ICS 2018 PHILADELPHIA

W1: Basic Urodynamics - An Interactive Workshop

Workshop Chair: Andrew Gammie, United Kingdom

28 August 2018 09:00 - 12:00

Start	End	Topic	Speakers
09:00	09:05	Welcome and introduction	Andrew Gammie
09:05	09:15	Introduction to Urodynamics	Marcus Drake
09:15	09:30	Physics For The Urodynamicist	Andrew Gammie
09:30	10:30	Practical Session 1	Andrew Gammie Arturo Garcia-Mora Marcus Drake
10:30	11:00	Break	None
11:00	11:55	Practical Session 2	Andrew Gammie Arturo Garcia-Mora Marcus Drake
11:55	12:00	Questions	All

Aims of Workshop

This workshop aims to provide a practical course offering an interactive 'hands on' environment for practitioners to improve their skills in urodynamics. The use of recorded tests, access to equipment and small groups means that individual problems can be addressed. At the end of the workshop delegates should feel more confident in their practice.

Learning Objectives

- Learn how to set up urodynamic equipment.
- Learn how to run a test and troubleshoot according to good practice guidelines.
- Learn how to interpret urodynamic traces.

Learning Outcomes

- Carry out good quality, relevant urodynamic tests.
- Interpret urodynamic traces and apply results to appropriate patient management.

Target Audience

All practitioners (nurses, technicians and doctors) who are involved with the practical aspects of urodynamic investigations but who do not consider themselves to be experts.

Advanced/Basic

Basic

Conditions for Learning

A hands-on course with demonstrations of urodynamic equipment for practical discussions and demonstrations.
The delegates split into smaller groups for better meeting of individual needs.

Suggested Learning before Workshop Attendance

- ICS Good Urodynamic Practices.
- ICS urodynamics Elearning modules.

Suggested Reading

As above.

Other Supporting Documents, Teaching Tools, Patient Education etc

The workshop handouts will be documents formatted for ease of use in the clinical settings as aide-memoires or laminated sheets.

Introduction to Urodynamics
Prof Marcus Drake

Urodynamics is the umbrella term that covers investigations of lower urinary tract function. The term encompasses the following investigations: uroflowmetry, cystometry, standard and video, urethral pressure profilometry and ambulatory urodynamics. Standard cystometry is the commonest investigation for storage and voiding symptoms. Cystometry aims to reproduce a patient's symptoms and, by means of pressure measurements, provide a pathophysiological explanation for them.

Detrusor pressure is measured indirectly from vesical and abdominal pressures using the formula: pves – pabd = pdet . Abdominal pressure is measured to allow for the effect of increases in abdominal pressure, for example straining, on vesical pressure. Cystometry has two parts: filling and voiding. Both are normally performed as part of every investigation, with some exceptions, for example in patients unable to void, when filling cystometry alone would be carried out.

During cystometry there is a constant dialogue between the investigator and the patient so that any symptoms experienced during the test can be related to urodynamic findings. A full report is produced following a urodynamic investigation, which will normally include history, examination, urodynamic findings and suggestions concerning management. The report should state whether the patient's symptoms were reproduced and whether voiding was felt to be representative.

<u>Physics for the urodynamicist – an introduction</u>
Mr Andrew Gammie

<u>Pressure</u>

- Pressure can be measured as the height of a column of fluid. To describe pressure you simply need to specify what the fluid is and the height to which it goes. In urodynamics, the unit of pressure has been standardised as the *cmH_2O*.

- There are usually two pressure transducers associated with urodynamic equipment. One to measure intravesical pressure p_{ves} and one to measure abdominal pressure p_{abd}. The pressure exerted by the detrusor smooth muscle, p_{det}, is derived by the urodynamic equipment electronically subtracting p_{abd} from p_{ves}.

- Pressure transducers are not perfect instruments, therefore it is important to regularly check their calibration to ensure that accurate pressure measurements are always made.

- In most urodynamics, the transducers are attached to the urodynamic equipment and are remote from the patient. Pressures inside the patient are transmitted to the pressure transducers via water-filled pressure catheters. To ensure appropriate pressure measurements there must be:

    - No bubbles of air in the water connection between the patient and the transducer
    - No water leaks
    - A good connection between the transducer dome and the diaphragm of the transducer if using non-disposable transducers.

- Good urodynamics is carried out by making pressure measurements relative to atmospheric pressure. This is achieved in a water-filled system by placing the pressure transducers at the upper level of the symphysis pubis and by zeroing the equipment with the transducers closed off to the patient and open to the atmosphere.

- Pressure measurements may also be made in urodynamics by using air-charged catheters. With these, there is a practically weightless connection between the patient and the external transducer. This means that the system is simpler to use compared to the external water-filled devices because there is no need to flush air from the system nor is there any need to place anything at a reference level. However, it is still important to set the baseline pressure of these devices to atmospheric pressure, and these catheters are regarded as not yet fully validated.

<u>Flow</u>

- Urine flow rate in urodynamics is measured using a flowmeter which can either be mounted on a stand or in a commode. Urine is usually directed into the flow sensor by a funnel.

