Standard terminology and good urodynamic practices

International Continence Society
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The Standardisation of Terminology of Lower Urinary Tract Function: Report from the Standardisation Sub-committee of the International Continence Society

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International Continence Society Guidelines on Urodynamic Equipment Performance

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The terminology for women, due to the absence of specific diagnoses as well as other female-specific terminology, may not have been advantaged by a single report.

Standardized terminology in female pelvic floor dysfunction to enable accurate communication for clinical and research purposes.
Principles:

• User friendly
• Clinically based
  – Symptoms
  – Signs
  – Urodynamic investigations
  – Other investigations
• Common diagnoses
Symptoms

- Patient or caregiver reported
- ‘Lower urinary tract symptoms’
  - Storage
  - Voiding
  - Post micturition
- Associated with sexual intercourse
- Associated with pelvic organ prolapse
- Genital / lower urinary tract pain

The subjective indicator of a disease or change in condition as perceived by the patient, caregiver or partner and may lead him/her to seek help from health care professionals.

Any morbid phenomenon or departure from the normal in structure, function, or sensation, experienced by the woman and indicative of disease, or a health problem. Symptoms are either volunteered by, or elicited from the individual, or may be described by the individual’s caregiver.
Symptoms: Storage

- Increased daytime frequency
- Nocturia
- Urgency
- Urinary incontinence
  - Stress urinary incontinence
  - Urge urinary incontinence
  - Mixed urinary incontinence
  - Enuresis
    - Nocturnal enuresis
  - Continuous urinary incontinence
  - Other types of urinary incontinence (giggle / intercourse)
Symptoms: Storage contn’d

• Bladder sensation
  – Normal
  – Increased
  – Reduced
  – Absent
  – Non-specific
Symptoms Voiding

- Slow stream
- Splitting spraying
- Intermittent stream (intermittency)
- Hesitancy
- Straining
- Terminal dribble
Symptoms Post micturition

• Feeling of Incomplete emptying
• Post micturition dribble
ICS/IUGA (added)

- Associated with intercourse
- Associated with pelvic organ prolapse
- Genital / lower urinary tract pain
  - (exactly) where; when; how much
- Pain syndromes
  - Painful bladder syndrome
    - *(Interstitial cystitis –not ICS)*
  - Other pain regions
    - Vulva
    - Vagina
    - Scrotum
    - Perineum
UIGA / ICS FEMALE

- Urinary Incontinence Symptoms (added)
  - Postural urinary incontinence
  - Insensible urinary incontinence
  - Coïtal incontinence

- Voiding Symptoms (added)
  - Position dependent micturition
  - Dysuria
  - Urinary retention

- Pelvic organ prolapse symptoms
  - Vaginal bulging
  - Pelvic pressure
  - Bleeding discharge infection
  - Splinting /digitation
  - Low backache
ICS/ IUGA (added)

- Dyspareunia
  - Superficial
  - Deep
- Obstructed intercourse
- Vaginal laxity

- Anal dysfunction
  - Faecal incontinence
  - Flatal
  - Faecal urgency
  - Straining to defaecate
  - Feeling of incomplete emptying
  - Diminished rectal sensation
  - Constipation
  - Rectal prolapse
  - Rectal bleeding/mucus
Pain

- **Bladder pain:**
  - Complaint of suprapubic or retropubic pain, pressure, or discomfort, related to the bladder, and usually increasing with bladder filling. It may persist or be relieved after voiding.

- **Urethral pain:**
  - Complaint of pain felt in the urethra and the woman indicates the urethra as the site.

- **Vulval pain:**
  - Complaint of pain felt in and around the vulva.

- **Vaginal pain:**
  - Complaint of pain felt internally within the vagina, above the introitus.
Pain

- **Perineal pain:**
  - Complaint of pain felt between the posterior fourchette (posterior lip of the introitus) and the anus.

