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Bladder scan, Residual urine and relation with UTIs

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Residual Urine

- Post-void residual urine (PVR) volume is the volume of urine remaining in the bladder at the end of micturition
- UTI is defined by the presence of physical symptoms ***and*** high amounts of bacteria in the urine
- Normally –no urine remaining

PVR

Increased in patients with:

1. Bladder outlet obstruction; BPH, poor sphincter relaxation, urethral/meatal stricture or bladder stones)
2. Detrusor underactivity (due to aging or neurological)
3. Bladder diverticulum
4. Large volume vesicourethral reflux → ”pseudo-residual”

- More useful if used in combination with uroflowmetry or other parameters.

- Belal M, Abrams P: J Urol 2006

What threshold for PVR?

- Poorly defined
- Most urologists agree that volumes of 50-100 mL constitute the lower threshold to define an abnormal PVR
- Bladder volume = bladder height (cm) X width (cm) X depth (cm) X 0.7
- Day- to day variability (150-670ml)
- It indicate the likelihood of back pressure on the kidneys
- 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

Abrams PH et al . Br Med J 1978

- Clinically asymptomatic adult men with a post-void residual volume of 180 ml are at a high risk for bacteriuria
- Close medical attention to introduce early drug therapy or surgical intervention to improve the bladder emptying

Truzzi et al J Urol 2008

Which Residual?

- Several studies (with residual urine volumes cut-offs ranging between 50– 200 ml) that assessed the accuracy of PVR compared with catheterisation in men and women
- Bladder scanner is less invasive with lower adverse effects.
- The sensitivity (range 67–95%) and specificity (range 63–99%) of ultrasound in detecting PVR
- However, one study showed a much lower sensitivity at residuals >100 ml.

NICE 2006

PVR measurement

- Urethral catheterisation has been accepted as the gold standard for PVR measurements, but this may cause discomfort for patients and carries a risk of urinary tract infection and trauma.

Schaeffer AJ, et al. J Urol 1983

- Non-invasive ultrasound bladder volume measurement has been used as an alternative to urethral catheterization, as a good compromise between accuracy and patients safety/comfort.

Griffiths CJ, et al. J Urol 1986

Meta-analysis review of 17 non-randomised controlled trials

- Reduction in the negative health outcomes due to the use Bladder scanner
- Catheterisations avoided ranged from 16–47% whilst UTIs were reduced by 38–72%
- Higher levels of accuracy were demonstrated in patients with spinal cord injuries compared with other acute care and rehabilitative patients
- There was variability in the type and model of bladder scanner used in the studies

Portable bladder U/S: an evidence-based analysis, HTA

PVR measurement by US

Ultrasound bladder volume estimation can be performed in two ways:

1. By a real-time ultrasound to directly visualize the bladder.

   Griffiths CJ, et al. J Urol 1986;136:808-812

2. By using a portable bladder scanner to calculate the volume automatically without directly visualising the bladder.

   Hartnell GG et al, Br J Radiol 60 (1987), pp. 1063–1065.

PVR- Bladder scanner

- Advantages:
  - easy to use
  - requires only basic training
  - can be carried out on the ward.
- Limitation:
  - The device records the volume of cystic structures within the pelvis
  - Morbidly obese
  - Postnatal women
  - Ascites
  - Large ovarian cyst or bladder diverticulum

Park YH: Neurourol Urodyn 2011

Types

- Portable vs stationary
- Real-time ultrasound imaging vs numeric bladder volumes
- U/S: 3-dimensional (3D) vs 2-dimensional (2D)
- Used in primary care, secondary care and community
- Battery-powered, ultrasound scanner utilises automated technology to digitally register bladder volume, including PVR urine volume, while providing images of the bladder area

Which Scanner

- Portable bladder scanners; BVI 3000®, BVI 6100®, Sonosite iLook 15® and Bardscan® in 28 healthy volunteers.
  - iLook 15® and Bardscan® under-predicted bladder volumes
  - BVI 3000® and BVI 6100® over-predicted bladder volumes
  - The authors concluded that no scanner could be classed as being the most accurate
  - BVI 6100® was however found to be the fastest and lightest scanner with a markedly less variable error
- BVI 6100® in measuring volumes ≤150 ml
  - compared with existing ultrasound, the 3D ultrasound device provides significantly greater accuracy for estimating lower bladder volume

