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REVIEW ARTICLE

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International Continence Society Good Urodynamic Practices and Terms 2016: Urodynamics, uroflowmetry, cystometry, and pressure-flow study

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Aims: The working group initiated by the ICS Standardisation Steering Committee has updated the International Continence Society Standard "Good Urodynamic Practice" published in 2002.

Methods: On the basis of the manuscript: "ICS standard to develop evidence-based standards," a new ICS Standard was developed in the period from December 2013 to December 2015. In July, a draft was posted on the ICS website for membership comments and discussed at the ICS 2015 annual meeting. The input of ICS membership was included in the final draft before ICS approval and subsequent peer review (for this journal).

Results: This evidence-based ICS-GUP2016 has newly or more precisely defined more than 30 terms and provides standards for the practice, quality control, interpretation, and reporting of urodynamics; cystometry and pressure-flow analysis. Furthermore, the working group has included recommendations for pre-testing information and for patient information and preparation. On the basis of earlier ICS standardisations and updating according to available evidence, the practice of uroflowmetry, cystometry, and pressure-flow studies are further detailed.

Conclusion: ICS-GUP2016 updates and adds on to ICS-GUP2002 to improve urodynamic testing and reporting both for individual care and scientific purposes.

KEYWORDS

clinical practice standard and quality, cystometry, incontinence, lower urinary tract dysfunction, pressure-flow study, urodynamic, uroflowmetry

1 | INTRODUCTION

The ICS Standardisation Steering Committee has initiated a working group (WG) to update the International Continence Society's Good Urodynamic Practice 2002[1] (GUP2002) with the aim of including new evidence and information on urodynamic practice and urodynamic quality control and the revised ICS standard on urodynamic equipment.[2] Following the traditional ICS Standardisation style, while including the new method and structure,[3] changes of current standards are recommended and arguments provided for making these changes.

This report provides evidence-based specific recommendations for routine clinical urodynamic testing, and includes expert consensus where evidence is lacking.

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

Conclusions and recommendations are highlighted in the text and can be used for summary and express reading. We define "ICS standard" as: "Best practice, based on evidence, with the use of standard terms and standard techniques, evaluated and reported clinically or scientifically, in a complete and validated manner." In individual cases and/or in research settings, the decision may be made not to adhere to this standard, but any deviation from the standard should be specified.

The ICS standard is particularly intended for evaluation of the function of the lower urinary tract (LUT) of adult persons without relevant neurological abnormalities and with intact "normal" anatomy of the LUT. Many of the recommendations in this document may, however, also be considered relevant, generalizable, or applicable for patients with neurological abnormalities, for Video-urodynamics or for urodynamics in research settings and/or also for patients with neobladders, augmented bladders, or diversions. The recommendations may also be helpful for performing urodynamics in children.[4]

2 | DEFINITIONS OF TERMS FOR URODYNAMIC TESTS

2.1 | Introduction and evidence base

Over the years, a variety of terms have been developed for the group of diagnostic tests that evaluate LUT function. The WG has constructed a table with terms and has provided their frequencies of use, both in PubMed (searching in title and abstract) and in Google (Table S1). Uroflowmetry, Post Void Residual (PVR), Cystometry, Pressure-flow study, Electromyography (EMG), Urethral Pressure Profile, and Video urodynamics are the terms most frequently used in the scientific literature. The ICS Standardisation of Terminology of LUT Function (ST2002)[5] (re-) introduced or used many of these terms, and the AUA-SUFU has also provided definitions of some terms.[6]

2.2 | Conclusions

Many terms have been introduced in earlier standardizations, without providing a precise definition.

A significant variety of synonyms are used for urodynamic tests and studies in the scientific literature as well as in lay texts and we conclude that the use of currently existing terms is not yet without variation in scientific literature.

2.3 | Discussion

Variations in the application of terms may bias communication, in science and also in communication with patients. The following terms are not really new and many were introduced earlier, sometimes long ago.

2.4 | Recommendation

For the purpose of uniformity, particularly in research we recommend and define the following as ICS standard terms:

Urodynamics: The general term to describe all the measurements that assess the function and dysfunction of the LUT by any appropriate method. Urodynamics allows direct assessment of LUT function by the measurement of relevant physiological parameters. (GUP2002 not changed).

Invasive urodynamics: Any test that is invasive, as it involves insertion of one or more catheters or any other transducers into the bladder and/or other body cavities, or insertion of probes or needles, for example for EMG measurement.

Non-invasive urodynamics: All urodynamics done without the insertion of catheters: for example, uroflowmetry, PVR, penile compression-release test, penile cuff, urethral connector, condom catheter, or sonography.

Ambulatory urodynamics: See the applicable ICS Standard.[7] (Not further discussed in this standard.)

ICS standard urodynamics protocol (NEW): a patient undergoing collection of a clinical history (should include (a) valid symptom and bother score(s) and medication list), relevant clinical examination, (3 days) bladder diary, representative uroflowmetry with post-void residual (PVR) and a complete ICS standard urodynamic test (see below), is referred to as having had the "ICS standard urodynamics protocol (ICS-SUP)."

ICS standard urodynamic test (NEW): Uroflowmetry and PVR plus transurethral cystometry and pressure-flow study (see below): all tests are performed in the patient's preferred or most usual position: comfortably seated and/or standing, if physically possible. The patient(s) is reported as having had an ICS standard urodynamic test (ICS-SUT).

ICS supplementary urodynamic tests: ICS-SUT may be supplemented with EMG, with imaging, with continuous urethral pressure(s) and/or with urethral pressure profile measurement. Cystometry may be done via a suprapubic catheter (specify supplements).

> **Recommendation**: The WG suggests all ICS-SUT-data as a minimum, and preferably complete ICS-SUP data should be specifically reported or summarized for the total cohort of patients in all research reports that contain (invasive) urodynamic results.
>
> Furthermore, the WG suggests referring to the current manuscript when research is reported as ". . . according to ICS Standard Good Urodynamic Practices (ICS-GUP2016)," when complete ICS-SUT or SUP data are reported.

Uroflowmetry: A test that produces the [Citation from GUP2002]: ". . . flow rate of the external urinary stream as

volume per unit time in millilitres per second (mL/s)." ICS uroflowmetry minimally reports the maximum flow rate and the volume voided and PVR. (GUP2002, not changed.) Other characteristics such as flow pattern (specify) and other parameters may be added but should be specified.

Post-void residual volume (PVR): (GUP 2002) The remaining intravesical fluid volume determined directly after completion of the voiding. The technique (eg, ultrasound or catheter) used to measure the volume should be specified.

Voided percentage (Void%): The numerical description of the voiding efficacy or efficiency which is the proportion of bladder content emptied. Calculation: [(volume voided/volume voided + PVR) × 100]. The WG suggests—solely for the purpose of standardization—that the term voided percentage with the abbreviation Void% is preferred. The relevance of the parameter is not discussed here.