- **Pelvic pain:**
  - The complaint of pain perceived to arise in the pelvis, not associated with symptoms suggestive of lower urinary tract, sexual, bowel, or gynecological dysfunction. It is less well defined than the above types of localized pain.

- **Cyclical (menstrual) pelvic pain:**
  - Cyclical pelvic pain related to menses that raises the possibility of a gynecological cause.

- **Pudendal neuralgia:**
  - Burning vaginal or vulval (anywhere between anus and clitoris) pain associated with tenderness over the course of the pudendal nerves.
Signs (suggestive of LUTD)

Are observed by the physician, including simple means, to verify symptoms and quantify them.

Any abnormality indicative of disease or a health problem, discoverable on examination of the patient; an objective indication of disease.
• **Urinary incontinence**: Observation of involuntary loss of urine on examination: this may be urethral or extraurethral.

• **Stress (urinary) incontinence (clinical stress leakage)**: Observation of involuntary leakage from the urethra synchronous with effort or physical exertion, or on sneezing or coughing.

• **Urgency (urinary) incontinence**: Observation of involuntary leakage from the urethra synchronous with the sensation of a sudden, compelling desire to void that is difficult to defer.

• **Extraurethral incontinence**: Observation of urine leakage through channels other than the urethral meatus, for example, fistula.

• **Stress incontinence on prolapse reduction (occult or latent stress incontinence)**: Stress incontinence only observed after the reduction of co-existent prolapse.

• **Uncategorised incontinence** is the observation of involuntary leakage that cannot be classified into one of the above categories on the basis of signs and symptoms. **2002**
Signs (suggestive of LUTD)

• Measuring frequency
  – Micturition time chart
  – Frequency volume chart
  – Bladder diary
    • Daytime frequency
    • Nocturia
    • 24-hour frequency
    • 24-hour production
      – Polyuria (>2.8L/24h)
      – Nocturnal urine volume
        » Nocturnal polyuria >1/3
      – Maximum voided volume
Signs

- Physical examination
  - Abdomen
  - Perineum
  - Genital
  - Pelvic floor muscle function
  - Rectal

- Pad testing

Normal pelvic floor muscles:
- Overactive pelvic floor muscles:
- Underactive pelvic floor muscles:
- Non-functioning pelvic floor muscles:

Examination for levator (puborectalis) injury:

Rectal examination
- Anal sphincter tone and strength:
  - Anal sphincter tear:
    - Confirm presence or absence of rectocele
    - Diagnose perineal body deficiency.
  - Other rectal lesions:
  - Anal lesions:
  - Other perianal lesions:

Allows the description of observed and palpable anatomical abnormalities and is the easiest method of assessing pelvic floor muscle function in children and men. In addition, rectal examination is essential in children with urinary incontinence to rule out faecal inpaction.
Prolapse
• **Anterior vaginal wall prolapse:**
  – Observation of descent of the anterior vaginal wall.

• **Posterior vaginal wall prolapse:**
  – Observation of descent of the posterior vaginal wall.
Other relevant examination

- **Neurological signs**: For patients with possible neurogenic lower urinary tract or pelvic floor dysfunction, there should be particular note of those neurological signs related to S2–S4, but these should be complemented by a more general neurological examination as indicated.

- **Abdominal signs**:
  - Bladder fullness/retention
  - Other abdominal masses or distension
  - Scars
  - Renal area: Examination for tenderness, masses.
Urodynamic technique

- Conventional urodynamic studies normally take place in the urodynamic laboratory and usually involve artificial bladder filling.

- **Artificial bladder filling** is defined as filling the bladder, via a catheter, with a specified liquid at a specified rate.

- **Natural filling** means that the bladder is filled by the production of urine rather than by an artificial medium.

