Post Void Residual (PVR) and urinary retention
“How much PVR can we tolerate?”

Clinical Case Discussion

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‘No Disclosures’
Adapted from Chapter 6, PhD thesis R. Hohnen 2016

**Targeted systems/processes involved in bladder contractility:**
- Oxidative stress
- Nitric oxide
- Prostanoid system
- Melastin
- Calcium Channels
- Stem Cells

**Targeted systems/processes involved in urethral sensory signalling:**
- Cholinergic system
- Purinergic system
- Vanilloids
- Macrophage migration inhibitory factor (MIF)
- Cannabinoids

**Targeted systems/processes within the Central Nervous System:**
- Gamma-aminobutyric acid (GABA)
- Glycine
- Dopamine

**Parasympathetic innervation:**
- Pelvic nerve fibres

**Sympathetic innervation:**
- Hypogastric nerve fibres

**Somatic innervation:**
- Pudendal nerve fibres

**Pudendal nerve stimulation:**
- \( T_{11}-S_2 \)
- \( S_2-S_4 \)
Is PVR dangerous?

• Upper UT complications?
• Mortality?
• Morbidity (UTI. ......? )

• Complaints
  – Bothersome (voiding) LUTS
  – Recurrent UTIs
  – Urinary retention
• Quality of Life
• Health-Care Related costs
PVR in men
Residual Urinary Volume and Urinary Tract Infection—When are They Linked?

José Carlos I. Truzzi,* Flávio Mistreta R. Almeida, Eduardo Capati Nunes and Marcus V. Sadi
From the Division of Urology, UNISA Medical School, University of Sante Amaro, São Paulo, Brazil

**Purpose:** Large post-void residual urinary volume may be related to the development of urinary tract infection. However, the maximum post-void residual volume that predisposes patients to a higher risk of urinary tract infection is not known. In this prospective study we determined the cutoff value for post-void residual volume that places adult men at risk for acute urinary tract infection.

**Materials and Methods:** Data were obtained from 196 consecutive healthy adult men (median age 60 years) who underwent a prostate evaluation without symptoms of acute urinary tract infection. Right after spontaneous voiding, urine was obtained under normal aseptic conditions, and the post-void residual volume measured for each patient. The results were compared to the various post-void residual volume cutoff values.

**Results:** Overall 27% of the patients presented with a positive urine culture. The mean post-void residual volume was 257 ml (range 150 to 560) compared to 133 ml (range 10 to 340) for the group with negative results. The post-void residual volume of 180 ml was determined to have the best specificity and predictive value for bacterial growth at a post-void residual volume of 180 ml or greater was 87.0% and an area under the curve was 94.7%.

**Conclusions:** Clinically asymptomatic adult men with a post-void residual volume of 180 ml or greater had bacteriuria. Such cases require close medical attention since it may be necessary to introduce early intervention to improve the bladder emptying.

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**Fig. 3.** ROC curve of PVR showing best correlation with positive urine culture.
<table>
<thead>
<tr>
<th>LE</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>B</td>
</tr>
</tbody>
</table>

Measurement of post-void residual (PVR) in male LUTS should be a routine part of the assessment.
Case 1: male patient, 47 years

- **History:**
  - 2009 left Liechtenstein
  - Knee surgery
- **Medication:** omeprazol, statin

- Since a couple of weeks pain in the left groin region. In addition, frequency and urgency complaints. Nocturia 3-4x. Voiding phase: no change in stream quality, no hesitation or post-micturition dribbling.

- **Examinations**
  - Physical examination: normal testicular volume, no other abnormalities
  - Neurological examination: no sensory nor motor loss
  - DRE: benign 30cc
  - Urine sedimentation: clean
  - Micturition diary: DF 8x 200-330, NF 2x, vol 150-200 ml
  - Cystoscopy: normal PU, bladder mucosa and orthotopic ostia
Uroflowmetry: 200cc residual volume
To treat or not to treat?