Cystometry: Continuous fluid filling of the bladder via a transurethral (or other route, eg, suprapubic or mitrofanoff) catheter, at least with intravesical and abdominal pressure measurement and display of detrusor pressure, including cough (stress) testing. Cystometry ends with "permission to void" or with incontinence of the total bladder content. The fluid type and temperature, filling method and rate, catheter sizes, pressure recording technique, and patient position should all be specified.

Cysto-urethrometry: A cystometry is done with continuous urethral pressure measurement (specify technique).

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

Pelvic muscle electromyography (EMG): Pelvic muscle activity is judged with surface electrodes. ICS Standard: two skin electrodes on the perineal surface with an appropriate reference (=Pelvic muscle EMG). Other type, for example, vaginal probe: "vaginal EMG," "anal EMG" or "needle EMG," etc. and/or number and position of electrodes should be specified.

Urethral pressure profile: See ICS Standardisation of urethral pressure measurement.[8]

Urodynamics may be combined with imaging (specify). Invasive urodynamics performed with contrast fluid as the filling medium is Video urodynamics: X-ray (image amplifier) pictures or cine-loops are made at relevant moments. The contrast medium and report patient radiation dose should be specified. Video urodynamics is not further discussed in this document.

3 | PATIENT INFORMATION AND PREPARATION OF THE PATIENT FOR INVASIVE URODYNAMICS

3.1 | Introduction and evidence base

Although evidence indicates that urodynamics is generally well tolerated, studies have examined pain and embarrassment, using a variety of questionnaire methods. Younger patients have been identified as a group that may experience more pain and apprehension[9] associated with depression, anxiety and/or bladder pain syndrome.[10] Effectiveness of patient information leaflets requires comprehensibility and communicative effectiveness.[11–13] However, reports analysing existing information conclude that this is of poor quality. Studies to develop a detailed explanatory leaflet, which were used in a double-blind randomized controlled trial to conclude that "leaflet" or "no leaflet" intervention had a disappointing satisfaction outcome.[14,15] Poor understanding of the test has been associated with lack of satisfaction with care and with, for example, the perception that the investigation in itself is therapeutic.[16]

3.2 | Conclusions

Some evidence exists that information leaflets about urodynamic investigations are too difficult for patients to understand.

Young adults and patients with a bladder pain syndrome may have a relatively negative experience with urodynamic investigation.

Conflicting evidence exists about which precise information is helpful to give to patients before urodynamic testing to reduce distress.

3.3 | Discussion

Effective communication is an expectation in modern healthcare, so that patients become actively engaged in the test and their care delivery. The WG has discussed that a leaflet with a minimum set of items would facilitate informed decision making. The WG is convinced that good information before and during the test increases a patient's acceptance and confidence, and will reduce confusion.

3.4 | Recommendation

The WG suggests, although in the absence of good evidence, that an explanatory leaflet about urodynamic investigation with sufficient information, which uses clear, unambiguous wording will be appreciated by the majority of patients.

The WG suggests that a leaflet should include the items listed here below. The WG recommends that a leaflet that includes these items in an understandable manner for the

patient is referred to as the (NEW) ICS Standard Information Leaflet for Urodynamics.

Overview of the content of an **ICS Standard Information Leaflet** for Urodynamics.

- What is a urodynamic investigation
- That the tests involves insertion of catheters into the bladder and rectum, and relevant technical issues
- What is the usefulness of urodynamics, Why is the testing done
- What are the different steps of urodynamic investigation and how they are performed (e.g. uroflowmetry, cystometry, urethral pressure measurement and pressure-flow)
- How dignity, communication and comfort during the investigation are maximized (What you do or offer in this regard)
- The symptoms that may occur following the investigation, what they indicate and how can they be handled or prevented, e.g. the fact that mild discomfort, frequency, dysuria and haematuria may be experienced, and a urinary tract infection may occasionally develop*
- Additional information including length of the investigation, sterility of relevant parts of equipment, lack of 'injections'
- That the test is done interactively and that communication with the patient is a necessary part of the test.
- What the patient should do before the test (e.g. arrive if possible with a full bladder for uroflow, and also with an empty bowel if possible).
- Whether the patient should continue medication before the test, or whether there are specific medications that the patient should not take in (a defined period) before the test.
  Note: This should be individualized, e.g. with a tick box or a written instruction of the requester.
- What the patient should do after the test
  - e.g.: Immediately drink one portion of ½ - 1L extra fluid to ensure prompt voiding again, in order to relieve urethral irritation rapidly.
  - All usual activities are permitted after the test.
  - Symptoms and signs of urinary tract infection and what steps to take if these arise.

** Consider (also depending on local situation and regulations) to list adverse events (and incidence) that a reasonable patient might be expected to be informed as a standard.*

4 | URODYNAMIC PRACTICE PROTOCOLS

4.1 | Introduction and evidence base

In an area where a minimum standard for urodynamic testing workload exists,[17] it was concluded on the basis of a postal survey that training had insufficient effect, and that practice significantly varied.[18] When 100 consecutive graphs from all men who underwent cystometry in one center were reviewed, "significant defects [in the pressures] were not uncommon"; furthermore, ±10% of the transurethral catheters was reported to have been "falling out during voiding."[19] Disappointingly, although willingness to change practice was observed, actual changes did not occur despite the distribution of a standard protocol for some of the elements of urodynamic testing.[20]

4.2 | Conclusions

Published evidence to support implementation of practice standards is scarce and the conclusion on the basis of simple implementation strategies toward the achievability of practice improvement is not very encouraging.

4.3 | Discussion

Implementation of standardized practice is a complex process that requires changing routine habits and beliefs while keeping an eye on context, for example, acceptability, adoption, appropriateness, feasibility, fidelity, and costs.[21] Furthermore, the quality of the practice guidelines or standards for implementation is of importance.[22] Simple dissemination is not usually very effective and, as an example, for example, "blended" or "continuous quality improvement," strategies may be required.[23]

4.4 | Recommendations

The WG recommends that departments develop urodynamic practice protocols on the basis of the ICS-GUP standards and facilitate specific training in, and evaluation of, urodynamic practice.

We recommend that centers should—ideally coordinated and together on a nationwide level—decide on individual accreditation and recertification (eg, required minimum number of tests) as well as the level of authority and autonomy to perform urodynamic tests.

5 | CLINICAL PRACTICE PRE-TESTING INFORMATION

5.1 | Introduction and evidence base

All guidelines on urinary incontinence recommend a clinical history, and validated symptom and/or bother scores are recommended in the majority of these.[24–28] Urinalysis and physical examination as the first step in the evaluation of a patient with urinary incontinence are considered routine. The GUP2002 has in this regard mentioned non-invasive urodynamics, frequency/voiding chart (FVC), or bladder diary (BD) uroflowmetry and PVR) for all patients with LUT symptoms (LUTS). FVC and BD are mentioned in ST2002 and defined after that publication.[29] The test should be requested with the goal of answering a specific question (GUP2002). In order to formulate this question prior to urodynamics, as mentioned here above, a complete history, a list of medications taken must available as well as the results of the physical exam. Observation of the patient's gait, evaluation of sacral sensation and reflexes and identification of other neuro-urological findings are important. An abdominal exam and evaluation of the extremities for oedema are also helpful. In women, a systematic pelvic exam should include evaluation for prolapse,[29] vaginal wall masses, atrophy, pelvic muscle quality, and the ability to voluntarily contract them (as is standardized[30]), urinary leakage with strain, and any other details. In men, genital exam and a digital rectal prostate examination with an estimation of size is necessary. Prostate pain or abnormalities and degree of anal tone should be noted.

