

PSA is a protein of the human Kallikrein family produced by the ductal epithelium of the prostate. Its function is to liquefy the seminal coagulum to release the spermatozoa after ejaculation. In the normal physiological state, the basement membrane of the prostatic epithelium acts as a barrier and allows only a small amount of PSA to enter the blood circulation. It is therefore normal for men to have low levels of PSA in their serum which is expressed in laboratory reports as a normal range relative to age.

The serum PSA level may increase in association with several conditions; consequently, this should be evaluated carefully to avoid misdiagnoses and obvious anxiety. The PSA test must be discussed with the patient in detail with provision of written information and adequate time provided to enable informed consent for this test. Some of the causes of an elevates serum PSA are:

- prostate cancer
- benign prostatic hyperplasia (BPH)
- chronic prostatitis
- urinary tract infections
- acute urinary retention
- following instrumentation (such as a cystoscopy or prostate biopsy but not after a digital rectal examination)
- in men with long-term catheters or who perform intermittent self-catheterization
- prostatic manipulation (prostate massage, cycling)

Studies have demonstrated a useful correlation between serum PSA levels, prostate volume and LUTS. A community-based study has shown that the odds of having moderate to severe LUTS were 1.5 times higher for men with prostate volumes >30 ml and 3.5 times higher for men with prostate volumes >50 ml.[2] The serum PSA acts as a surrogate marker for prostate volume when prostate cancer has been ruled out: a PSA of <1.4 ng/ml correlates with a prostate size of <30 g. Data suggests that larger prostates are associated with not only more severe LUTS but also progressive disease. Progression is measured by worsening symptom scores, deterioration of flow rates or increasing

residual volumes, and this increases risk of urinary retention and higher probability of requiring prostate surgery. Consecutive serum PSA levels may be useful for monitoring disease progression for LUTS attributed to BPE.

The PSA test should be performed for the following reasons:[6]

- If a diagnosis of prostate cancer will change the management of the patient and there is at least a 10-year life expectancy.
- If the PSA can assist in decision making in patients at risk of progression of LUTS.

Criteria for PSA testing in men with LUTS are:[1]

- their LUTS are suggestive of bladder outlet obstruction secondary to BPE
- their prostate feels abnormal on DRE
- they are concerned about prostate cancer
- when potential causes for spurious elevations of PSA have been ruled out (e.g. absence of urinary retention, urinary tract infection)
- when there is a life-expectance of >10 years.

If the serum PSA is established to be higher than the age-specific normal range, the guidelines for the diagnosis and management of prostate cancer should be followed. This may include a prostate biopsy or imaging such as an MRI, as appropriate.

Renal function measurement

The biochemical measurement of renal function is most often achieved by serum creatinine or estimated glomerular filtration rate (eGFR). Although this is tested almost universally in clinical practice, there is a lack of understanding of the mechanism of renal insufficiency in patients with LUTS, i.e. why some individuals develop renal dysfunction while others do not. BPO is, however, associated with renal insufficiency in 11% of men, and hydronephrosis and urinary retention is more prevalent in individuals with LUTS.[6]

Higher risk patients who may be suspected of having renal insufficiency include individuals with diabetes, hypertension, a history of stone disease, a palpable bladder, nocturnal enuresis and recurrent urinary tract infections.

Many patients will have had previous blood test records and consequently the change in function in relation to baseline should be looked for, rather than interpreting a single test reading.

Cystoscopy

Endoscopic examination of the lower urinary tract is not routinely indicated for LUTS. When required, this is most commonly performed under local anaesthesia by use of a flexible fibreoptic cystoscope. Rigid cystoscopy under general or spinal anaesthesia is an alternative. Indications for cystoscopy in patients with LUTS include:

- haematuria (visible or non-visible)
- recurrent urinary tract infections
- sterile pyuria
- bladder pain
- previous history of pelvic malignancy
- severe symptoms not adequately responsive to medical therapy
- suggestion of urethral stricture disease.

Rigid cystoscopy is usually undertaken when better visibility is required, more extensive biopsies are required, when surgical intervention is highly likely such as in suspected urethral strictures, or when flexible cystoscopies are not tolerated by the patient.

Imaging of the renal tract

Routine imaging of the renal tract, such as by ultrasound, MRI or computed tomography, is not recommended for the diagnostic work-up of LUTS. There are, however, specific situations where imaging is requested:

- haematuria
- large post-void residual volume
- history of urinary stones
- where it may help specific treatments: prostate volume measurement
- for investigation of suspected prostate cancer.

Urodynamic studies

Urodynamics is a general term for different means of assessment of the storage and voiding phase functions of the micturition cycle. As stated at the start, the fundamental concept to grasp is that the lower urinary tract comprises of a functional unit. Consequently, a urodynamic assessment commences from the start of the assessment of LUTS, and includes a frequency volume chart/bladder diary, uroflowmetry, filling cystometry, pressure-flow studies, videourodynamics and ambulatory urodynamics.

Before requesting any such tests, the clinician should have a clear clinical question which the test aims to answer. Ascertaining this will determine which urodynamic test is appropriate. When tests are performed, the clinician should seek to replicate the patient's symptoms and correlate these with the urodynamic findings. Quality control of the data is essential for accurate interpretation of the results.