- **Ambulatory urodynamic studies** are defined as a functional test of the lower urinary tract, utilising natural filling, and reproducing the subject’s every day activities.
• **Intravesical pressure** is the pressure within the bladder

• **Abdominal pressure** is taken to be the pressure surrounding the bladder. The simultaneous measurement of abdominal pressure is essential for the interpretation of the intravesical pressure trace

• **Detrusor pressure** is that component of intravesical pressure that is created by forces in the bladder wall (passive and active). It is estimated by subtracting abdominal pressure from intravesical pressure
Filling Cystometry

• the method by which the pressure/volume relationship of the bladder is measured during bladder filling.
  – The filling phase starts when filling commences and ends when the patient and urodynamicist decide that permission to void has been given.
• Bladder and urethral function, during filling, need to be defined separately.

The rate at which the bladder is filled is divided into:
• **Physiological filling rate**
  – *is* defined as a filling rate less than the predicted maximum - predicted maximum body weight in kg divided by 4, expressed as ml/min
• **Non-physiological filling rate**
  – *is* defined as a filling rate greater than the predicted maximum filling rate - predicted maximum body weight in kg divided by 4 expressed as ml/min
Bladder sensation

- **First sensation of bladder filling**
  - is the feeling the patient has when he/she first becomes aware of the bladder filling

- **First desire to void**
  - 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**
  - a persistent desire to void with-out the fear of leakage.
- **Increased bladder sensation**
  - an early first sensation of bladder filling (or an early desire to void) and/or an early strong desire to void, which occurs at low bladder volume and which persists.

- **Reduced bladder sensation**
  - diminished sensation throughout bladder filling.

- **Absent bladder sensation**
  - the individual has no bladder sensation.

- **Non-specific bladder sensations**
  - may make the individual aware of bladder filling, for example, abdominal fullness or vegetative symptoms
• **Bladder pain**
  – during filling cystometry, is a self explanatory term and is an abnormal finding

• **Urgency**
  – is a sudden compelling desire to void which is difficult to defer

• **The vesical/urethral sensory threshold**
  – defined as the least current which consistently produces a sensation perceived by the subject during stimulation at the site under investigation
Bladder capacity during filling cystometry

• **Cystometric capacity:**
  – Bladder volume at the end of filling cystometry, when “permission to void” is usually given by the urodynamicist.

• **Maximum cystometric capacity:**
  – In patients with normal sensation, this is the bladder volume when he/she can no longer delay micturition.
Detrusor function during filling cystometry:

• **Normal (previously “stable”) detrusor function:**
  – little or no change in detrusor pressure with filling. There are no involuntary phasic contractions despite provocation with activities such as postural changes, coughing, hearing the sound of running water, hand-washing.

• **Detrusor overactivity:**
  – involuntary detrusor contractions during filling cystometry. These contractions, which may be spontaneous or provoked, produce a wave form on the cystometrogram, of variable duration and amplitude. The contractions may be phasic or terminal.
  – Symptoms, for example, urgency and/or urgency incontinence may or may not occur. If a relevant neurological cause is present, then *neurogenic detrusor overactivity* is noted, otherwise *idiopathic detrusor overactivity* should be the term used (Fig. 6).

• **Neurogenic detrusor overactivity:**
  – This is where there is detrusor overactivity and there is evidence of a relevant neurological disorder.
Compliance

• Compliance is calculated by dividing the volume change ($\Delta V$) by the change in detrusor pressure ($\Delta P_{\text{det}}$) during that change in bladder volume.

• Compliance is expressed as ml per cmH$_2$O.

• Bladder compliance can be affected by:
  – *Bladder filling*: Faster filling is more provocative. An artifact may be produced which settles when filling is interrupted.
  – *Contractile/relaxant properties of the detrusor*

2010

• *Starting point for compliance calculations*: Usually the detrusor pressure & volume at the start of bladder filling (usually zero).

• *End point for compliance calculations*: The detrusor pressure (and volume) at cystometric capacity or immediately before the start of any detrusor contraction that causes significant leakage (and therefore causes the bladder volume to decrease, affecting compliance calculations). Both points are measured excluding any detrusor contraction.
Urodynamic conditions / observations

The urethral closure mechanism during storage may be competent or incompetent.