- One common type of flowmeter is the *load cell* or *gravimetric* flowmeter. A collection vessel is placed onto a weight sensor. Urine is directed into the collection vessel, via a funnel, and the weight sensor effectively monitors the increasing volume of fluid going into the vessel by measuring the increasing weight. The electronics of the flowmeter converts the changes of volume with time into urine flow rate *Q*. This is measured in the units of ml/s.

- Another common type of flowmeter is the rotating disc flowmeter. In this device, the collecting vessel has a motor inside it which rotates a disc at the mouth of the collection vessel at a constant speed. Urine is directed into the collection vessel and when it hits the disc, it slows it down. The electronics of the flowmeter puts more energy into the motor to bring the disc back up to its original speed. The amount of energy required is proportional to the urine flow rate *Q* provided the stream hits the disc fairly perpendicularly. The electronics of the flowmeter then calculates the volume voided.

- Both these flowmeters (and other less common ones) will measure flow rate accurately but it is important to examine the flow trace after it has been produced in order to correct for any artefacts that have occurred during voiding:
    - Knocking the flowmeter may produce 'spikes' on the trace which need to be ignored.
    - Moving the urinary stream relative to the flowmeter will produce artefactual fluctuations in the flow trace – *the wag factor*.
    - If making simultaneous measurements of pressure and flow, it may be necessary to correct for the time delay between the stream exiting the urethral meatus and it being recorded by the flow meter – *the lag factor*.

References for equipment and measurement issues

Air filled, including "air-charged," catheters in urodynamic studies: does the evidence justify their use? *Abrams P, Damaser MS, Niblett P, Rosier PF, Toozs-Hobson P, Hosker G, Kightley R, Gammie A. Neurourol Urodyn. 2016 Aug 31. doi: 10.1002/nau.23108.*

ICS teaching module: Artefacts in urodynamic pressure traces (basic module). *Gammie A, D'Ancona C, Kuo HC, Rosier PF. Neurourol Urodyn. 2015 Sep 15. doi: 10.1002/nau.22881.*

International Continence Society guidelines on urodynamic equipment performance. *Gammie A, Clarkson B, Constantinou C, Damaser M, Drinnan M, Geleijnse G, Griffiths D, Rosier P, Schäfer W, Van Mastrigt R; International Continence Society Urodynamic Equipment Working Group. Neurourol Urodyn. 2014 Apr;33(4):370-9. doi: 10.1002/nau.22546.*

Urodynamic features and artefacts. *Hogan S, Gammie A, Abrams P. Neurourol Urodyn. 2012 Sep;31(7):1104-17. doi: 10.1002/nau.22209.*

<u>Setting up equipment</u>

Mr Andrew Gammie

<u>External, Water-filled Non - Disposable Transducers:</u>

Disposables required:

- Syringes
- Three way taps
- Domes
- Manometer tubing/catheter to patient
- Sterile water or physiological saline

The lines to the patient need to be primed with sterile water to remove air bubbles, and thus create a continuous column of water between patient and transducer. This can be done before the start of the test. The use of two three-way taps either side of the dome makes it easier for troubleshooting (checking zero and flushing) before and during the test, without introducing unnecessary air into the system.

- <u>Prime System</u>: Flush sterile water through the length of the system, with both three way taps open before the domes are attached to the external transducers.

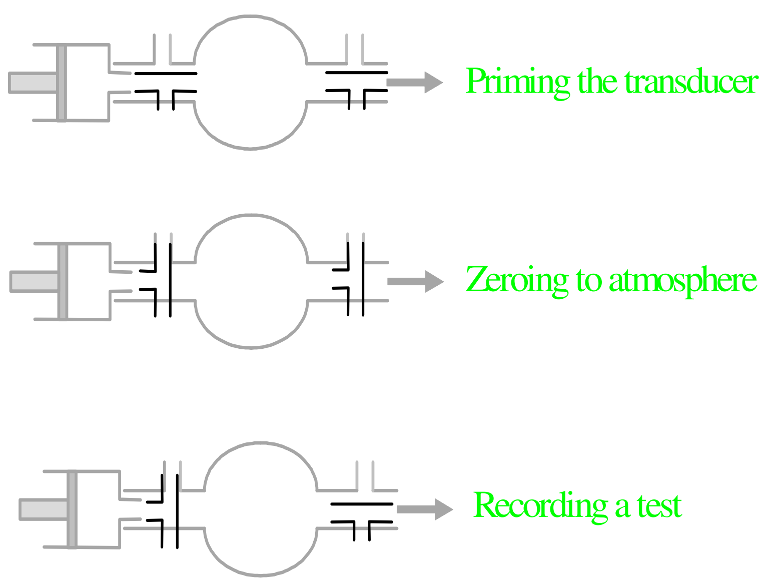
- <u>Zero to Atmosphere</u>: This is done by positioning the taps so that the transducer is open to the atmosphere and closed to the patient. The “zero” or “balance” option on the urodynamic equipment is then selected. Any subsequent pressures will now be read relative to atmospheric pressure.