- A: Treatment
- B: No treatment

Kaplan et al. J Urol 2007
Mochtar et al. J Urol 2006

Fig. 1. AUR incidence in men by age in English,\textsuperscript{20} Dutch\textsuperscript{17} and 2 American\textsuperscript{18,19} population studies

**Table 4.** Frequency distribution of patients with PVR less than 300 or 300 ml or more at baseline who were re-treated due to urinary retention with $\alpha_1$-blocker or watchful waiting within 5 years of followup

<table>
<thead>
<tr>
<th>Retention Status</th>
<th>$\alpha_1$-Blocker</th>
<th>Watchful Waiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVR Less Than 300 ml</td>
<td>PVR 300 ml or Greater</td>
<td>PVR Less Than 300 ml</td>
</tr>
<tr>
<td>No. yes (%)</td>
<td>5 (1.4)</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td>No. no</td>
<td>355</td>
<td>18</td>
</tr>
<tr>
<td>Totals</td>
<td>360</td>
<td>19</td>
</tr>
</tbody>
</table>
Case 2: male patient, 60 years

- **History**
  - Hypertension
  - Diabetes mellitus (insulin dependent)
  - 2000 transverse myelitis (cervical spine)
  - 2014 atrial fibrillation
  - 2014 CAG, CABG

- **Medication:** atorvastatin, bumetanid, metoprolol, pantoprazol, perindopril, novorapid, salbutamol
• Since myelitis in 2000 bladder complaints, worsened since CABG in 2014.
  – Spontaneous micturition, urinary incontinence for which pads are necessary
• Presentation at outpatient clinic with urinary retention and overflow incontinence

• **Examinations**
  – Urine sedimentation: clean
  – Cystoscopy: open prostatic urethra, normal bladder mucosa
  – DRE/Prostate ultrasound: benign, 24cc
  – Laboratory results: creatinin 132, GFR 48, PSA 3.8 (at time of urinary retention)
Uroflometry: Qmax 8ml/s, volume 125ml, residual volume 300cc. Second flow with 150cc residual
Which treatment?

- A: TURP
- B: CISC
- C: SNM

Plan:
- Start Clean Intermittent Self-Catheterisation
- (could be candidate for SNM → first ambulatory urodynamic study)
## PFS in men

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients</th>
<th>Age (mean, yr)</th>
<th>Clinical/pressure-flow</th>
<th>Criteria</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resnick 1989</td>
<td>17</td>
<td>89</td>
<td>Pressure-flow</td>
<td>Absence of BOO</td>
<td>41.2</td>
</tr>
<tr>
<td>Ameda 1999</td>
<td>193</td>
<td>69</td>
<td>Video-urodynamics</td>
<td>Piso&lt;60 or unsustained isovolumetric contraction</td>
<td>41.9</td>
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<tr>
<td>Abarbanel 2007</td>
<td>82</td>
<td>≥70</td>
<td>Pressure-flow</td>
<td>PdetQmax&lt;30 Qmax&lt;10</td>
<td>48</td>
</tr>
<tr>
<td>Kuo 2007</td>
<td>1407</td>
<td>45-96</td>
<td>Video-urodynamics</td>
<td>‘Relaxed sphincter EMG with open membranous urethra during voiding and low flow rate’</td>
<td>10.6</td>
</tr>
<tr>
<td>Jeong 2012</td>
<td>632</td>
<td>&gt;65</td>
<td>Pressure-flow</td>
<td>BCI&lt;100</td>
<td>40.2</td>
</tr>
<tr>
<td>Lee 1999</td>
<td>96</td>
<td>&gt;50</td>
<td>Pressure-flow</td>
<td>Qmax≤10 PdetQmax≤30</td>
<td>37</td>
</tr>
<tr>
<td>Fusco 2001</td>
<td>541</td>
<td>64</td>
<td>Video-urodynamics</td>
<td>PdetQmax≤30 Qmax≤12</td>
<td>10</td>
</tr>
<tr>
<td>Nitti 2002</td>
<td>85</td>
<td>18-45</td>
<td>Video-urodynamics</td>
<td>BOOI&lt;20 Qmax&lt;12</td>
<td>9</td>
</tr>
<tr>
<td>Wang 2003</td>
<td>90</td>
<td>18-50</td>
<td>Video-urodynamics</td>
<td>PdetQmax&lt;30 Qmax&lt;15</td>
<td>10</td>
</tr>
<tr>
<td>Kaplan 1996</td>
<td>137</td>
<td>18-50</td>
<td>Video-urodynamics</td>
<td>PdetQmax&lt;45 Qmax&lt;12</td>
<td>23</td>
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<tr>
<td>Karami 2011</td>
<td>456</td>
<td>18-40</td>
<td>Pressure-flow</td>
<td>ICS definition</td>
<td>12.9</td>
</tr>
<tr>
<td>Jamzadeh 2014</td>
<td>87</td>
<td>&lt;40</td>
<td>Video-urodynamics</td>
<td>PdetQmax&lt;30 Qmax&lt;12</td>
<td>11.9</td>
</tr>
<tr>
<td>Gammie 2015</td>
<td>507</td>
<td>63</td>
<td>Pressure flow</td>
<td>BCI&lt;100 BOOI&lt;20 BE&lt;90</td>
<td>25.0</td>
</tr>
</tbody>
</table>
PVR in women
### EAU guidelines on PVR in women (UI)