A (3-day) FVC or BD provides information that may obviate cystometry (eg, when excessive fluid intake is recognized) or may help to ensure and evaluate whether the cystometry, especially cystometric capacity, is representative of the patient's typical situation ("typical voided volumes";

from GUP2002). Non-invasive urodynamic testing, that is, uroflowmetry plus PVR in men and women, should precede invasive urodynamics. This information gathering process serves as the foundation for determining treatment as well as formulating questions that can be answered with (invasive) urodynamics. A urinalysis to screen for infection or haematuria should be available.

When planning urodynamic tests, the physician should specifically instruct the patient whether or not to change any conservative measures or change or take medication before or after the test according to ((local) standards and/or guidelines and) the individual situation of the patient.

5.2 | Conclusion

We conclude that clinical practice guidelines and expert "first principles" agree that prior to invasive urodynamics, history, physical examination, and urinalysis should be completed.

The usefulness of a FVC-BD to help anticipate cystometric capacity and appropriate fill rate has never been formally investigated. It is, however, the WG's conclusion that the FVC-BD voided volumes should be considered relevant to evaluate the representativeness of the cystometry, as was recommended in GUP2002.

5.3 | Recommendation

The WG advises that apart from the clinical information (history, medication, and clinical examination), the information from the (3-day) FVC or BD, and the uroflowmetry and PVR are utilized while performing invasive urodynamics.

The WG advises specific instructions to the patient with regard to the continuation of usual LUT management (eg, medication) if the patient is on treatment, and—persisting or new onset—symptoms require urodynamic analysis.

6 | PRACTICE OF UROFLOWMETRY

6.1 | Introduction and evidence base

GUP2002 presents uroflowmetry as a first line screening for most patients with LUTS and has provided practice recommendations. ICI consultations and clinical practice guidelines have reconfirmed uroflowmetry as the first line test.[5,7,28] Data quality control is relevant and important[31] and ICS has updated equipment performance requirements.[2] Apart from technical quality, the clinical situation is relevant. Some papers concerning position during voiding of men[32–39] or women[40–46] have been published since GUP2002, with a variety of primary outcomes related to different voiding positions (see Table S2). The results do not allow a very strong recommendation to be made, partly because test-retest variation inherently plays a role.[47] On the basis of these results and also on the basis of expert experience and plausibility, the WG concludes as follows.

6.2 | Conclusions

The WG concludes that it is useful, considering the representativeness of the test-result, for patients to be allowed to undergo uroflowmetry in their own preferred position.

6.3 | Discussion

Uroflowmetry and therefore flow rate, voided volume, and PVR are inherently sensitive to patient cooperation and emotion, and should only be clinically interpreted if the voiding has been representative with regard to both voided volume and the patient's opinion (eg, uroflowmetry may be abnormal if voiding was postponed for too long before the test). Furthermore, the interpretation can only be relevant if the test was done in a technically reliable manner, based on the examiner's opinion.

6.4 | Recommendations

The WG recommends permitting patients to undergo uroflowmetry in their preferred position and to strive for minimum physical discomfort and anxiety for the patient, as well as ensuring personal dignity.

The WG recommends checking if the voiding is representative, based on the patient's report and also on the association with the patient's FVC or BD volumes.

The position of the patient during voiding studies should be reported.

The WG recommends considering repetition of the uroflowmetry if the result has not been representative for the patient or if the result indicates abnormality. Particularly, if the voided volume and/or flow rate are unexpectedly low or the PVR is (much) larger than expected or explainable in both women and in men.

7 | PRACTICE OF CYSTOMETRY

7.1 | Introduction and evidence base

GUP2002 has specified catheters, pressures, pressures reference and quality checks for cystometry (and also for pressure-flow study). The WG has not found evidence that supports changes in these specifications. The WG has however studied and further specified six items in relation to the practice of filling cystometry. For each item we report

conclusions on the basis of the evidence and provide recommendations below.

7.2 | What determines filling rate?

The rate at which the bladder is filled during cystometry affects the results of the cystometry.[48,49] ST2002 has defined two different ranges of filling rate: maximum physiological filling rate as estimated by body weight in kilogram divided by four, thus typically in the range of 20–30 mL/min. The commonly applied filling rate in practice is often higher and, and this is (ST2002-) referred to as non-physiological filling rate. Neither ST2002 nor GUP2002 are however specific in the rate to select however GUP2002 has stated that the [citation] "typical voided volumes should be used for the control of subsequent invasive studies."

The actual volumes in the bladder during cystometry may differ from the recorded filling volumes due to diuresis, which can add significantly volume, for example, up to 25% to the cystometry volume.[50,51] Cystometric capacity is most reliably determined by calculation of voided volume (mL) plus PVR (mL) immediately after pressure-flow study (ST2002). The WG has been unable to find evidence that stopping or slowing down the filling rate, for example, when urgency is perceived and/or when detrusor overactivity (DO) is observed, is of any relevance. GUP2002 has suggested that the investigator should stop filling and observe the pressure, when reduced compliance is thought to be a consequence of filling rate above physiological filling rate.

7.2.1 | Conclusions

Current ST2002 cystometry (pump-) non-physiological filling rate is frequently applied, but a recommended more specific value or range is lacking.

Filling rate, especially when very fast or to volumes that are very much larger than the person's usual (maximum) volumes, may influence the results or the representativeness of the cystometry. Evidence that filling rate should be changed during the cystometry is lacking.

Diuresis, occurring during cystometry, adds volume that is not recorded by the urodynamics system with automated filling volume recording, but that is relevant for interpretation of the results.

Correction of filled volume for diuresis in retrospect should be considered with regard to reporting of filling sensation parameters, compliance and cystometric capacity (=pressure-flow voided volume plus PVR; and assuming the diuresis to be constant).

7.2.2 | Discussion

A balance between a filling rate that is slow enough to mimic a representative bladder filling and fast enough to complete the cystometry in an efficient fashion is a pragmatic approach to achieving a representative result. The WG considered, without specific evidence, but similar to practice in children's cystometry, that a filling rate in mL/min of roughly 10% of the largest voided volume (reported on a FVC or −BD; and PVR should be taken into account here) at a constant rate is a practical means to implement the above cited GUP2002 recommendation to use the person's typical voided volumes. This would, in a sensible manner, narrow the currently existing non-physiological fill rate-range and may also prevent too fast filling or filling to very unusual volumes. The WG suggests standardizing the filling in a fixed rate for the purpose of comparability in clinical cohort (management) research protocols where cystometric capacity, sensation, or compliance are outcome parameters.