- <u>Set reference height:</u> The pressure transducers need to be placed at the upper edge of the symphysis pubis to avoid artefactual pressure measurements due to the hydrostatic pressure effect. If the patient changes position during the test, the height of the transducers should be changed to the new level of the symphysis pubis.

- <u>For recording</u>: The tap to the syringe remains off. The other tap is open to the transducer and the patient, but off to atmosphere. A cough test can now be performed. If the height of one cough peak is less than 70% of the other, the line with the lower value should be flushed with water and the cough test repeated.

Three way tap settings for cystometry are illustrated below:

3 way tap settings for cystometry



<u>Air-charged catheters</u>

To measure pressure the air-charged catheters need to be connected to their individual pressure transducer units. This can be done with the catheters already inside the patient. The switches on the transducer units are turned to the “open” position and the “zero” or “balance” option on the urodynamic equipment is then selected. The switches on the transducer units are then moved to the “charge” position and the catheters will record pressures inside the patient relative to atmospheric pressure.

Checking Calibration:

A simple check of calibration for external pressure transducers (before connection to the patient) is to simply move the end of the filled pressure line through a known vertical distance (e.g. 20 cm) above the transducer dome and the pressure reading on the urodynamic equipment should change by the same amount (i.e. 20 cmH_2O). For air-charged or catheter tip transducers, calibration can be checked, if necessary, by submerging the catheter tip in a known depth of sterile water. Again, the pressure reading on the equipment should change by the value of that depth.

<u>Running a Test</u>
Dr Arturo Garcia Mora

Before test:
Identify the urodynamic question, i.e. what symptoms are we trying to reproduce?

History:	*Frequency Volume Chart (Bladder Diary):*

• Symptoms
  ◦ Duration
  ◦ Stress/urge/other incontinence
• Degree of leakage
  ◦ Pad usage
• Voiding difficulties
• Quality of life
• Past medical history
• Medication e.g. anticholinergics
• Allergies (latex)
• Parity (where relevant!)
	• Fluid intake – caffeine / alcohol
	• Voided volumes
	• Voiding frequency
	• Nocturia?
	• Post-void residual (if measured)
	
	Decide whether they actually need the test
	
	If so, what special considerations:
	Paediatric, Neurological, Stoma etc

➔ Use these to inform the urodynamic test, i.e. to make it individual to the patient

Also before the test:
- Check reference level & zero
- Check vesical and abdominal pressures are in normal range
- Initial cough to test both lines

If any problems delay starting the test until quality has been fully addressed

During Test Using annotation marks while running the test is helpful

Quality Control	Artefacts	Tailoring

Presence of physiological signals
 	
Regular coughs / deep exhalations
 	
Can check zero if needed
	Drift of baseline pressures
	
	Position changes (both fill and void)
	
	Rectal contractions
	
	Tube artefacts: leaks & knocks
	
	Pump artefacts
		Expected cystometric capacity
		Void volume expected
		Supine to fill overactive bladder
		Void position
		Filling speed changes
		Running water as provocation
		Stress testing if required
		  Cough while sitting/standing
		  Crouching
		  Exercises
		  VLPP

After test:
Writing a report:
- Were the symptoms reproduced?
- Was the voiding typical? Was there a residual?
- Leakage – was it on first cough? On an overactive wave? How much leaked?
- History, Examination, summary of FVC as above
- Description of test with filling speed and position as well as any problems encountered.
- Urodynamic diagnosis and management suggestions.

Troubleshooting
Prof Marcus Drake

Troubleshooting is a form of problem solving, defined by Wikipedia as "the systematic search for the source of a problem so that it can be solved". Troubleshooting is necessary if there are concerns about the quality of a urodynamic test while it is in progress. There is little that can be done to correct poor traces retrospectively; therefore quality control checks should be performed both before and during the investigation. Any problems with quality control should be addressed as soon as they are noted; the test can be paused while troubleshooting is performed.

The following information provides only a guide to common problems that are encountered during setting up and running a test, when quality control is not satisfactory. The unexpected can always happen, but problems can be solved if troubleshooting is performed in a systematic manner.

At the start of the test:

Pressure readings outside acceptable range:

According to the International Continence Society (ICS) standardisation report on 'Good urodynamic practices'[1], vesical and abdominal pressure measurements should be within the range of 5-20 cmH_2O if measured with the patient supine, 15-40 cmH_2O, if measured sitting and 30-50 cmH_2O if recorded standing.

***Troubleshooting in water filled systems*:**

If pressures are outside the acceptable range:

- If vesical and abdominal pressures are similar, but outside the acceptable range: check the height of the transducers. The ICS reference height is the upper edge of the symphysis pubis.
    - If the reference level is not correct, adjust accordingly.
- If only one pressure is outside the acceptable range:
    - Flush catheter
    - Check that zero has been set correctly on the relevant transducer
    - Consider resiting catheter

Unequal transmission of pressure between vesical and abdominal lines

- Flush lines
- Check whether there is any air in the dome over the external transducer
- Check taps are in the correct position
- Consider resiting catheter

During the test:

Fall in pressure of vesical or abdominal line during filling:

Neither the vesical or abdominal pressures should decline during filling. Vesical and abdominal pressures should be constantly monitored during the test and, if the pressures are noted to drop, then attempts should be made to correct this:

- Flush line – this may be enough to restore pressure
- If pressures continue to fall, check for leaks in a systematic manner
    - Check taps and all connections have been adequately tightened
    - Check lines – occasionally there may be a manufacturing fault

Unequal transmission of pressure between vesical and abdominal lines

See above

If lines stop recording and the pressures drop dramatically:

This is probably because one of the catheters has fallen out or become compressed

- Reposition or resite catheter
- If vesical catheter has fallen out before Q_{max}, consider refilling and repeating the pressure/flow

Troubleshooting with air charged catheters:

If any problems arise with quality control:

- Try ‘opening’ them, ‘recharging’ the catheters, ensuring that the patient coughs between charges to remove air from the catheter
- While ‘open’ the zero level can be checked
- If this fails – catheter will need to be changed

<u>Interpreting Urodynamic Traces</u>

Prof Marcus Drake

At the end of the workshop you should be able to:
1. Identify resting baseline pressures (p_{ves}, p_{abd}, p_{det}) and understand their significance
2. Recognise normal artefact, and discuss causes of artefact.
3. Determine where pressure measurements can be reliably taken from on a trace.
4. Explore a systematic approach to trace interpretation within your own scope of practice

Urodynamic trace interpretation is complex. To become competent in elements of interpretation the urodynamic practitioner will need to be trained, supervised, and assessed in the set-up and use of urodynamic equipment, demonstrate an understanding of how to assure quality control, and have the ability to critically analyze the results of the investigation with the urodynamic traces. All interpretation should be undertaken within the context of the patients' presenting urinary symptoms.

Understanding 'normal', or, in simple terms, what a normal urodynamic trace should look like during a urodynamic investigation, can provide a strong foundation for developing skills in interpretation. This is based on normal pattern recognition, and an understanding of how the traces are displayed – axes for scale and time, and the framework of normal values/urodynamic parameters. Developing and using a systematic approach to trace interpretation can be simple. Approaches to developing such a system are outlined below.

Guidelines to reviewing and interpreting urodynamic traces

The initial void (prior to catheterisation) is a very important baseline measurement as it provides flow rate, flow pattern, voided volume, residual urine measurements, and the voiding time. It is important to ask the patient whether their void is normal for them, and whether they feel their bladder has emptied completely. This helps to establish a baseline for comparing values from their voiding cystometry.

Consider the following characteristics when you are reviewing a trace:

1. What are the p_{abd}, p_{ves}, and p_{det} resting pressures at the beginning of filling cystometry? The vesical and abdominal pressures are 'real' and can differ between patients depending on their size and position during filling.
2. Describe what you see, what is your analysis of the filling Cystometry – consider artefacts (physical or physiological). Fine artefact can be caused by talking and breathing, and it is important to be able to identify these as normal artefacts during an investigation.
3. What are the p_{abd}, p_{ves}, and p_{det} resting pressures at the end of filling cystometry? Consider whether there are normal pressure changes during filling, is the bladder compliance normal? Normal detrusor function allows the bladder to fill with little or no change in pressure.
4. What information can you get from the voiding cystometry? Is it normal / abnormal – consider voiding pressures, voiding time, flow pattern, residual urine?
5. Quality control – is it good/bad?
   Consider the annotation of the trace – are all bladder events recorded (e.g., first desire, urgency, detrusor overactivity, leak), regular coughs/quality checks.
6. What are the overall findings – do they correlate with patients symptoms?

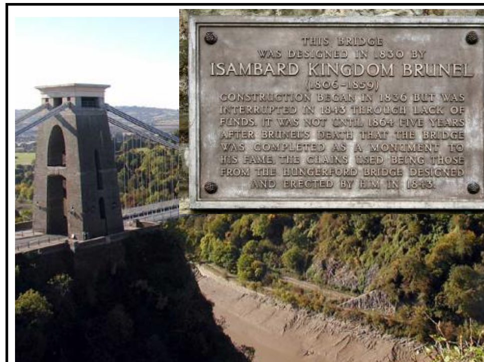
References:

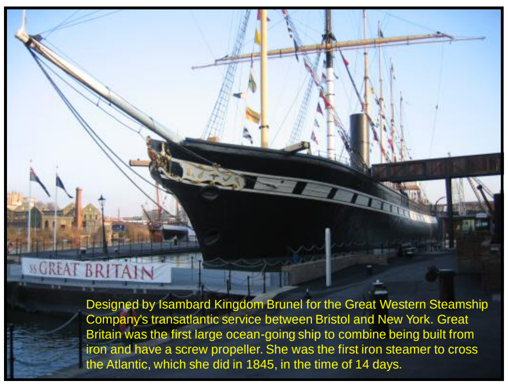
The standardisation of terminology of lower urinary tract function: Report from the standardisation sub-committee of the ICS. *Abrams P, Cardozo L, Fall M, Griffiths D et al. Neurourol Urodyn. 2002. 21: 167-178.*
Good urodynamic practices: Uroflowmetry, filling cystometry, and pressure-flow studies. *Schäfer W, Abrams P, Liao L, Mattiasson A et al. Neurourol Urodyn. 2002. 21: 261-274.*