- **Normal urethral closure mechanism**
  - maintains a positive urethral closure pressure during bladder filling even in the presence of increased abdominal pressure, although it may be overcome by detrusor overactivity

- **Incompetent urethral closure mechanism**
  - one which allows leakage of urine in the absence of a detrusor contraction

- **Urethral relaxation incontinence**
  - leakage due to urethral relaxation in the absence of raised abdominal pressure or detrusor overactivity

- **Urodynamic stress incontinence**
  - involuntary leakage of urine during increased abdominal pressure, in the absence of a detrusor contraction.
Leak point pressures

• The pressure values at leakage should be measured at the moment of leakage.

• Detrusor leak point pressure (detrusor LPP):
  – the lowest value of the detrusor pressure at which leakage is observed in the absence of increased abdominal pressure or a detrusor contraction

• Abdominal leak point pressure (abdominal LPP):
  – the lowest value of the intentionally increased intravesical pressure that provokes urinary leakage in the absence of a detrusor contraction.
  – The increase in pressure can be induced by a cough (cough LPP) or Valsalva (Valsalva LPP). Multiple estimates at a fixed bladder volume (200–300 ml) are desirable. Catheter size will influence LPP values and should be standardized.
Flow Studies

• *Pressure flow studies* of voiding are the method by which the relationship between pressure in the bladder and urine flow rate is measured during bladder emptying.

• The voiding phase starts when permission to void is given or when uncontrollable voiding begins, and ends when the patient considers voiding has finished.
• **Urine flow**
  – is defined either as continuous, that is without interruption, or as intermittent, when an individual states that the flow stops and starts during a single visit to the bathroom in order to void. The continuous flow flow curve is defined as a smooth arc shaped curve or fluctuating when there are multiple peaks during a period of continuous urine flow.

• **Flow rate**
  – the volume of fluid expelled via the urethra per unit time. It is expressed in ml/s.

• **Voided volume**
  – the total volume expelled via the urethra

• **Maximum flow rate**
  – the maximum measured value of the flow rate after correction for artefacts.
• **Voiding time**
  – total duration of micturition, i.e. includes interruptions. When voiding is completed without interruption, voiding time is equal to flow time.

• **Flow time**
  – the time over which measurable flow actually occurs.

• **Average flow rate**
  – voided volume divided by flow time. The average flow should be interpreted with caution if flow is interrupted or there is a terminal dribble.

• **Time to maximum flow**
  – the elapsed time from onset of flow to maximum flow.
Pressure – flow studies

- **Premicturition pressure**
  - recorded immediately before the initial isovolumetric contraction

- **Opening pressure**
  - recorded at the onset of urine flow (consider time delay). (ORIGINAL)

- **Opening time**
  - the elapsed time from initial rise in detrusor pressure to onset of flow. This is the initial isovolumetric contraction period of micturition. Flow measurement delay should be taken into account when measuring opening time.

- **Maximum pressure**
  - maximum value of the measured pressure
• **Pressure at maximum flow**
  – lowest pressure recorded at maximum measured flow rate. (ORIGINAL)

• **Closing pressure**
  – pressure measured at the end of measured flow. (ORIGINAL)

• **Minimum voiding pressure**
  – minimum pressure during measurable flow. This is not necessarily equal to either the opening or closing pressures.

• **Flow delay**
  – time delay between a change in bladder pressure and the corresponding change in measured flow rate.
Detrusor function during voiding

- **2002**: Normal voiding is achieved by a voluntarily initiated continuous detrusor contraction that leads to complete bladder emptying within a normal time span, and in the absence of obstruction. For a given detrusor contraction, the magnitude of the recorded pressure rise will depend on the degree of outlet resistance.