The end of filling should relate to a "strong but not uncomfortable need to void." The largest voided volume on the FVC-BD may be an indicator for this volume, however with as yet unknown specificity, and PVR should be taken into account. "Strong desire to void" (SDV) should be indicated on the urodynamic graph. Permission to void is given when the pump is stopped (ST2002) and end of filling should be regarded as the beginning of the voiding phase. A specific marker on the urodynamics graph to indicate permission to void must be used however, if there is a delay between halting the pump and permission to void.

7.2.3 | Recommendations

The WG recommends that the person doing the cystometry knows the FVC-BD results as well as the results of uroflowmetry and PVR, prior to performing invasive urodynamics.

The WG suggests that the ICS maximum physiological filling rate is standard and suggests that "non physiological filling rate" is standardized on the basis of the individual patient's typical voided volumes (including estimation of the PVR volume) to prevent too fast filling and/or too large volumes.

The WG recommends use of the maximum physiological rate when comparability is relevant (eg, this may be required in prospective research cohorts, before and after intervention).

Parameters during cystometry depending on bladder volumes should be corrected for diuresis if relevant for clinical management or for scientific purposes.

The WG recommends that "permission to void" should always be marked on the urodynamic graph to indicate the beginning of the pressure-flow study. Stopping the fill pump is a more or less automatic marker, but when there is a delay between stopping the filling and this permission, a specific marker should be used to allow correct interpretation of the graphs after the test.

7.3 | How is the patient instructed to report sensations?

Prior to filling cystometry, patients are typically informed (written and verbal) that they will be asked to report the sensations they experience during the test. The ST2002

recommends that three sensation parameters be recorded during cystometry: first sensation of filling (FSF), first desire to void (FDV) and SDV. In addition, the patient may report sensation(s) that are considered to represent "urgency" (ST2002) which can be marked specifically. These sensory parameters have been confirmed as applicable, consistent, and reproducible in healthy persons and in patients with overactive bladder (OAB) syndrome.[52–54,57,58] There is, however, conflicting data regarding the reliability and/or representativeness of bladder sensation reporting during cystometry.[55–57,59,60] The use of a visual analogue scale (VAS) to grade the level of sensation has been shown to correlate well with some of the standard sensation parameters.[61] Similarly, a keypad, allowing patients to indicate differing levels of sensation, had a good and reproducible association with filling volume.[62]

7.3.1 | Conclusions

The ST2002 expert-based recommendation for the assessment of sensations during cystometry is reasonable and applicable as is demonstrated in various study reports.

7.3.2 | Discussion

The WG has decided not to change the ICS standard in favor of the use of VAS. However, despite introduction of standard terms in 2002, few studies published have reported cystometry filling sensations and the WG feels the need to reintroduce these and to add practice recommendations. It should be noted that the WG has not evaluated the relevance of the filling sensation parameters.

FSF should, at the beginning of the cystometry, be separated from the (urethral) sensations caused by the catheterization. The explanation to the patient may be that FSF is "Tell me the moment when you perceive that your bladder is not empty anymore"; FDV is (if little or no chronic PVR exists) usually roughly associated with FVC-BD "typical voided" volumes and can be asked as "Tell me when you have the sensation that normally tells you to go to the toilet, without any hurry, at the next convenient moment." SDV is "... the moment that you, without any pain or any fear of losing urine, will not postpone the voiding; you will visit the nearest restroom also, for example, while shopping." SDV may however occur suddenly and include the fear of leaking (or actual urine loss) in specific patients and patients should report this also. Correlating the results of cystometry volume and sensations with FVC-BD may provide background information regarding day-to-day sensory findings and bladder volumes and may also limit the risk of overfilling.

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

7.3.3 | Recommendations

The WG recommends marking FSF, FDV, and SDV, during cystometry as recommended by ST2002, on the basis of explicit verbal instructions and communication before and during the test specified in this GUP, and reporting the results.

7.4 | Fluid-filled external transducers and catheter system

Current ICS standard cystometry and pressure-flow study requires fluid-filled catheters with external pressure transducers to be leveled at the height of the upper edge of symphysis pubis. (GUP2002, ST2002). The urodynamic pressure is therefore the excess pressure above atmospheric pressure at the hydrostatic level of the upper edge of the symphysis pubis. Some studies that have compared fluid-filled catheters with microtip sensor catheters or air-filled catheters have shown that the results of the cystometry using these alternative systems are not interchangeable with the current ICS standard.[63–65]

7.4.1 | Conclusions

ICS standard urodynamic intravesical pressure (p_{ves}), abdominal pressure (p_{abd}) or other urodynamic pressure is the excess pressure above atmosphere at the hydrostatic level of the upper edge of the symphysis pubis. This is valid for all pressures recorded with fluid-filled lines.

The WG concludes that comparisons of micro-tip catheter systems (multicenter group averages) or air-filled catheters in vitro or in vivo (pairwise averages of two measurements) with ICS standard fluid-filled systems demonstrated that both systems give different results. The reports of these studies have concluded that systems are not interchangeable.

7.4.2 | Discussion

Fluid-filled external pressure systems referenced to the symphysis pubis are fundamentally different from the micro-tip or air-filled catheter systems, as the latter record pressure without a clear reference level. The use of ICS standard urodynamic pressures allows pressure related data to be comparable between patients and centers. Systematically obtained clinical evidence for the clinical reliability of micro-tip or air-filled catheter systems is scarce. Every urodynamic laboratory should be familiar with the potential artefacts of the specific system used for pressure measurement, and take the possibility of system- differences of up to 10 cm H_2O into account.[66] The WG considers that the availability of alternative systems has consequences for multi-center studies. Also the WG has considered generalizability of pressure values published in studies using

other than fluid-filled external pressure systems is undecided.

ICS guidelines on equipment performance provide minimum system requirements for pressure responses and calibration.[2,66] Centers that utilize other pressure systems should provide reference values for their data.

7.4.3 | Recommendations

ICS standard cystometry is performed with a fluid-filled system with external transducers at the reference level of the upper edge of the symphysis pubis.

Urodynamic laboratories should ensure that the equipment, including the catheters and transducers, meet the requirements as explained in the ICS guideline on equipment performance.[2,66]

Urodynamic laboratories should check the performance of their system at regular intervals and calibrate according to manufacturer recommendation, and as advised in the ICS guideline on equipment performance.[66]

7.5 | Transurethral catheter

ICS standard invasive urodynamics is done with the thinnest possible (6–7F) transurethral double or triple lumen catheter or a suprapubic catheter on the basis of ST2002 and GUP2002.