Andrew Gammie, Marcus Drake, Arturo Garcia Mora
Urodynamics Unit
www.bui.ac.uk

WELCOME TO BRISTOL IN PHILADELPHIA

Bristol Airport
Amazing journeys start here





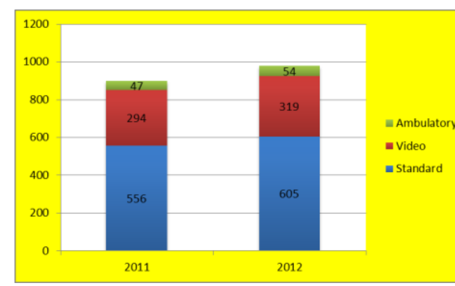
Designed by Isambard Kingdom Brunel for the Great Western Steamship Company's transatlantic service between Bristol and New York. Great Britain was the first large ocean-going ship to combine being built from iron and have a screw propeller. She was the first iron steamer to cross the Atlantic, which she did in 1845, in the time of 14 days.

Aims of course

For those who have some experience, but are not experts

– confidence with equipment
– quality control
– troubleshooting
– interpretation

Emphasis on practical aspects rather than management



~1000 invasive UDS tests per year

Education

- Certificate in UDS course – ICS recognised
  - 12 National in the UK per year
  - 2-3 International per year
    - Middle East & Far East

- Basic UDS course
- Advanced UDS course
- Consolidation UDS course

- Interactive UDS workshop at the ICS & EAU

Bristol Urological Institute

Plan for today

- 2 stations
- 60 minutes/station
- Rotate between stations at ring of bell
- Equipment provided by Laborie

Bristol Urological Institute

Program for session

- Introduction + Physics (30 min)
- Setting-up + Running a test (60 min)
- Break (30 min)
- Trouble-shooting + Interpretation of traces (55 min)
- Questions, answers and feedback (5 min)

Bristol Urological Institute

A bit of house-keeping!!

- Switch mobiles off or put on vibrating mode
- Emergency exits
- Fill out feedback form online

Bristol Urological Institute

Andrew Gammie

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Affiliations to disclose[†]:

Project grant: Andromeda, Digitimer, Laborie
Consultancy: Astellas, Ipsen

Funding for speaker to attend:

- [ ] Self-funded
- [x] Institution (non-industry) funded
- [ ] Sponsored by:

Basic Principles of Urodynamics
- in a nutshell

Andrew Gammie
Bristol Urological Institute, Southmead Hospital, Bristol, UK

With grateful acknowledgement of
Gordon Hosker
The Warrell Unit, St Mary's Hospital, Manchester. UK.

What is pressure?

Force per unit area

Unit of pressure

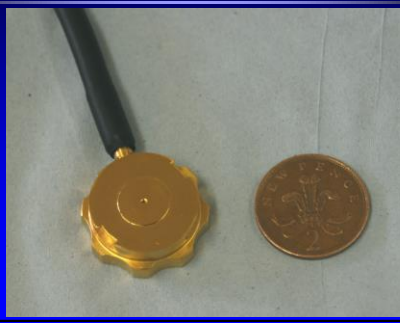
cm H_2O

1 cm H_2O = 0.74 mm Hg
100 cm H_2O = 74 mm Hg

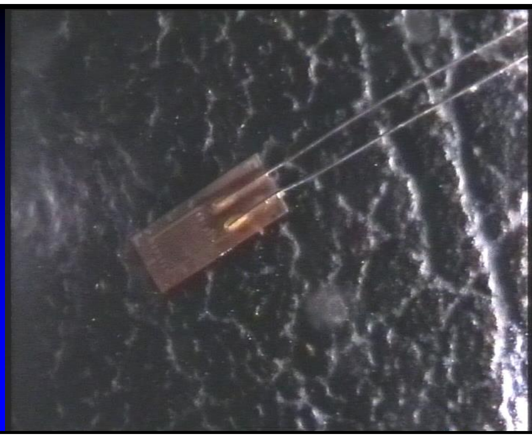
1 mm Hg = 1.36 cm H_2O

External pressure transducer with dome and taps

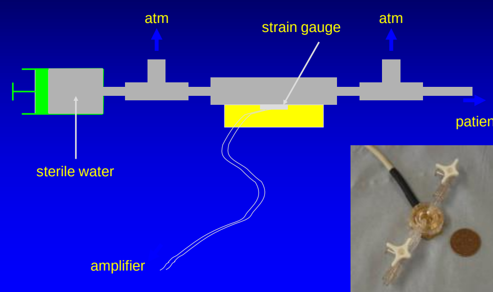
External pressure transducer without dome