- **2010**: Normal voiding in women is achieved by an initial (voluntary) reduction in intraurethral pressure (urethral relaxation). This is generally followed by a continuous detrusor contraction that leads to complete bladder emptying within a normal time span. Many women will void successfully by urethral relaxation alone, without much of a rise in detrusor pressure. The amplitude of the detrusor contraction will tend to increase to cope with any degree of bladder outflow obstruction.
Abnormal detrusor activity

- **Detrusor underactivity** is defined as a contraction of x reduced strength and/or duration, resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within a normal time span.

- **2002**: A contractile detrusor is one that cannot be demonstrated to contract during urodynamic studies.

- **2010**: A contractile detrusor: The detrusor cannot be observed to contract during urodynamic studies resulting in prolonged bladder emptying and/or a failure to achieve complete bladder emptying within a normal time span, where there is a neurological cause use neurogenic acontractile detrusor.

- **Post void residual (PVR)** is defined as the volume of urine left in the bladder at the end of micturition.
Urethral Function During Voiding Cystometry

**Normal urethra function**

A urethra that opens, and is continuously relaxed to allow the bladder to be emptied at a normal pressure.

**Abnormal urethra function**

Due to either obstruction to urethral overactivity, or a urethra that cannot open due to anatomic abnormality, such as an enlarged prostate or a urethral stricture.

**Bladder outlet obstruction**

Generic term for obstruction during voiding and is characterised by increased detrusor pressure and reduced urine flow rate. It is usually diagnosed by studying the synchronous values of flowrate and detrusor pressure.

**Dysfunctional voiding**

An intermittent and/or fluctuating flow rate due to involuntary intermittent contractions of the periurethral striated muscle during voiding, in neurologically normal individuals.

**Detrusor sphincter dyssynergia**

A detrusor contraction concurrent with an involuntary contraction of the urethral and/or periurethral striated muscle. Occasionally flow may be prevented altogether.

**Non-relaxing urethral sphincter obstruction**

Usually occurs in individuals with a neurological lesion and is characterised by a non-relaxing, obstructing urethra resulting in reduced urine flow.
Conditions

• **Acute retention of urine**
  – a painful, palpable or percussable bladder, when the patient is unable to pass any urine

• **Chronic retention of urine**
  – a non-painful bladder, which remains palpable or percussable after the patient has passed urine

• **Benign prostatic obstruction**
  – may be diagnosed when the cause of outlet obstruction is known to be benign prostatic enlargement, due to histologic benign prostatic hyperplasia

• **Benign prostatic hyperplasia**
  – the typical histological pattern which defines the disease

• **Benign prostatic enlargement**
  – prostatic enlargement due to histologic benign prostatic hyperplasia. The term prostatic enlargement should be used in the absence of prostatic histology.
DIAGNOSES

• Bladder Oversensitivity
  – diagnosis made by *symptoms and urodynamic investigations*, is more likely to occur in women with symptoms of frequency and nocturia, and a voiding diary showing a clearly reduced average voided volume.

• Recurrent Urinary Tract Infections
  – diagnosis by *clinical history* assisted by *the results of diagnostic tests* involves the determination of the occurrence of at least three symptomatic and medically diagnosed UTIs over the previous 12 months
Ultrasound

- Perineal
- Introïtal
- Transvaginal
- Transabdominal

- Intercurrent pelvic pathology
  - Position of pelvic organs
  - Postoperative findings

- Pelvic floor
- Bladder
- Urethra
Radiological

- Videocystourethrography
- Intravenous urography
- Micturating cystogram
- Defecography
- Colporecto-cystourethrography

- MRI
Rehabilitation

• Pelvic floor training
• Biofeedback
• Behavioural modification
• Electrical stimulation

• Catheterisation
  – Intermittent
    • Clean intermittent
    • Aseptic intermittent
  – Indwelling

• Reflex triggering
• Expression (credé)
Good urodynamic practice
The committee

- Werner Schafer
- Paul Abrams
- Limin Liao
- Anders Mattiasson
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Principles

• 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
RECORDING MICTURITIONS AND SYMPTOMS

• Micturition Time Chart
  • records the time of each micturition

• Frequency Volume Chart
  • time of micturition & voided volumes are recorded

• Bladder Diary
  • Records time of micturition & voided volumes, relevant symptoms and events such as urgency, pain, incontinence episodes, and pad usage
• Recording for a minimum of 2 days is recommended.