7.5.1 | Discussion

The ICS recommendation, reiterated here above, is based on expert opinion and consensus. GUP2002 notes that the use of two separate catheters is "less convenient." However, many studies since 2002 report the use of separate filling and pressure catheters and the removal of the filling catheter for stress provocation and/or for the pressure-flow study. Reported practice includes the range from 5 to 8F for the pressure recording catheter and usually ±10F for the filling catheter. The WG has no arguments for discarding the use of double catheter systems at present but has again (after GUP2002) discussed the need to re-catheterize if the test needs to be repeated and also the necessity to interfere with the patient at the moment of SDV, just before the voiding. However, the excess cost of the double or triple lumen catheter is a disadvantage. No head to head comparisons have been performed and no new evidence has been published on the spectrum of advantages and disadvantages of two catheter technique versus the recommendations in GUP2002.

Publications applying results of invasive urodynamics sometimes report a high rate of expelled catheters and it is the WG's opinion that advice on catheter fixation, applicable for both intravesical (shown here for double lumen) and rectal catheters, will reduce that problem:

Men (left picture): Catheter is taped in the length of the penis over the catheter, without obstructing the meatus.

Women (right picture): Catheter is taped to the inner side of the labia or (similar in men and women) adjacent to the anus.

7.5.2 | Recommendation

ICS standard invasive urodynamics is done with the thinnest possible double lumen catheter. However, on the basis of the lack of evidence for inferiority of two catheter techniques, this alternative is considered acceptable.

The WG recommends finding evidence with specific studies to direct practice standardization and harmonization for the catheters used for invasive urodynamics.

The WG recommends fixation of the catheters as adjacent as possible to the anus and the urethral meatus with tape, without blocking the urinary meatus.

7.6 | Abdominal pressure catheter placement: rectal versus vaginal

Flaccid filled balloon which may be punctured or slowly perfused open end catheters in the rectal ampulla are used to measure abdominal ("perivesical") pressure (GUP2002). The WG has discussed that "slowly perfused open end" should not be used because rectal filling may cause a sensation of need to defecate and may influence the result of urodynamics, though there is no research evidence on this topic.

In a prospective, randomized trial comparing open (without balloon) vaginal versus open rectal abdominal pressure 6F catheters in women undergoing external sensor, fluid fill cystometry, the authors noted no differences in discomfort or patient acceptability, however it was reported that women declined randomization on the basis of a preference for a vaginal catheter. Set-up time, catheter events affecting signal quality (including during provocation), or alteration in patients with vaginal prolapse were also not different. The report states that despite quality control measures (catheter repositioning and flushing of air bubbles, checking signal quality during and at end of study) only 13% of graphs all had optimum quality and a significant number of catheters was lost during the tests.[67]

7.6.1 | Conclusions

Although limited evidence suggests that women may prefer vaginal reference catheter placement, the WG concludes that this is insufficient to demonstrate that this is a reliable alternative to rectal catheterization.

7.6.2 | Discussion

After bowel resection with anal closure, the stoma may need to be considered as the route to measure abdominal pressure, especially in men. There is no specific evidence, but the position of the catheter-tip is usually above the bladder in a stoma, and bowel activity may much more likely cause artefacts in those cases, hampering measurement of absolute abdominal pressures and detrusor subtraction pressure, and therefore, the interpretation.

The WG considered that full (pre) filling or overfilling of rectal catheters with a balloon, as widely used, is a significant source of abdominal pressure measurement error. The catheter and balloon should be filled with water in a way that all air is replaced and without causing any excess pressure inside the balloon. Rectal balloon catheters should not be re-filled after insertion and therefore should be punctured to prevent over-filling and measurement error.

7.6.3 | Recommendations

Rectal placement of a fully fluid-filled open, or punctured balloon catheter, to measure abdominal pressure should be considered the ICS standard.

The WG recommends that vaginal or stoma placement of the abdominal pressure catheter is used alternatively only if rectal catheter placement is impossible.

7.7 | Patient positioning for cystometry and pressure-flow

It was noted on the basis of a literature review that DO was detected with a consistently higher rate in the upright position compared to supine position. DO would have been missed in 76% of cases of cystometry was done in the supine position and 60% would have been missed if the study was done supine compared to seated. Having the patient stand after being filled increased the chance of detecting DO by 21%.[68] In a prospective study, urodynamic stress incontinence was detected in 55% if the women were sitting but only 2% if supine, while DO was detected in 55% when seated but only in 9% when supine.[69] Combined diagnosis (DO plus USI) was observed seated in 18%, and zero when supine. Volumes at the time of reporting—ICS-standard—filling sensations and cystometric capacity were lower for seated cystometry.[2] Position during cystometry may also be relevant for the need to change the position for the optimal pressure-flow study (see below).

7.7.1 | Conclusions

The detection of DO, the detection of urodynamic stress incontinence, and bladder volumes at reported bladder filling sensation are influenced by the position of the patient. Sitting or standing position appears to have a higher sensitivity for detecting these abnormalities.

7.7.2 | Discussion

The sitting or standing position is the most representative for daily life situations and is probably the least uncomfortable and/or embarrassing for the patient. Furthermore, in the sitting position the intra-rectal as well as the intravesical catheter are at similar levels in the pelvic cavity (and similar to the transducer) which makes reliable (better balanced) pressure and subtraction more likely. Seated or standing (men) cystometry also allows a smooth transition from cystometry to pressure-flow study when SDV is reached, causing little movement artefact.

7.7.3 | Recommendations

ICS standard cystometry is done in the vertical position (standing or normally seated) whenever physically possible.

A pressure-flow study is done comfortably seated (women, some men) or standing if that is preferred position (men).

7.8 | Reliability and need for repeat cystometry for confirmation

In a prospective study of invasive urodynamics in healthy, asymptomatic female volunteers, poor reproducibility of sensory volume markers (FSF and FDV) as well as Q_{max} and $p_{detQmax}$ between two cystometries done at the same session was reported.[70] Similarly, poor reproducibility of urodynamic results at short-term follow-up (1–5 months) was noted.[71] In another prospective study of immediate repeat cystometry in patients with neurogenic LUT dysfunction, the authors noted wide 95% limits of agreement for differences in same session test parameters (maximum cystometric capacity, compliance, storage $p_{det.max}$, DLPP, Q_{max}, voiding $p_{det.max}$, $p_{detQmax}$).[72] However, the study reported excellent reproducibility in the detection of DO. The authors suggested that one single urodynamic study may be inadequate to form the basis for clinical decisions in patients with spinal cord injury.[73]

In a later single-center study in women with symptoms and signs of urinary incontinence (without neurological abnormalities), the reproducibility of immediate repeat cystometry plus pressure-flow analysis was overall good to excellent, with intra-class correlations of around 0.75 and few differences in urodynamic diagnosis between the first and second run. Nevertheless, these authors suggested that repetition of urodynamic tests is justified to ensure diagnosis.

