

# MEASUREMENT OF POST-VOID RESIDUAL URINE WITH A PORTABLE ULTRASOUND MACHINE

**JKH Luk. MSc., MRCP (U.K.)**

Medical Officer.

**E Hui. MRCP (U.K.) FHKAM (Med)**

Senior Medical Officer.

**CM Lum. FHKAM (Med), FRACP, FRCP (Edin)**

Consultant.

**J Woo. MD, FRCP (Lond, Edin), FRACP.**

Chief of Services.

Medical and Geriatrics unit, Shatin Hospital

*J HK Geriatr Soc 2000;10:10-12*

Correspondence to:

Dr. James K.H. Luk

Senior Medical Officer

TWG Fung Yiu King Hospital

Sandy Bay

Hong Kong

## Abstract:

*The portable ultrasound machine can measure residual urine volume non-invasively. Study was done in 95 patients to test its accuracy and inter-user reliability. Paired values of ultrasound and catheterized residual volumes were determined. (Number of measurements=150). Ultrasound measurements were done twice first by a nurse followed by a doctor in some patients to test the inter-user reliability. Linear regression showed a high correlation between the ultrasound and catheter residual volumes ( $y=0.99x + 23$ ,  $r=0.93$ ,  $p<0.0001$ ). The machine was highly sensitive and specific in detecting various residual volumes. Analysis of the data limited to 50 subjects age  $\geq 70$  also revealed high sensitivity and specificity in various urine volumes (number of measurements=90). Good inter-user reliability was found between the nurse and doctor (number of measurements=69, coefficient of correlation =0.97,  $p<0.0001$ ). The portable ultrasound machine provides a non-invasive and accurate means to determine residual bladder urine volumes.*

**Key words:** bladder scan, retention of urine, residual urine

## Introduction

Urinary retention and incontinence are common in elderly patients<sup>1</sup>. The proper assessment of elderly subjects with urinary problems usually requires the determination of post-void residual urine volumes. The use of catheterization has been regarded as the standard method in assessing residual urinary volume post-void. However, the procedure can cause discomfort to the patients and may lead to urinary tract infection. In addition, catheterization may be difficult to perform in patients with behavioral disturbances or prostatic hypertrophy. The accuracy of catheterization in

measuring residual urine volumes has also been questioned by some reports<sup>2,3</sup>. The portable ultrasound machine (BVI 2500, Diagnostic Ultrasound Corp, Redmond, Washington, USA) has been developed to offer a non-invasive and easy-to-use means to measure residual post-void urine. This machine is available in many hospitals in Hong Kong. The present study was conducted to evaluate the accuracy of the machine in the local population. In addition, the precision of the machine in older subjects as well as inter-user reliability were examined.

## Materials and Methods

The BVI 2500 (Diagnostic Ultrasound Corp, Redmond, Washington, USA) is a portable battery operated ultrasound machine with a scan head. To measure residual volume, the scan head is placed over the lower abdomen. In a few seconds, the volume will be calculated by a soft ware built-in the machine and shown on the display.

A total of 95 patients of age ranging from 15 to 95 attending the urodynamic investigation in Shatin hospital between July, 1997 and November, 1998 were recruited. At the commencement of each urodynamic study, the patients were asked to void in standing or sitting position. The residual urine volume was then determined by the ultrasound machine in the supine position (ultrasound volumes). All measurements were made by one urodynamic nurse using the same machine. The patients were then catheterized in the routine sterile fashion for 5 minutes to assess the catheterized residual volumes (catheter volumes). Ultrasound and catheter residual volumes were measured again at the end of urodynamic study in some patients. To test the inter-user reliability, ultrasound measurements were done twice in some patients, first by the nurse followed by a designated doctor.

The correlation between ultrasound and catheter volumes was analyzed by linear regression and determination of the correlation coefficient. Inter-user reliability between the ultrasound measurements made by the nurse and doctor was analyzed by simple correlation. The sensitivity and specificity of each ultrasound residual volume were calculated in relation to the catheter volume. Subgroup analysis was also done by determining the sensitivity and specificity of the ultrasound machine in patients ≥70 years old. Statistically significance was defined as  $p < 0.05$ .

**Results**

There were 48 men and 47 women included in the study. The mean age was 67.5 with a standard error (SE) of ±2. The range of ultrasound and catheter volumes were both from 0 ml to 700 ml. The average ultrasound and catheter urine volumes were 196 ml and 174 ml respectively. A high correlation was obtained when ultrasound volumes were plotted against catheter volumes. ( $y = 0.99x + 23$ ,  $r = 0.93$ ,  $p < 0.0001$ ) (Figure 1). Table 1 shows

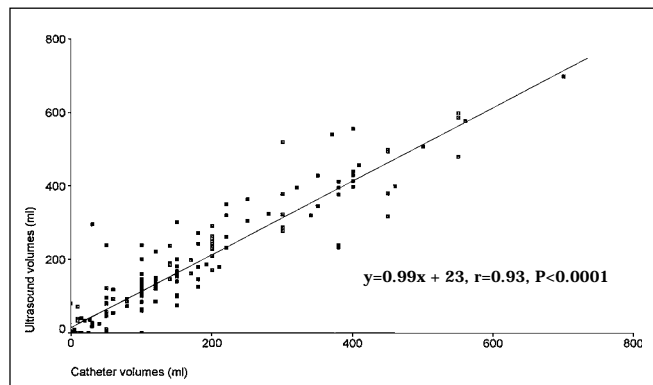


Figure 1. Correlation between ultrasound and catheter volumes

Table 1: Comparison between catheterized residual urine volume against ultrasound (USG) detected residual urine volume in all subjects. (N=150)