• From the recordings, the average voided volume, voiding frequency, and day/night urine production and nocturia can be determined.

• Provides objective verification of the patient’s symptoms, and values for plausibility control for subsequent urodynamic studies.
UROFLOWMETRY

• Adequate privacy should be provided and patients should be asked to void when they feel a “normal” desire to void.

• Patients should be asked if their voiding was representative of their usual voiding and their view should be documented.

• Automated data analysis must be verified by inspection of the flow curve, artifacts must be excluded, and verification must be documented.
UROFLOWMETRY

• The results from uroflowmetry should be compared with the data from the patient’s own recording on a frequency/volume chart.
• Sonographic estimation of post-void residual volume completes the non-invasive assessment of voiding function.
Detrusor contractility

• As the voiding function reflects the interaction between the relaxed outlet and the contracting detrusor, variation of both will affect the flow.
• For steady outflow conditions, all variations in flowrate are related to changes in detrusor activity alone.
• The detrusor contraction strength varies neurogenically and myogenically, and can cause significant variability in urine flow rate measurements.

This is not “contractility”
Bladder Outflow Resistance & volume

• If detrusor, “contractile function” is constant, then changes in outflow resistance will lead to changes in flow rate, for example, in patients with detrusor-sphincter dyssynergia.

• As the bladder volume increases and the detrusor muscle fibres become more stretched, there is an increase in the potential bladder power and work associated with a contraction.

• $Q_{max}$ is physiologically dependent on the bladder volume.
Recommendations for Uroflowmetry

• graphical scaling should be standardized as follows:
  – one millimetre should equal 1 s on the x-axis and 1ml/s & 10 ml voided volume on the y-axis.
• routine clinical measurements should read flowrate values only to the nearest full ml/s and volumes to the nearest 10 ml.
• a sliding average over 2 s should be used to remove positive and negative spike artifacts.
• It is recommended that:
  – only flow rate values, which have been ‘smoothed’, either electronically or manually, should be reported.
• If a maximum flow value is determined electronically by simple signal peak detection without the recommended electronic smoothing, it should be labelled differently, Qmax.raw.
• The interpretation of any dynamic variation (signal patterns) in free flow will rely on personal experience, can be only descriptive, and in general will remain speculative.
• Maximum (smoothed) urine flow rate should be rounded to the nearest whole number.
• Voided volume and post void residual volume should be rounded to the nearest 10 ml.
• The maximum flow rate should always be documented together with voided volume and post void residual volume using a standard format

VOID: Maximum Flow Rate/ VolumeVoided/PostVoid Residual Volume.
International Continence Society Guidelines on Urodynamic Equipment Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Guideline value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy for flow rate</td>
<td>±1 ml/sec</td>
</tr>
<tr>
<td>Accuracy for voided volume</td>
<td>The greater of ±3% of true value or ±2 ml</td>
</tr>
<tr>
<td>Range for flow rate</td>
<td>0–50 ml/sec</td>
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<tr>
<td>Range for voided volume</td>
<td>0–1,000 ml</td>
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<tr>
<td>Maximum duration of flow recordable</td>
<td>≥120 sec</td>
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<tr>
<td>Minimum flow recordable</td>
<td>≤1 ml/sec</td>
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<tr>
<td>Bandwidth of flow measurement</td>
<td>0 to between 1 and 5 Hz</td>
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</tbody>
</table>

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TABLE II. Desirable Features of Uroflowmetry Equipment