In elderly men, the immediate or longer interval test retest variation is less with regard to pressure-flow analysis. However, it is not reported whether differences in cystometry values have been observed.[74–78]

7.8.1 | Conclusions

Predominantly, single-center evidence suggests that immediate or longer term test- retest variation is sometimes large

for specific parameters (like sensation) but less with regard to pressure-flow variables, especially in elderly men.

There is no convincing evidence that the clinical diagnosis on the basis of the first cystometry is often changed on repetition of the test. There is no definite evidence that immediate repetition of an adequately performed urodynamic test "for confirmation" is required.

7.8.2 | Discussion

The WG considered that large test-retest variations may also reflect inadequately standardized methods of testing. Test retest data is scarce which was the reason to also include studies with patients with neurological abnormalities in the WG's summary of the evidence. Measurement errors are a significant source of test-retest variation, but are seldom reported. The WG considers it prudent to repeat a technically adequate test when observations are not explainable in relation to the patient's symptoms and signs, and especially when the urodynamic question is insufficiently answered and consequences for management are significant. Furthermore, the WG considers that some observations may be situational (eg, the inability to void during a test) and may not always be soluble.

7.8.3 | Recommendations

The WG does not recommend routine immediate repetition of invasive urodynamics "for confirmation" if the test was technically adequate, has been considered representative, and has answered the clinical question.

The WG recommends immediate repetition of the test when doubt exists as to whether the test has answered the clinical question.

The WG recommends repetition of a urodynamic test when technical errors and artefacts have been observed at immediate post-test analysis.

8 | PRACTICE OF PRESSURE-FLOW STUDIES AND AN UPDATE OF TERMS

8.1 | Introduction

An ICS subcommittee (ST1997) on standardization of terminology for pressure-flow studies revised and expanded diverse sections of the earlier ICS terminology.[79,80] ST1997 identified and defined five relevant parameters with the preferred abbreviations to depict pressure-flow studies.

For urodynamic practice: the "pressure-flow study" (as defined above) begins immediately after permission to void (ST2002) and ends when the detrusor pressure has returned to the baseline value and/or the flow rate to zero and/or the patient considers the micturition completed. Note that pressure-flow analysis is only validated for voluntarily initiated micturitions and not for incontinence.

The WG considered that the relevance of instruction, position and privacy for the patient while performing pressure-flow study is equal to uroflowmetry and we refer to both the paragraphs here above for the practice of uroflowmetry and/or cystometry for the practice of pressure-flow study.

8.2 | Discussion

There is an inevitable delay between the fluid stream leaving the bladder and hitting the flowmeter which should be taken into account when a pressure-flow study is analysed (ST1997; GUP2002).[2] The delay between urethral meatus and flowmeter should be reduced by placing the flowmeter as close to the meatus as possible for every voiding position. Reducing the meatus to flowmeter distance may also result in more relaxed voiding because the patient may experience less concern about spattering.

8.3 | Recommendation

The WG recommends, especially for the purpose of pressure-flow analysis, a shortest possible meatus-to-flowmeter distance, adjusted to the voiding position, but recommends correcting for delay between pressure and flow.

8.4 | Discussion and suggested terms

Presentation of pressure-flow studies should be with a plot of the flow (-delay corrected) rate (mL/s) on the X-axis and the (delay corrected) synchronous detrusor pressure (cm H_2O) on the Y-axis in addition to the time-based graphs (ST 1997).

ST1997 introduced "urethral function" and "urethral resistance (relation)" without precisely defining these as (new or standard) terms. The "(passive) urethral resistance relation" as a means of quantifying bladder outflow obstruction (in male patients with prostatic enlargement) was defined before ST1997.[81,82] New ICS terms are desirable to acknowledge the relevance of the anatomical structures adjacent to the anatomically defined urethra per se, to describe outflow conditions during micturition (with or without further specifying anatomy) and the WG suggests introducing a specific (ICS)standard to further detail terms and practice for pressure-flow study analysis.

The terms bladder outlet obstruction and bladder outflow obstruction are already frequently used. The WG introduces **(NEW) Bladder Outflow Obstruction** (BOO) ("outflow" to recognize what is measured) with the definition: a (specified) cut-off of bladder outflow resistance based on the pressure flow relation (ratio) that is considered clinically relevant (the WG does not define cut-off values

but advises that the term should be preferred for both genders and all ages).

ST1997 also stated that the urethral function during voiding can be overactive, without further definition or specification. There is a lack of terminology with regard to specific diagnosis of voiding dysfunction, also here the here above mentioned specific new ICS standard is needed.

The WG suggests already now: **(NEW) Normal voiding function**: flow rate (and pressure-rise) are within normal limits, begin more or less directly after permission to void and ends with an empty bladder.

Bladder outflow physical properties may vary during one course of voiding and the WG suggests that new terms are introduced when analysis methods and cut-off values or pattern descriptions are provided to describe (as introduced in ST1997) "overactive urethral function during voiding." We conclude that no commonly agreed parameter or pattern description exists to clinically quantify or qualify "(over-) active urethral function" (if) outflow properties vary during a voiding.

"Underactive detrusor" and "acontractile detrusor" are defined in ST1997 and ST2002 as different from "normal detrusor" during micturition. GUP 2002 has also introduced that contraction during micturition may vary, or may be variable. Within this context, the WG discussed that voiding may be influenced by mental state and, although evidence is lacking in the neuro–gyneco–urological literature, anxiety in the test situation for the patient may plausibly influence initiation of the voiding reflex[83–85] and consequently affect detrusor function. The WG suggests **(NEW) "Situational inability to void"** and **"Situational inability to void as usual"** when in the opinion of the person performing the test, in communication with the patient, the attempted voiding has been not representative.

The WG here introduces the term **"detrusor voiding contraction"** for any analysis of combined pressure and flow (± other variables) that qualifies or quantifies the actual observed voiding. Following on to this: **"detrusor contractility"** is now suggested for any method that aims to quantify "intrinsic" detrusor muscle properties (eg, potential-maximum-force or velocity) by any method. We refer to, for example, stop-flow or interrupted-voiding tests and mathematical (extrapolation) or graphical analysis methods of pressure, flow and/or other parameters, such as, for example, the bladder working function.

Acknowledging the GUP2002, we suggest that the terms **"unsustained contraction"** (when waxing and waning) or **"fading contraction"** may be used when analysis methods and cut-off values or pattern descriptions are provided. We also acknowledge that no parameters to clinically demarcate normal, stable, or sustained detrusor contraction are available as yet.

8.5 | Recommendations

The WG has suggested some terms with the aim of improving communication with regard to pressure-flow analysis. However, the WG strongly recommends an updated ICS standard for pressure-flow analysis to ensure optimal ICS standardization of quantitative analysis (and standardization of diagnosis) of bladder outflow function as well as of detrusor voiding contraction diagnosis and/or detrusor contractility analysis for all patient groups.