Small et al 2008

- Portable scanners; BVI 3000®, Bardscan® and HDI 4000®)
  - HDI 4000® is the most accurate of all three scanners
  - Estimated volumes from all three ultrasound scanners were found to be significantly correlated to voided volumes ($p < 0.001$)
  - Bardscan® underestimated (21 ml) and BVI 3000® overestimated bladder volumes.
  - Bardscan® is not as accurate as the BVI 3000® despite having the advantage of producing real-time images

- Portable scanners; BME-150A® and BVI 3000®
  - no significant difference in the accuracy and precision in estimating residual volumes

Choe et al. 2005

Technique

It consists of :

- Base component with a display screen
- Hand-held ultrasound transducer (scan head) which is usually positioned on the patient’s abdomen
- The base component employs ultrasound technology, to automatically create an image of the bladder and calculate bladder and PVR measurements

PVR and bacteriuria

- Large PVRs may be associated with UTIs, especially in persons at risk (children, patients with spinal cord injury or diabetes)
- Other studies, however, demonstrated that elevated PVR is not correlated to bacteriuria, incontinence, immobility, impaired cognition, or neurological disease.

Kelly CE. Rev Urol. 2004

PVR, UTIs in Elderly

- Nursing Home Resident study- 150 residents
- 2/3 had a PVR less than 100 mL, and 52 (34.7%) had a PVR of 100 mL or greater
- During the follow-up period, 51 residents (34.0%) developed one or more UTIs
- The prevalence of UTI in women was higher than in men (40.4% vs 19.6%; *P*=.02)
- There was no significant difference in mean PVR between residents who did and did not develop a UTI (79 vs 97 mL, *P*=.26)
- PVR of 100 mL or greater was not associated with greater risk of developing a UTI (*P*=.59)

- High PVR is common in nursing home residents. No association between PVR and UTI was found.

Omli et al 2008

Urine Bacterial Titres

- PVR increased with high Urine Bacterial Titres
- Significant threshold was reached for 10(6) CFU/mL: 100mL mean PVR for patients with BT ≤ 10(5) CFU/mL versus 248 mL for patients with BT >10(5) CFU/mL.
- High PVR and BT were associated with complicated infections, concomitant bacteraemia, and delayed apyrexia
- Screening for patients with BT ≥ 10(6) CFU/mL is an easy way to identify patients at high risk for acute retention and voiding disorders

Caron et al 2015

PVR, UTI in stroke patient

- The incidence rate of UTI in stroke patients is about 40% (low cognitive function, low functional level, high PVR, and long Foley catheter indwelling)
- Likelihood of developing UTI was 4.87 times higher with a PVR of 100 ml or more, and the incidence rate of UTI was higher in the patients with a higher PVR, irrespective of sex and age
- PVR monitoring with the use of a bladder scanner is the most important and simplest observation method to prevent UTI
- Clean intermittent catheterisation in patients with a PVR of 100 ml or more will be helpful for the prevention of UTI

Bo-Ram Kim et al 2012

PVR- Recommendations

- The interval between voiding and PVR measurement should be as short as possible (ask the patients if the voiding was similar to a typical micturition in his/her daily life)
- Use preferably noninvasive ultrasound bladder volume measurement instead of urethral catheterization
- Measurement of PVR is recommended at the management of female urinary incontinence
- Assessment of PVR is considered mandatory in a variety of pediatric patients

PVR - Evidence summary

- Unrepresentative results :
  - voiding in unfamiliar surroundings
  - on command with an only partially filled or an overfilled bladder
- Portable bladder scanner may present some advantages over real-time ultrasound, especially if equipped with an additional real-time pre-scan imaging
- There is no universally accepted definition of a significant residual urine volume.

PVR - Evidence summary

- PVR may be associated with UTI, especially in subjects at risk, such as children or patients with spinal cord injury or diabetes
- Cut of PVR is still not clear