<table>
<thead>
<tr>
<th>Summary of evidence</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower urinary tract symptoms coexisting with UI are associated with a higher rate of PVR compared to asymptomatic subjects.</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>When measuring post void residual urine volume, use ultrasound.</td>
<td>A</td>
</tr>
<tr>
<td>Measure post-voiding residual in patients with urinary incontinence who have voiding symptoms.</td>
<td>B</td>
</tr>
<tr>
<td>Measure post-voiding residual when assessing patients with complicated urinary incontinence.</td>
<td>C</td>
</tr>
<tr>
<td>Post-voiding residual should be monitored in patients receiving treatments that may cause or worsen voiding dysfunction, including surgery for stress urinary incontinence.</td>
<td>A*</td>
</tr>
</tbody>
</table>

*Recommendation based on expert opinion.*
<table>
<thead>
<tr>
<th>Study</th>
<th>Group</th>
<th>N</th>
<th>Cut-off (ml)</th>
<th>% above the upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwyer 1994</td>
<td>Suggestive of VD</td>
<td>165</td>
<td>150</td>
<td>34%</td>
</tr>
<tr>
<td>Haylen 1999</td>
<td>LUTS</td>
<td>250</td>
<td>30</td>
<td>5 vs 9% (non- vs symptomatic)</td>
</tr>
<tr>
<td>Fitzgerald 2001</td>
<td>Urgency, frequency</td>
<td>336</td>
<td>100</td>
<td>5%</td>
</tr>
<tr>
<td>Constantini 2003</td>
<td>LUTS and/or incontinence</td>
<td>348</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Millerman 2004</td>
<td>OAB</td>
<td>201</td>
<td>100</td>
<td>19%</td>
</tr>
<tr>
<td>Lukakc 2007</td>
<td>Pelvic floor disorders</td>
<td>1399</td>
<td>100</td>
<td>11%</td>
</tr>
<tr>
<td>Gehrich 2007</td>
<td>Asymptomatic (mostly) postmenopausal women</td>
<td>96</td>
<td>50</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>5%</td>
</tr>
<tr>
<td>Haylen 2008</td>
<td>Pelvic floor dysfunction</td>
<td>1140</td>
<td>0-10</td>
<td>76%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11-30</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31-50</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>51-100</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;100</td>
<td>6%</td>
</tr>
<tr>
<td>Lowenstein 2008</td>
<td>LUTS</td>
<td>636</td>
<td>150</td>
<td>Low correlation with obstructive voiding symptoms</td>
</tr>
<tr>
<td>Tseng 2008</td>
<td>SUI + no previous pelvic surgery or prolapse</td>
<td>902</td>
<td>50</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>16%</td>
</tr>
<tr>
<td>Saaby et al 2012</td>
<td>Urogynaecologic complaints</td>
<td>396</td>
<td>100</td>
<td>T1 14%; T2-3 1-2%</td>
</tr>
<tr>
<td>Khayyami 2015</td>
<td>VD based on PF study</td>
<td>205</td>
<td>150</td>
<td>2/20 &gt;150 with voiding dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18/20 &lt;150 with voiding dysfunction</td>
</tr>
<tr>
<td>Park 2016</td>
<td>&gt;65 yrs + OAB</td>
<td>151</td>
<td>100</td>
<td>36%</td>
</tr>
<tr>
<td>Lo 2016</td>
<td>POP-Q III-IV and reconstruction</td>
<td>1370</td>
<td>&gt;200cc</td>
<td>OR 2.15 for post-op VD</td>
</tr>
</tbody>
</table>