9 | TECHNICAL AND CLINICAL QUALITY CONTROL DURING INVASIVE URODYNAMICS

9.1 | Introduction and evidence base

Quality control and standardization are an important part of urodynamics. Without training and standardization of equipment, and adherence to quality control and standards of urodynamic practice has been shown to be difficult.[17] The consequence is a large inter-site variability.[18] One national board has argued that maintaining expertize requires performing at least 30 urodynamic tests a year per urodynamicist and 200 tests in a department.[19,20]

A number of recommendations for control during urodynamics has been provided in the GUP2002 and a number are renewed or added, in the recently published "ICS guidelines on urodynamic equipment performance."[2] Furthermore, an overview of common features errors and artefacts has been published.[66,86]

The WG has found no new evidence necessitating re-discussion of equipment requirements, labelling and scaling of traces in the graph and refers to earlier documents in this regard.[1,2,5,79]

Typical signal patterns, such as straining, rectal contractions, coughing and DO are important in quality control and everyone who performs or evaluates urodynamic tests should be able to recognize these during the test.[66,87,96–100] In diverse retrospective single and multicenter evaluations, it was demonstrated that the expert recognition and identification of specific patterns occurring in the urodynamic traces has required adaption or correction of the—initial—diagnoses.[19,87–100]

9.2 | Conclusions

Expert evidence confirms that prevention, recognition and management of errors and recognition of artefacts are important elements of urodynamic quality control. Systematic urodynamic quality management, including plausibility analysis, is relevant before, during and after the test as well as while reporting the results of the test.

9.3 | Discussion

The WG considers that regular calibration of pressure measurement systems should be documented in each urodynamic laboratory and that, in general, new technologies need to prove their usefulness as well as accuracy compared to existing standards before clinical application.

9.4 | Recommendations

The WG recommends that everyone performing or evaluating urodynamics should be able to recognize usual pressure patterns and be able to perform continuous quality control during the test.

The WG recommends that training and a process of continuous knowledge maintenance as the basis for performing urodynamic tests should be established.

Terms related to the cystometry observations and evaluation.

Adequate set-up of the system and continuous quality monitoring are mandatory and all patterns and features occurring during the test should be recognized. Typical patterns may lead to recognition of pathophysiology or explain the perceived dysfunction. However, when an error or an artefact is observed during the test,[59] the person performing the test should act accordingly and prevent continuation in case of an error. The WG explains here for clarity that artefacts are, like rectal activity, in analogy with, for example, scattering on ultrasound imaging, more or less unavoidable. Errors are usually preventable or correctable.

Recommended terms to describe most common features, artefacts, and errors during invasive urodynamics: A fluid-filled pressure measuring system shows patient movement and external manipulation of the catheter. This causes signals or signal patterns that should be recognized during the test and at (re-) evaluation of graphs. Prevention of fluid leaks and air bubbles in the pressure tubing system is needed (GUP2002). This already starts before beginning the test while setting up the equipment. However, the effects of fluid leaks and air in the system on the pressures should be recognized at the beginning of the test and during the test also and should be corrected (GUP2002). Furthermore, they should also be recognized and reported during post-test analysis, if recognition and correction during the procedure has failed, to prevent mis-diagnosis.[66]

Urodynamic laboratories should apply standard practice and therefore be aware of all potential features, errors, and artefacts that may occur when measuring with the fluid-filled system. Whoever is performing tests should be able to recognize artefacts and prevent, recognize, and correct errors.

The WG has listed terms here that are considered to be of use during the test and its evaluation. Many of the terms have been used in earlier ICS standardization documents, but usually not with precise definitions. While many terms refer to preventable or correctable problems, these features including artefacts should nevertheless also be recognized during evaluation after the test. The WG has opted for terms that are as descriptive as possible and is convinced that better definition and description of these errors and artefacts is a tool to improve practice. The features, patterns or events terms mentioned here should also be used in the ICS standard urodynamics report (see below).

Initial resting pressure (NEW) is the p_{ves} and the p_{abd} pressure at the beginning of the cystometry. To prevent reading measurements from a kinked catheter in an empty bladder with the catheter holes blocked with (insertion) gel and/or pushed against the bladder surface, the WG recommends (GUP2002) gentle flushing of both catheter channels and/or filling 20–30 mL of the bladder, before the initial resting intravesical pressures are considered to be "established." Initial resting pressures should be within the physiological limits specified in previous manuscripts[96,97] and GUP2002.

Dead signal (NEW): A signal that is not showing small pressure fluctuations and is not adequately responding on straining, patient movements, or coughing is reported as a dead signal.

Previously (GUP2002): "In principle, a good p_{det} signal requires only that p_{ves} and p_{abd} show the same fine structure and quality of signals before filling, during filling, and after voiding."

Pressure drift (NEW): Continuous slow fall or rise in pressure, that is physiologically inexplicable.

Poor pressure transmission (NEW): Poor pressure transmission has occurred when the cough/effort pressure peak signals on p_{ves} and p_{abd} are not nearly equal.

Note: The WG does not define a new limit for not "nearly equal."

Expelled catheter (NEW): When a catheter is expelled, this is observed as a sudden drop in either p_{ves} or p_{abd}, usually below zero.

Earlier ICS description: "If a sudden drop or increase occurs in either p_{ves} or p_{abd} signal, the usual cause is movement, blockage, or disconnection of a catheter."

Expelled catheter is usually simply visible during the test and should provoke correction or repetition of the test. However, this term should also be used in post-test evaluation.

Catheter flush (NEW): When one of the catheters is flushed during the test a steep pressure rise is observed in that pressure line for one or two seconds followed by an immediate fall to resting pressure.

A catheter flush is not always necessary after a carefully performed set-up but is suggested in GUP2002.

Flushing of the catheter measuring channel may be considered necessary to wash away entrapped air, or the gel used during insertion or urethral mucus, from the measuring hole. The rectal catheter can only be flushed when an open or a punctured balloon catheter is used, and flushing should definitely not be done if a closed balloon is used (which is not ICS standard). A catheter flush should be marked accordingly, but flushes are normally unnecessary after the cystometry has continued after the first milliliter of filling.

Tube knock (NEW): Tube knock is observable as high frequency, short duration spikes visible in p_{ves}, p_{abd}, or both, and with spikes also usually visible in p_{det}.

Pump vibrations (NEW): Pump vibrations are visible as stable frequency oscillations of small but constant amplitude if the filling tube touches the pressure connecting tube (when a two catheter system is used) and the pump is switched on (switching of the pump can ascertain the situation).

Cough pressure peak (NEW): A cough pressure peak is recognizable during post-test evaluation as a phasic positive pressure change observed in p_{ves} and in p_{abd}.

Urodynamic stress test (NEW): The term urodynamic stress test is used for any physical effort of the person tested, to elevate abdominal pressure during cystometry, with the aim of examining (urodynamic) stress urinary incontinence.

ICS has defined urodynamic stress incontinence. Evidence is lacking (or conflicting) with regard to the preferred technique of urodynamic stress testing.

Note: The provocation method, the pressure measuring catheter(size) and method, the leak detection method as well as the absolute or relative (percentage of cystometric capacity) intravesical volume(s) while testing should be reported.