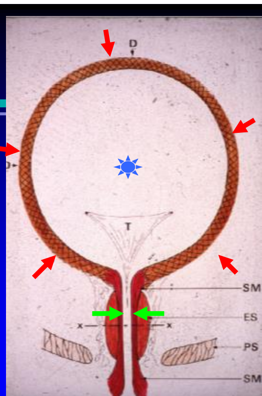


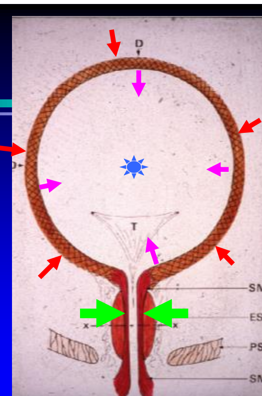
“No fluid” pressure measurement



The pressure transducer







Definition of detrusor pressure

$$p_{det} = p_{ves} - p_{abd}$$

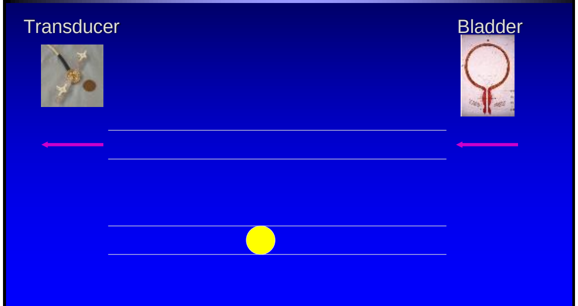
The effect of air in the system

Effect of air in the system

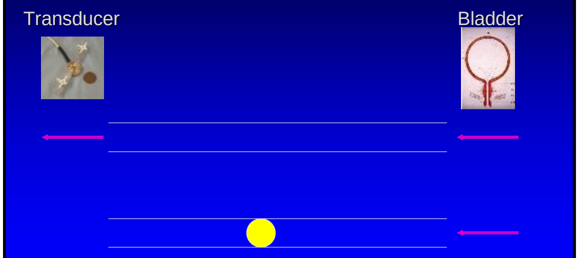
Effect of air in the system

Effect of air in the system

Effect of air in the system

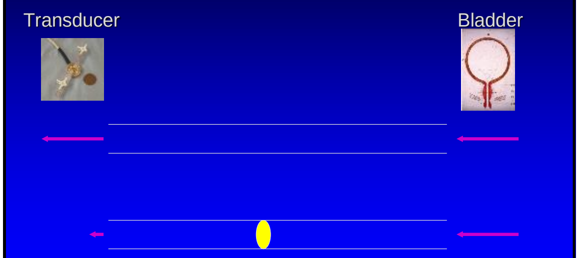


Effect of air in the system



Effect of air in the system

Effect of air in the system



External pressure transducer

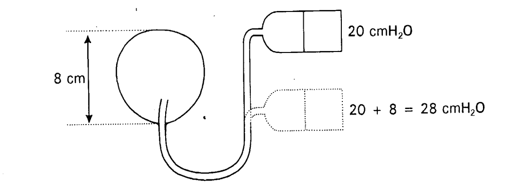
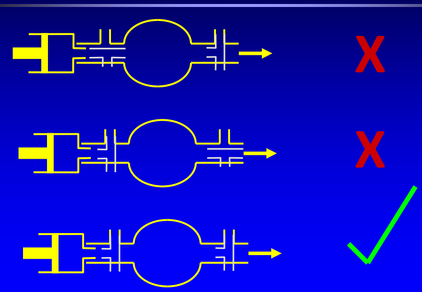


Fig. 3.31 External pressure transducers measure pressure according to their position (outside the body) in relation to the bladder: the lower position (dotted lines) also records the 8 cm pressure head of the bladder itself. The position of the catheter in the bladder does not change the pressure measurement.

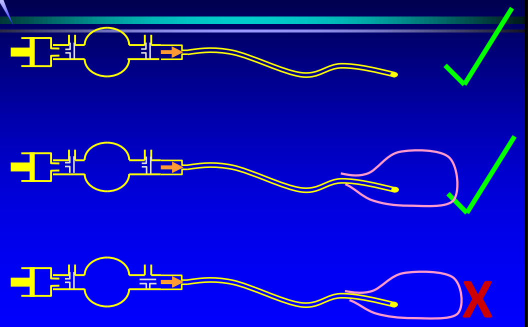
Where do you start from?

- We need to know the reference height of the transducers
  - Compare readings on the same patient
  - Check for realistic pressures
  - Equal reference for p_{abd}, p_{ves} relative to bladder
- The standard reference height is the upper edge of the symphysis pubis

Zeroing to atmosphere



Zeroing while connected



Summary

- Pressure
- Transducers
- P_{ves}, P_{abd}, P_{det}
- Air bubbles
- Reference height
- Zero

Affiliations to disclose[†]:

Allergan, Astellas, Ferring

† All financial ties (over the last year) that you may have with any business organisation with respect to the subjects mentioned during your presentation

Funding for speaker to attend:

- [ ] Self-funded
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- [ ] Sponsored by:

What is Urodynamics?

Marcus Drake
University of Bristol, UK

A step in a long pathway

Presentation
History and examination
Symptom score
Urinalysis
Ultrasound
Conservative therapy
Free flow rate
Filling cystometry and pressure flow study*
Therapy decision

Sometimes; videoUDS, urethral pressure profilometry, ambulatory urodynamics.