TA vs TV vs catheterisation!
Case 1: woman, 42 years

- History:
  - Vaginal delivery 2x
  - Hypertension

- Medication: valsartan, thyrax

- Since last vaginal delivery (18 years ago), change in bladder filling sensation (only sensation when the bladder is full). Post micturition dribbling. No hesitation or feeling of residual volume. No recurrent UTIs.
  - No constipation

- Examinations
  - Urine sedimentation: clean
  - Micturition diary (3-day): DF 6-8x (volume 50-450cc) NF 1x (volume 150-400cc)
  - Cystoscopy: Orthotope ostia, normal bladder mucosa
  - VE: cystocele gr 2
Uroflowmetry: 188cc residual volume
To treat or not to treat?

• A: Treatment
• B: No treatment
• C: Additional diagnostic tests
<table>
<thead>
<tr>
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<th>Age (mean, yr)</th>
<th>Clinical/pressure-flow</th>
<th>Criteria</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resnick 1989</td>
<td>77</td>
<td>89</td>
<td>Pressure-flow</td>
<td>'Failure to empty in the absence of an increase in abdominal pressure.'</td>
<td>37.7</td>
</tr>
<tr>
<td>Resnick 1996</td>
<td>97</td>
<td>87</td>
<td>Pressure-flow</td>
<td>'Reproducible failure of the involuntary contraction to empty at least half of bladder contents in the absence of straining, urethral obstruction, and detrusor-sphincter dyssynergia'</td>
<td>45</td>
</tr>
<tr>
<td>Choi 2013</td>
<td>102</td>
<td>61</td>
<td>Pressure-flow</td>
<td>Qmax&lt;15 PdetQmax&lt;20</td>
<td>12.8</td>
</tr>
<tr>
<td>Groutz 1999</td>
<td>206</td>
<td>62</td>
<td>Pressure-flow</td>
<td>Qmax&lt;12 and PVR&gt;150ml</td>
<td>19</td>
</tr>
<tr>
<td>Abarbanel 2007</td>
<td>99</td>
<td>&gt;70</td>
<td>Pressure-flow</td>
<td>PdetQmax&lt;30 Qmax&lt;10</td>
<td>12</td>
</tr>
<tr>
<td>Valentini 2011</td>
<td>442</td>
<td>&gt;55</td>
<td>Pressure-flow</td>
<td>'Impaired detrusor contraction leading to prolonged voiding time and high residual volume'</td>
<td>13.8</td>
</tr>
<tr>
<td>Jeong 2012</td>
<td>547</td>
<td>&gt;65</td>
<td>Pressure-flow</td>
<td>Qmax≤12 PdetQmax≤10</td>
<td>13.3</td>
</tr>
<tr>
<td>Gammie 2015</td>
<td>1281</td>
<td>59</td>
<td>Pressure-flow</td>
<td>PdetQmax&lt;20 Qmax&lt;15 BVR&lt;90</td>
<td>24.0</td>
</tr>
</tbody>
</table>
To treat or not to treat?

• A: Treatment
• B: No treatment
• C: Additional diagnostic tests

• Plan:
  – Start pelvic physiotherapy

• Next outpatient clinic visit after 2 months:
  – Ultrasound residual volume 90cc
  – Patient is satisfied with result

• What have we been treating?
  – No UTIs, only feeling of incomplete emptying
Case 2: woman, 43 years

- History:
  - abdominal wall surgery
  - caecerian section 2x
  - Epilepsia

- Medication: lamictal

- Since a couple of years recurrent UTIs. No storage or voiding LUTS. This year 4x UTI.

- Examinations
  - urine sedimentation: clean
  - Micturition diary: intake 2-3L, DF 6-7x, portions 300-425cc, NF 0x
  - VE: no cystocele
  - Cystoscopy: normal urethra and bladder mucosa, orthotopic ostia
Uroflowmetry: residual volume of 432cc (no urge)
To treat or not to treat?