Leak point pressure (NEW): The leak point pressure (LPP) is the pressure (spontaneous or provoked) that has caused fluid to be expelled from the bladder at the moment that it is visible outside the urethra (may also be used for extra-urethral urine loss or stoma). This may refer to Abdominal, Cough or Valsalva LPP or Detrusor LPP.[5,6,28,29] Provocation and pressure recording site ("type of LPP") should be reported.

Diverse methods of LPP measurement have been published with a variety of combinations of provocation or pressure recording site/type and/or technique. Detrusor LPP and Valsalva LPP were defined in ST2002. However, no ICS (or commonly agreed) standard technique or protocol is available and a variety of terms and techniques are used (counts in PubMed (April 2015): Cough LPP: 21; Valsalva LPP: 226; Detrusor LPP: 64; Abdominal LPP: 98; Overactivity LPP: 0).

Cough associated detrusor overactivity (NEW): Cough associated DO is reported when the onset of the DO (with or without leakage) occurs immediately following the cough pressure peak.

No precise definition of cough associated detrusor activity is available. "Cough induced DO" is sometimes reported, although the precise (patho-)physiology and/or relevance remain speculative.

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

Note: A position change should be (is readily) noted during the test. Position change should be followed by readjustment of the external pressure sensors height to the standard so that the p_{ves} and p_{abd}-values are similar to the pressure values before the position change. A position change should not affect p_{det}. The position change pattern should be recognized during post-test evaluation of the cystometry.

Rectal contractions (NEW): Rectal contractions are temporary phasic increases in p_{abd} without synchronous change in p_{ves} resulting in negative deflections of p_{det}.

Previously (GUP-2002), "Rectal contractions are usually of low amplitude and may or may not be felt by the patient."

Dropped p_{abd} at void (NEW): A drop in p_{abd} during voiding is reported during the voiding time, p_{abd} decreases below the previous resting pressure (as a consequence of pelvic (and abdominal) muscle relaxation).

Note: The WG considers that this phenomenon will affect the pressure-flow analysis result, because it affects p_{det}. This observation should be differentiated from expelled catheter (that usually results in a much larger pressure drop).

Straining (NEW): Straining is observable as a temporary increase in both p_{ves} and p_{abd} pressure. Straining may be associated with (patient-active) position change (such as repositioning from leaning backwards to upright).

Note: A short abdominal strain peak may in retrospect be indistinguishable from a position change or a cough.

After-contraction (NEW): An after-contraction, is a continued or new detrusor pressure rise immediately after flow ended. It is important to note if this occurs with the complete emptying of the bladder.

Note: Cough checking of (intravesical) catheter position is always required after pressure-flow. To separate the after-contraction pattern from expelled catheter or catheter tip (with measuring hole) bending in the outlet when the bladder empties, this cough check is specifically important when a p_{ves} increment after voiding is observed.

Previously published description: a pressure increase after flow ceases at the end of micturition.

10 | THE URODYNAMIC GRAPHS AND THE URODYNAMICS REPORT

10.1 | Introduction and evidence base

A standard urodynamics protocol contains diverse elements. Results of clinical analysis and evaluations are documented when a (ICS Standard) Urodynamic Test is ordered. An ICS-SUT should be followed by a urodynamics report. The WG has not found evidence with regard to the standardization of such a report and no evidence regarding the elements that it should contain.

ICS (ST2002) has acknowledged urodynamic observations, but has not been specific in the definition of the type of observations relevant for diagnosis or for urodynamic conditions or the elements of urodynamic testing to be reported. Furthermore, the ST2002 has only mentioned (or standardized) a few of the possible observations, out of the many that can be the result of a complete ICS-SUT. Contemporary urodynamic equipment is able to provide lists test data and/or graphs, but here too no standard exists for these.

GUP2002 has standardized the layout of the urodynamic graph. The WG presents elements for qualitative reporting of the results of a ICS-SUT to ensure a descriptive and objective urodynamic diagnosis or establishment of a urodynamic condition.

10.2 | Discussion

While it will not be possible to cover all possibilities in one standard urodynamics report, the report may be customized, for example, relevant to the final diagnosis the urodynamic evidence has to be reported. However, when a test is done, all results and observations should be systematically reported. It is good clinical practice to integrate the urodynamics report with what is known about the patient from history and other examinations and tests.

On the basis of expert experience and consensus, the WG lists qualitative elements to be included in the urodynamics report of an ICS SUT without standardizing the numerical values.

10.3 | Recommendations

The WG recommends that, in addition to the GUP2002 standard urodynamic graph, a [cited form ST1997] "plot of detrusor pressure against flow rate during voiding" should be provided, according to the example in this ICS standard (ST1997).[79] For the "ICS standard urodynamic test," the WG recommends both (NEW) an "ICS standard urodynamic (time-based) graph" as well as (NEW) an "ICS standard pressure-flow plot" to be required elements in the ICS standard urodynamics report. The WG recommends development of an ICS standard urodynamics report template.

Furthermore, the WG recommends **reporting as follows**:

- Overall judgement of the *technical quality* and the *clinical reliability* of the test to represent the lower urinary tract function 'as usual', to be evaluated by the person who performed the tests.
- Uroflowmetry: *Voiding position*, urge (before the test) and *representativeness*, as reported by the patient.
- Introduction of catheters: *sensation;* (if occurring; pain), *muscular* (pelvic or adductor) *defence* and -perceptibly unusual- *obstruction(s) during insertion*.
- *Position(s)* during cystometry and pressure flow study.
- *Patient's ability to report* filling sensations and/ or urgency and/ or urine loss.
- Method of urodynamic stress test (if applicable).
- Pressure-flow: position and representativeness as reported by the patient.
- Accessory tests or measurements (if applicable -no further standard).
- Representativeness of the tests to reflect the 'usual LUT behaviour' as reported by the patient.
- Filling *sensation -diagnosis*.
- Cystometry (detrusor) pressure *pattern -diagnosis*.
- Pressure-flow *-diagnosis* (compared with uroflowmetry) includes:
  - Bladder *outflow* function, or obstruction (and the method for assessment)
  - Detrusor *contraction*, (and the method for assessment)

11 | CONCLUSION

The ICS Standardisation WG has updated the International Continence Society's Good Urodynamic Practice standard. This evidence-based ICS GUP2016 has defined terms and standards for the practice of urodynamics labs in general as well as for the (individual) practice of quality control during and after cystometry, and pressure-flow analysis. Furthermore, the WG has included recommendations for pretesting information and for patient information and preparation as well as recommendations for the urodynamics report. On the basis of earlier ICS standardisations and the available evidence, the practice of uroflowmetry, cystometry and pressure-flow study have been further detailed. The WG expresses the hope that implementation of this update of Good Urodynamic Practices will help to increase the quality of both individual clinical and research urodynamics.

12 | POTENTIAL CONFLICTS OF INTEREST

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