Cystometry aims to reproduce a patient's symptoms and, by means of pressure measurements, provide a pathophysiological explanation for them. **Listen to the patient before and during the test**

Both vesical pressure in the bladder (pves) and abdominal pressure (Pabd) are measured together, since the bladder is an abdominal organ. Pabd is generally estimated from rectal or vaginal recordings.

Detrusor pressure (Pdet) is that component of intravesical pressure that is created by forces in the bladder wall (passive and active), and it is calculated by subtracting Pabd from Pves.

Pdet is computed throughout filling cystometry and PFS, and is plotted alongside the two measured pressures (Pves and Pabd) and flow (Q)

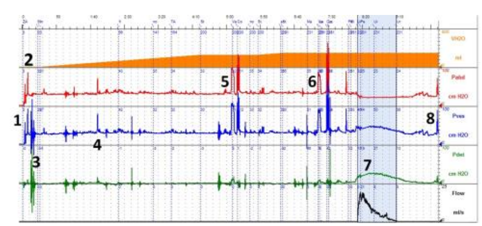
A test that is acceptable to undergo

One that provides meaningful information

- Knowing what clinical information is needed, and how to get it
- Setting up the equipment correctly
- Running the test appropriately

A full report is produced, covering history, examination, urodynamic findings and suggestions concerning management.

The report should state whether the patient's symptoms were reproduced and whether voiding was felt to be representative.



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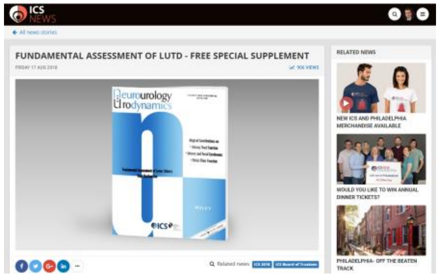

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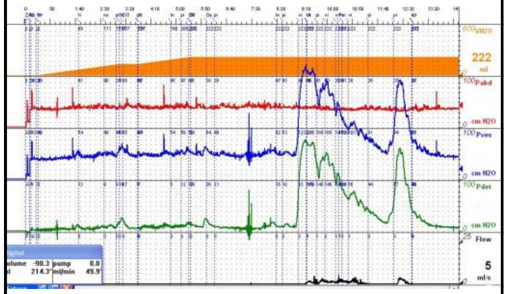
TABLE OF CONTENTS

Interpretation- objectives

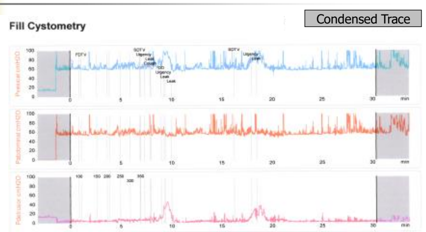
- Identify resting baseline pressures (Pves, Pabd, Pdet) and understand their significance
- Recognise artefact
- Determine where pressure measurements can be reliably taken from on a trace
- Explore a systematic approach to trace interpretation within your scope of practice



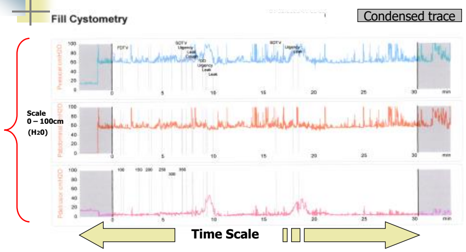
What is a normal trace?

- Resting pressures in the bladder (P_{ves}) = abdominal (P_{abd}) (+/- 10cm H_2O)
- Pressures should be within the following ranges, according to patient position:
  - Supine 5 – 20 cm H_2O
  - Sitting 15 – 40 cm H_2O
  - Standing 30 – 50 cm H_2O

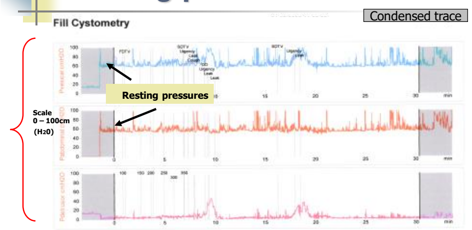
Trace Characteristics: What do you see?



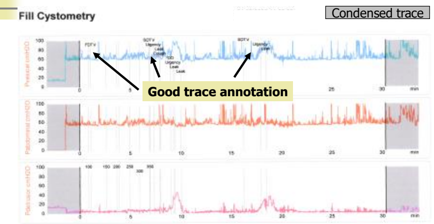
Trace Quality: Axes for scale and time



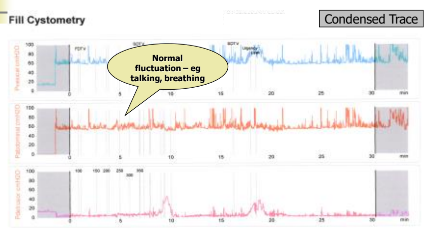
Trace Quality: Resting pressures



Trace Quality: Annotation!