• A: Treatment
• B: No treatment
• C: Additional diagnostic tests

• Plan:
  – Start CISC

• Visit outpatient clinic 1 year later:
  – No UTIs with 2x daily CISC and spontaneous voiding in between
Take home messages

• The large epidemiological studies in men show no ‘progression’ of residual volume over time

• Voiding efficiency might be a better surrogate parameter to estimate bladder emptying function

• Do not strictly follow the number, look at your patient
  – Can the complaints be related to incomplete emptying of the bladder?
Additional slides
Management

• Non-surgical
  – Pelvic physiotherapy
  – Pharmacological
  – Clean Intermittent Self-Catheterisation (CISC)

• Surgical
  – Desobstructive surgery (TURP / laser / BNI)
  – Sacral Neuromodulation (SNM)
  – Reduction cystoplasty
  – Bladder wrap surgery
Why ambulatory urodynamics?

[Bar chart showing success rates for different urodynamic diagnoses]

Legend:
- conventional-UDS
- ambulatory-UDS
- success rate 2 years post-implantation
- number of patients with successful SNM test evaluation period, of total patients per urodynamic diagnosis group

Drossaerts et al. WJUrol 2015
Sacral Neuromodulation

Results of Sacral Neuromodulation Therapy for Urinary Voiding Dysfunction: Outcomes of a Prospective, Worldwide Clinical Study


From the Academische Ziekenhuis Maastricht, Maastricht (PEVV, ACVV), Academisch Ziekenhuis Radboud, Nijmegen (JPFAH), Academisch Ziekenhuis Leiden, Leiden (AABLNN), and Twenteborg Ziekenhuis, A’Hannover, Germany (UJ), National Hospital for Neurology and Neurosurgery, L University of Gothenberg, Gothenberg, Sweden (MF), Policlinico Multimedica, M Switzerland (UVH), Queen Elizabeth II Health Science Center, Halifax, Nova Scotia, Royal Victoria Hospital, Montreal, Quebec (MME), Canada, Metropolitan Urology, University, Nashville, Tennessee (DFM), and Albany Medical College, Albany, N

Purpose: This 5-year, prospective, multicenter trial evaluated the long in patients with refractory urge incontinence, urgency frequency and ret
Materials and Methods: A total of 17 centers worldwide enrolled 163 patients declined implantation and 152 underwent implantation using Inte had urge incontinence, 25 (16.4%) had urgency frequency and 31 (20.4%) ha 5 years. Clinical success was defined as 50% or greater improvement from
Results: Data for all implanted cases were reported. For patients with decreased from 9.6 ± 6.0 to 3.9 ± 4.0 at 5 years. For patients with urg 19.3 ± 7.0 to 14.8 ± 7.6, and mean volume voided per void increased fro retention the mean volume per catheterization decreased from 379.9 ± catheterizations decreased from 5.3 ± 2.8 to 1.9 ± 2.8. All changes threat or irreversible adverse events occurred. In 102 patients ob served. At 5 years after implantation 68% of patients with urge inc retention had successful outcomes.
Conclusions: This long-term study demonstrates that InterStim the appropriately selected cases refractory to other forms of treatment.

Average voiding diary parameters during 5 years after implantation. A, patients with UI. B, patients with UF. C, patients with retention. Missing values were imputed using last observation carried forward. Except for degree of urgency, voiding parameter changes from baseline were statistically significant (p < 0.001) from repeated measure analysis.
12. Rademakers et al. NAU 2015
Pelvic physiotherapy

• Aim: “Reduce functional outlet obstruction (guarding reflex) or to alter psychological inhibition and so provide a non-invasive rearrangement of the micturition coordination”

• Randomised trial in children non-neuropathic UAB:
  – Urotherapy vs animated biofeedback and PFM exercise
    • Increase in Qmax, decrease in PVR
Clean Intermittent Self-Catheterisation (CISC)

- Transurethral, or via diversion technique (Mitrofanoff, Boari, Monty)

- CISC well tolerated compared to aged-matched controls

- Alternatively, permanent TUC or SPC
  - Cons: irritative bladder complaints, clogging, decubitus and/or renal function decay

Bolinger et al. Journal of Wound Ostomy & Continence Nursing 2013
Zhang et al. Spinal Cord 2014