USG volume (ml)	Catheter volume (ml)						
	<50	50	100	150	200	300	400+
<50	25	4	1	0	0	0	0
50-99	2	10	5	1	0	0	0
100-149	0	3	17	5	0	0	0
150-199	0	0	5	8	2	0	0
200-299	1	1	4	3	13	4	0
300-399	0	0	0	1	5	8	3
400+	0	0	0	0	0	4	15
Total	28	18	32	18	20	16	18

Table 2: Sensitivity and specificity of different urinary volumes in all subjects

Catheter Volume (ml)	Sensitivity (%)	Specificity (%)
<50	89	96
50-99	89	93
100-149	93	89
150-199	96	86
200-299	94	89
300-399	88	95
400+	83	97

the comparison between catheter and ultrasound volumes in all the subjects (number of measurements=150). Sensitivity and specificity of the ultrasound measurements compared with various volumes of catheterized urine post-void residual volumes were computed (Table 2). In general, the ultrasound machine achieves good sensitivity and specificity in all ranges of urinary volumes. There were 50 older subjects with (age ≥ 70 mean age ±SE = 80.5 ±0.94). The comparison between catheter and ultrasound volumes in subjects with age ≥70 is shown in Table 3 (number of measurements=90). The sensitivity and specificity of this subgroup were also high, as depicted in Table 4. Good inter-user reliability was found between the nurse and doctor (number of measurements=69, correlation coefficient=0.97,  $p < 0.0001$ ).

**Discussion**

The development of the portable ultrasound machine enables clinical staff to evaluate the post-void residual urine of patients without invasive procedures like catheterization. It is particularly important for geriatric patients, as the prevalence

Table 3: Comparison between catheter urine volume against ultrasound (USG) urine volume in 50 patients with age (70). (N=90)

USG volume (ml)	Catheter volume (ml)						
	<50	50	100	150	200	300	400+
<50	17	3	1	0	0	0	0
50-99	3	4	4	1	0	0	0
100-149	0	3	11	3	0	0	0
150-199	0	0	2	5	2	0	0
200-299	0	1	4	3	5	3	0
300-399	0	0	0	0	4	4	0
400+	0	0	0	0	0	1	6
Total	20	11	22	12	11	8	6

Table 4: Sensitivity and specificity of different urinary volumes in subjects  $\geq 70$ 

Catheter Volume (ml)	Sensitivity (%)	Specificity (%)
<50	85	94
50-99	87	90
100-149	90	87
150-199	89	87
200-299	92	88
300-399	79	95
400+	100	100

of urinary problems like incontinence and urinary retention are common in elderly, and that catheterization may be difficult and may lead to complications such as urinary tract infection, albeit the rate is low<sup>1,4</sup>.

Previous studies have shown that the portable ultrasound machines are reasonably accurate in adult subjects<sup>5,6,7</sup>. In nursing home elderly residents, Ouslander demonstrated that the machine was highly sensitive but only moderately specific for low residual volumes<sup>8</sup>. On the other hand, it was moderately sensitive but highly specific for high residual volume. The present study showed that the sensitivity and specificity of the machine were high in various residual urinary volumes, ranging from <50 ml to =400 ml. In addition, similar high sensitivity and specificity could be found in elderly subjects. Hence, the portable ultrasound machine is able to pick-up most abnormal residual volumes and at the same time will not trigger many unnecessary referrals for evaluation due to false positive detection. Similar to previous reports, high inter-user reliability was observed in this study<sup>6,8</sup>.

The machine is not cheap and it causes about 7000 US dollars. However, it is non-invasive, fast and easy to use. No special training is required for the staff. The use of the machine can reduce the rate of catheterization needed. This can result in less labour and sterile equipment cost, fewer antibiotics and complications like urinary tract infection (which may prolong hospital stay or even lead to mortality). It appears that the portable ultrasound machine is cost effective in institutions and units which frequently encounter patients with a lot of urinary problems.

#### References:

1. Resnick NM, Baumann MM. Incontinence in the nursing home patient. *Clin Geriatr Med* 1988;**4**:549-570.
2. Stroller ML, Millard RJ. The accuracy of a catheterization residual urine. *J Urol* 1989;**141**:15-16.
3. Purkiss SF. Assessment of residual urine in men following catheterization. *Br J Urol* 1990;**66**:279-280.
4. Cox CE. Nosocomial urinary tract infections. *Urology* 1988;**32**:210-215.
5. Ireton RC, Krieger JN, Cardenas DD et al. Bladder volume determination using a dedicated, portable ultrasound scanner. *J Urol* 1990;**143**:909-911.
6. Massagli TL, Cardenas DD, Kelly EW. Experience with portable ultrasound equipment and measurement of urine volumes: Inter-user reliability and factors of patient position. *J Urol* 1989;**142**:969-971.
7. Fuse H, Yokoyama T, Muraishi Y, Katayama T. Measurement of residual urine volume using a portable ultrasound instrument. *Int Urol and Nephrol* 1996;**28**:633-637.
8. Ouslander JG, Simmon S, Tuico E et al. Use of a portable ultrasound device to measure post-void residual volume among incontinent nursing home residents. *J Am Geriatr Society* 1994;**42**:1189-1192.