Uroflowmetry

Uroflowmetry, or 'flow test', as it is often called, is a useful and widely used urodynamic test.

It is non-invasive and involves the patient voiding into a flowmeter; this comprises of a receptacle that collects the urine and a transducer which calculates the rate of flow over time. Flow rate is the volume of fluid expelled via the urethra per unit time (in ml/s). A graphical representation of the flow rate is obtained. Measurement of post-void residual volume must be combined with uroflowmetry.

Patients should be asked to pass urine when they feel a 'normal' desire to void, and this may occur at different bladder volumes. The expected voided volume can be gleaned from the frequency volume chart. If the voided volume is too small the flow rate may be difficult to interpret.

Parameters commonly measured include the maximum flow rate (Q_{max}), voided volume, flow time, and the post-void residual volume. The shape of the curve on the recorded trace may suggest what might be the underlying pathology, but this is not reliable or specific. For example, a normal male flow trace looks like a bell-shaped curve. A flat plateau shape suggests the

presence of a urethral stricture, and an intermittent flow pattern may indicate straining or a pelvic floor disorder.

Specific artefacts should be looked out for, such as straining, squeezing of the urethra, movement of the urinary stream around the funnel, as these affect the flow rate measurements.

The main limitation to uroflowmetry is its inability to differentiate between BOO and poor detrusor contractility; a poor flow rate could be caused by either.[2,7] Apart from the clues from the flow trace, it is useful for a diagnosis of exclusion as the majority of men with a good flow rate will not have BOO. Although not diagnostic, a very low flow rate (<8 ml/s) has been shown to have a positive predictive value of 90% for BOO in males.[2] Uroflowmetry is females is more difficult to interpret.

Post-void residual (PVR)

Measurement of the residual volume of urine within the bladder immediately after a void provides important information regarding LUTS. This is achieved by means of a portable bladder scanner commonly used in outpatient clinics or wards, a diagnostic ultrasound or by catheterization. The latter option is invasive and obviously therefore the least preferable.

PVR readings are of limited value in isolation. There is considerable variation in PVR between individuals, and there is no established threshold for significance. As with uroflowmetry, an elevated PVR does not distinguish between BOO and impaired detrusor contractility.

In various studies a PVR of >100 ml has been associated with a higher incidence of urinary retention. Individuals with PVR >300 ml should have imaging of the upper renal tracts and biochemical tests of renal function performed as this may indicate a risk of high-pressure chronic retention. A residual of >300 ml should prompt multichannel urodynamics as this may signify either underlying detrusor under activity or BOO, and the treatments and long-term outcomes are different for these two conditions.

An elevated PVR is not an indication for surgery provided renal function and imaging of the renal tract is confirmed to be normal.

When BOO is being treated medically, worsening of PVR over time may suggest disease progression or failure of treatment.

Multichannel urodynamics

Multichannel urodynamics is the procedure where urodynamic lines are introduced into the bladder and rectum to simultaneously measure vesical pressure (P_{ves}) and abdominal pressure (P_{abd}). Computerized subtraction of P_{abd} from P_{ves} in real time gives the detrusor pressure (P_{det}). The pressure readings are converted into electrical signals by a transducer. This is standardized before each test, a process known as zeroing to atmosphere. This investigation is often called 'invasive urodynamics' although that is not a very patient-friendly term.

Filling cystometry assesses the storage phase of the micturition cycle. The bladder is filled with saline, water, or radiographic contrast at a predetermined rate. Real-time data on bladder, abdominal and the subtracted detrusor pressure is correlated with sensations and symptoms.

Important parameters assessed include detrusor overactivity, bladder compliance, and bladder volume. **Compliance** refers to the relationship between the changes in bladder volume and change in pressure as the bladder is progressively filled. **Detrusor overactivity** (DO) is the urodynamic observation of involuntary detrusor contractions during bladder filling. These are usually considered significant when associated with urgency. Provocation techniques like running a tap in the room, change of posture or using a cooled medium may bring about DO.

This is followed by asking the patient to voluntarily initiate voiding, with the urodynamic lines in situ, and then measurement of post-micturition residual urine. This assesses the voiding phase of the micturition cycle. **Bladder outlet obstruction** (BOO) is characterized by a high detrusor pressure and low flow rate. **Detrusor underactivity** (DUA) refers to detrusor contraction of reduced strength and/or duration. Both BOO and DUA may be associated with a reduce flow rate, prolonged voiding time and a high residual volume. Nomograms such as the BOO Index (BOOI) and the Bladder Contractility Index (BCI) help quantify the problem in males. Nomograms are more difficult to interpret in females.

Multichannel urodynamics is a specialized test that is usually requested when invasive treatment is being considered, such as bladder neck or prostatic surgery for suspected BOO, or when an assessment of complex LUTS is undertaken, such as that associated with neuropathy (e.g. after spinal cord injury, Parkinson's, or myelomeningocele), suspected fistula, urethral diverticula, congenital anomalies, LUTS associated with POP, and failed surgery for incontinence or bladder outlet obstruction. **Video-urodynamics** employs the use of a fluoroscopy machine and radiographic contrast to fill the bladder to provide additional anatomical information to the functional data. Consequently, a clear urodynamic question should be formulated before embarking on this test, and it should be performed by a suitably trained clinician with a specific interest in this area who would be able to elicit and interpret the various pieces of information. ◆

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