Documentation should state the minimum recordable volume change or flow rate
Equipment should allow the user to set the expected density of voided fluid
Equipment with load cells should not be damaged by loads less than 5 kg
Equipment should allow the user to reset the volume recorded to zero between voids during a test
Documentation should clearly state what filtering or integration is used in signal processing
Equipment should display the delay value used when synchronizing urine flow with pressure signals, preferably allowing modification of the value
An adjustable height urine collection funnel is recommended
In order to reduce flow artefacts, good delivery of the urine stream to the meter is recommended
INVASIVE URODYNAMICS: FILLING CYSTOMETRY, PRESSURE-FLOW STUDY OF VOIDING

• A good urodynamic investigation should be performed interactively with the patient.
• It should be established by discussion with the patient that the patient’s symptoms have been reproduced during the test.
• There should be continuous and careful observation of the signals as they are collected, and the continuous assessment of the qualitative and quantitative plausibility of all signals.
• Artifacts should be avoided, and any artifacts that occur should be corrected immediately.
• the same quality criteria apply for ambulatory urodynamic monitoring
• before invasive urodynamics, a frequency volume chart should be completed and multiple free flows should be evaluated.
• A significant delay is to be expected for the typical urodynamic flow rate recorded extracorporally (0.5-2.0s). This delay will vary with anatomy, pathology, flow rate, and the set-up for measurement.

• The time delay between urethral closure and the end of any flow recording may be much longer in,
  – prostatic obstruction
  – terminal dribbling

• Than between the opening of the urethra and the start of a flow rate signal

• Descriptive terminology for synchronizing pressure and flow values,
  – $p_{\text{det} \cdot Q_{\text{beg}}}$ for the pressure at which flow begins instead of $p_{\text{det} \cdot \text{open}}$
  – $p_{\text{det} \cdot Q_{\text{end}}}$ when flow ends instead of $p_{\text{det} \cdot \text{close}}$
Multi-channel cystometry

- Measurement of intravesical and abdominal pressure
  - ICS standardization of zero pressure and reference height.
  - Zero pressure and reference height are concepts which are often confused in urodynamics.
  - Zero pressure is the surrounding atmospheric pressure, recorded when a transducer is open to the environment when disconnected from any tubes or catheters, or when the open end of a connected, fluid-filled tube is at the same vertical level as the transducer.
  - The reference height is defined as the upper edge of the symphysis pubis.
Microtip pressure transducers

- It is impossible to define the precise position of an intravesical and a rectal catheter.
- It is impossible to position them at the standard level of the upper border of the symphysis pubis.
- Setting the catheter mounted pressure transducers to zero pressure when inside the body at the start of pressure recording means that both the standard zero pressure as well as the reference level are ignored:
  - such recorded pressures cannot be compared between patients or centres.
  - initial intravesical and abdominal resting pressures are different between patients, and depend significantly on patient’s position.
  - by ignoring the correct atmospheric zero pressure, an error of up to 50 cmH₂O, can occur.
- In addition, when a study starts with zero abdominal pressure then the commonly observed abdominal pressure decrease at pelvic floor relaxation during voiding will result in negative abdominal pressure values, and $p_{\text{det}}$ will be higher than $p_{\text{ves}}$. 
• For intravesical and abdominal pressure recording external transducers connected to fluid filled tubing and catheters be used.

• If microtip or air-filled catheters are used, any deviation from standard zero and reference level should be minimized and taken into account at the time of data analysis.
Urodynamic catheters

- For the measurement of intravesical pressure and for bladder filling, the standard catheter for routine urodynamics is a transurethral double-lumen catheter.

- A double lumen catheter facilitates a second fill/void study to establish reproducibility. Re-introduction of the separate filling tube for a repeated study is more invasive and complicated.
• The use of a rectal balloon catheter is recommended for the measurement of abdominal pressure, $p_{\text{abd}}$.

