academicJournals

Vol. 7(6), pp. 108-115, June 2015
DOI: 10.5897/IJNM2015.0164
Article Number: C90D36953631
ISSN 2141-2456

http://www.academicjournals.org/IJNM

International Journal of Nursing and Midwifery

Full Length Research Paper

Systematic bladder scanning identifies more women with postpartum urinary retention than diagnosis by clinical signs and symptoms

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Received 13 March, 2015; Accepted 5 May, 2015

This study aims to determine if systematic use of bladder scan accurately identifies more women with postpartum urinary retention compared with diagnosis using clinical signs and symptoms, alone. A prospective, quasi experimental study was performed at the Department of Obstetrics and Gynecology, County Hospital Ryhov, Jönköping, Sweden. A total of 252 women participated in this study; they were women who gave birth between the period of March and April, 2011. One hundred and twenty-six women were included in an experimental group, they received ultrasound scanning of post-void residual bladder volume for identification of urinary retention; patients were catheterized if post-void residual bladder volume was ≥400 ml. A control group of 126 women, matched by parity and age, were also included. The latter group were catheterized on clinical signs or symptoms of urinary retention. Twenty-one women in the experimental group were identified as having post-void residual bladder volume ≥400 ml compared to 9 in the control group, verified by catheterization ($p < 0.05$). Eleven women in the experimental group had covert urinary retention with a post-void residual bladder volume of 400 to 1200 ml. No woman who gave birth by caesarean section was identified with postpartum urinary retention. Univariable logistic regression analyses identified seven risk indicators of postpartum urinary retention: first pregnancy, delivery with use of ventouse, oxytocin infusion, epidural analgesia, second stage of >120 min, active pushing >30 min and perineal tear. Oxytocin infusion and perineal tear were independent risk indicators in a multivariable regression analysis. Systematic bladder scanning identifies more women with postpartum urinary retention in women with vaginal delivery than diagnosis by clinical signs and symptoms, alone. Oxytocin infusion and perineal tear are independent risk indicators for urinary retention in new delivered women.

Key words: Postpartum urinary retention, postpartum voiding dysfunction, bladder scanning, catheterization, birth.

INTRODUCTION

Postpartum urinary retention (PUR), or voiding dysfunction, is a well-known phenomenon in the puerperium (Yip et al., 2004; Mulder et al., 2014). The incidence of PUR varies from 0.5 to 45% in women who have just delivered babies. This variability among studies may be due to an unclear definition for PUR (Kekre et al., 2011). PUR has been defined as the inability to void adequately within 6 h after delivery. PUR can be sub-divided into clinically

covert and overt PUR (Carley et al., 2002; Glavind and Bjork, 2003; Yip et al., 2004; Ismail and Emery, 2008; Humburg et al., 2011; Kekre et al., 2011). Covert PUR refers to asymptomatic women with post-void residual bladder volume (PVRBV) ≥150 ml (Yip et al., 2004; Kekre et al., 2011). Overt PUR is the inability to void spontaneously within 6 h of vaginal delivery or removal of a urinary catheter after birth (Carley et al., 2002; Yip et al., 2004; Kekre et al. 2011).

The pathophysiology of PUR is likely to be multifactorial. The bladder muscle loses tone during pregnancy, possibly as a result of hormonal changes (Liang et al., 2014). Bladder capacity, urethral length and urethral closing pressure increase. A non-pregnant woman has a maximal bladder capacity of 350 to 450 ml; during pregnancy, the capacity may increase to 1000 to 1200 ml (Saultz et al., 1991). The postpartum bladder tends to be hypotonic, and physiological changes in the bladder persist for days to weeks after delivery (Saultz et al., 1991). The pelvic floor muscles and pudendus nerve may be damaged during labour, resulting in reduced bladder sensitivity (Saint et al., 2009). Peri-urethral and valvular oedema may cause obstruction (Mulder et al., 2014). Finally, reduced pressure from the uterus after birth may lead to incomplete bladder emptying during the first hours to days after delivery (Saultz et al., 1991). PUR is more frequently observed after instrument-assisted birth, and in women who received regional analgesia or prolonged labour or suffered lower genital tract laceration during birth (Carley et al., 2002; Humburg et al., 2011; Buchanan and Beckmann, 2014). Post-void residual urine is a source of urinary tract infections. A distended bladder may lead to detrusor damage, which requires catheterization (Carley et al., 2002; Zaki et al., 2004). PUR may be a transient, spontaneous healing phenomenon or may result in disturbed bladder function and the inability to void. However, the long-term consequences of PUR remain largely unknown (Yip et al., 2002; Mulder et al., 2014).