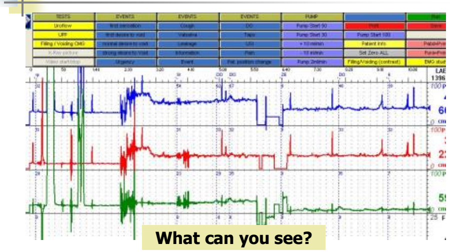


Trace Quality: Normal artefacts

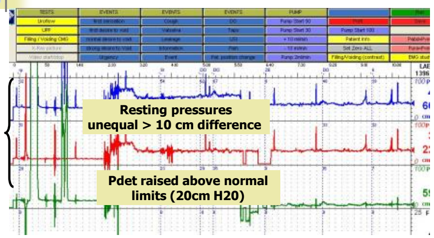


Trace Quality: Cough

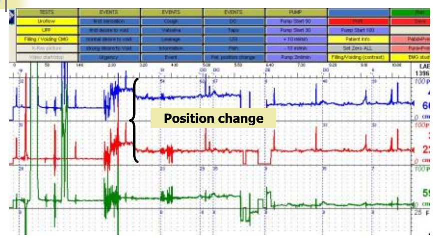
Artefacts



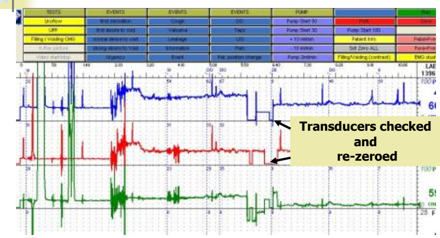
Artefacts



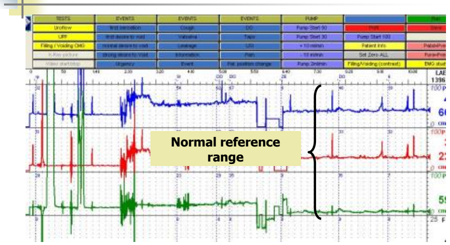
Artefacts



Artefacts



Artefacts



Quality Control

- Eyeball the trace – initial impressions count!
- Is the trace annotated – are urinary 'events' captured?
  e.g.,
  - First desire
  - Urgency – detrusor overactivity
  - Leakage – urodynamic stess incontinence/detrusor overactivity incontinence
  - Position change
- Regular coughs?
  - Consider alternatives to coughing, e.g., staining/valsalva
  - Quality of fine movement on trace/artefact

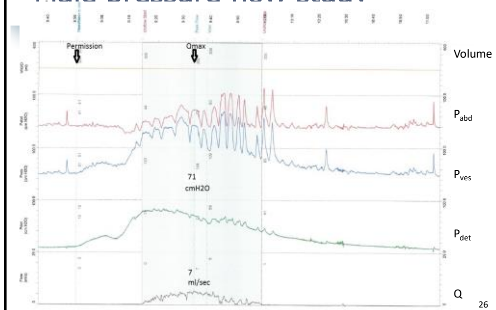
Quality control - Annotation

- Investigator may not be the trace interpreter/ treating doctor
- Good practice – an accurate record of events during the investigation

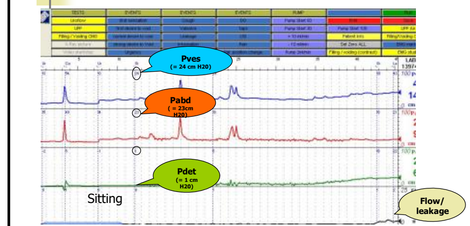
Describing what you see – the analysis

- What are the Pabd, Pves, Pdet at the beginning of the filling cystometry?
- What are the Pabd, Pves, Pdet at the end of the filling cystometry?
- What are the Pabd, Pves, Pdet during voiding cystometry?

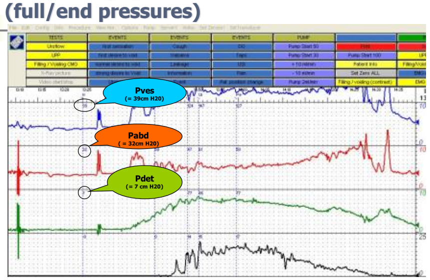
Male pressure flow study



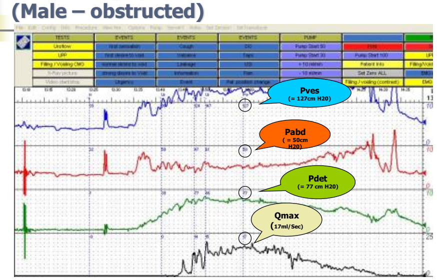
Resting pressures
(empty/start pressures)



Resting pressures
(full/end pressures)



Voiding pressures
(Male – obstructed)



Further Considerations for Good Interpretation

- Also consider:
  - Bladder compliance/Bladder volume
    (1cm for 40ml infused volume e.g., 400ml/10cm)
  - Voiding times
  - Flow pattern/shape
  - Residual volume

Developing a systematic approach…Key Points

- Consider normal trace characteristics when you are interpreting a trace
- Maintain good trace quality – annotation, cough
- Know 'normal' values/ranges, Use of nomograms is helpful to assess detrusor function during voiding
- Developing pattern recognition skills – only when you can identify normal can you begin to identify abnormal