• a **flaccid**, air-free balloon in the rectal ampulla gives a suitable signal for $p_{\text{abd}}$ to determine a meaningful $p_{\text{det}}$ when $p_{\text{ves}}$ is measured synchronously.

• In females, vaginal recording may be more acceptable and provides comparable results.
Requirements for Filling Cystometry and Pressure-Flow Studies of Voiding

• three measurement channels, two for pressure and one for flow, a display and secure storage of three pressures \((p_{\text{abd}}, p_{\text{ves}}, p_{\text{det}})\) and flow \((Q)\) as tracings against time

• infused volume and voided volume may be shown graphically or numerically

• on-line display of pressures and flow, with adequate scale and resolution; scales must be clearly given on all axes; no information should be lost electronically when tracings go off-scale on display;

• possibilities to record standard information about sensation and additional comments (event recording).
• Minimum accuracy should be ± 1 cmH\textsubscript{2}O for pressure and ± 5\% full scale for flow and volume;
• Ranges of 0-250 cmH\textsubscript{2}O, 0-25(50) ml/s, and 1,000 ml for pressure, flow, and volume
• The software must ensure that no information for pressures up to 250 cmH\textsubscript{2}O and for flow rates up to 50 ml/s is lost internally even when not displayed and that off-scale values are clearly identified;
• An analog/digital (A/D) frequency of 10 Hz per channel as the lower limit for pressure and flow;
• A higher frequency (minimum 20 kHz) is necessary for recording EMG;
• Calibration of all measurements should be possible.
The following criteria form the minimum recommendations for ensuring quality control of pressure recordings:

- Resting values for abdominal, intravesical, and detrusor pressure are in a typical range
- 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 $p_{\text{det}}$
- Coughs are used (every 1 min. or, for example, 50 ml filled volume) to ensure that the abdominal and intravesical pressure signals respond equally.
- Coughs immediately before voiding and immediately after voiding should be included.
- When standards are followed, a typical range for initial resting pressures values for $p_{\text{ves}}$ and $p_{\text{abd}}$
  - supine 5-20 cmH₂O.
  - sitting 15-40 cmH₂O.
  - standing 30-50 cmH₂O.
• All negative pressure values, except when caused by rectal activity, should be corrected immediately.

• $P_{\text{det}}$ cannot be negative.

• The urodynamic findings and the interpretation of the results should be documented immediately after the study is finished.
Pressure artefacts

- Catheter-tip transducers and air-filled transducers will have an error due to their unknown and changing height within the bladder, which is difficult to correct.
- Air bubbles
- Dislodged catheter.
- Incomplete pressure transmission
- Incomplete cough cancellation.
- Artefacts with separate lines.
- Single Lumen artefact.
- Dual-lumen artefact (pump)
## User interface

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access and cleaning</td>
<td>Equipment laid out ergonomically</td>
</tr>
<tr>
<td>Display</td>
<td>Should allow for later review with line thicknesses representing smaller values than recommended measurement accuracy</td>
</tr>
<tr>
<td>Data export</td>
<td>Text/spreadsheet format, ICS format and electronic patient record interface</td>
</tr>
<tr>
<td>Data storage</td>
<td>Backup facility and option for network connection required Secure data storage should be made possible</td>
</tr>
<tr>
<td>Image capture and display</td>
<td>Simultaneous recording and playback with pressure traces required, if images are used</td>
</tr>
<tr>
<td>Display scales</td>
<td>Clearly displayed and adjustable</td>
</tr>
<tr>
<td>Event marking</td>
<td>Required</td>
</tr>
<tr>
<td>Automated analyses</td>
<td>Relevant parameters should be controlled by user, not fixed</td>
</tr>
</tbody>
</table>
Conclusions

- Standardised terminology assists communication and analysis
- GUP assures quality investigations
- Standardised equipment performance allows data sharing and grouped analysis
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I forgot my business cards
Dr. Bing Chung Tong will make the slides available