It may be difficult to diagnose PUR, especially in asymptomatic women, as this relies on an accurate estimation of PVRBV. Abdominal palpation may reveal an abnormal fundal height or palpable bladder. However, bladder volumes less than 300 ml are not easily detected by abdominal palpation; therefore, abdominal palpation alone is not recommended as a diagnostic method. Abnormal bleeding, abdominal pain, incomplete bladder emptying, weak urine beam, urinary incontinence and urinary infection are symptoms that may be associated with PUR. Catheterization is an accurate diagnostic and therapeutic method, but can lead to infection (Yip et al., 2004). Ultrasound scanning is non-invasive but ultrasound measurements may be inaccurate in women who recently delivered (Teng et al., 2005; Altschuler and Diaz, 2006; Saint et al., 2009). The use of a bladder scan routine for identification of PUR is debatable (Mulder et al., 2014; Buchanan and Beckmann, 2014).

The aim of this study was to determine if systematic use of bladder scan accurately identifies more women with PUR than diagnosis by clinical signs and symptoms alone.

MATERIALS AND METHODS

A total of 252 women who gave birth by vaginal or caesarean section during the period of March and April, 2011 at the Department of Obstetrics and Gynecology, County Hospital Ryhov, Jönköping, Sweden participated in this study. Six women did not participate because of difficulties to understand the Swedish language or they did not want to join the study. All women who were willing and able to participate were classified according to parity (primipara versus multipara) and age (Figure 1). One hundred and twenty six, that is every third consecutive women, were included to (I) an experimental group who received systematic bladder scanning and catheterization according to a new regimen for prevention of urinary retention and bladder damage during hospital care (Johansson et al., 2013). One hundred and twenty six of the remaining women were selected, matched by parity and age (± two years), and included to (II) a control group.

All participants were asked to void within 3 h after delivery. A bladder volume ≥400 ml after micturition, or an attempt to void, as the threshold for catheterization and definition of PUR was used in this study. Women in the experimental group received systematic ultrasound scanning for PVRBV with BladderScan™ BVI 3000® (Verathon, Seattle, USA, Allytec AB, Stockholm). The measurement was performed at least twice, and the highest volume was reported. When the ultrasound scan showed a PVRBV ≥400 ml, clean intermittent catheterization (Coloplast A/s Speedicath nr.12 and 4.0 mm) was performed, and the urine volume was measured. If the measured urine volume was >1000 ml, an indwelling urinary catheter (IUC) was inserted. If the urine volume was ≤1000 ml, bladder scanning was performed within four hours of new voiding. The measurement of PVRBV was terminated when two consecutive bladder scan assessments showed PVRBV <200 ml. Women in the experimental group were only catheterized if bladder scan showed a PVRBV ≥400 ml independent of clinical signs or symptoms of PUR. The women in the control group were catheterized when they were unable to void spontaneously within 3 h after delivery or had clinical signs or symptoms of PUR according to the clinical judgement of the midwife, that is, abdominal pain, abnormal bleeding, abnormal fundal height, or a palpable bladder (World Health Organisation; Fraser and Cullen, 2006p; Leach, 2011). All staff members, consisting of 60 midwives and nursing auxiliaries, were informed about the study protocol and given an introduction to the correct use of the bladder scan before data collection. To assess the inter-observer agreement for the ultrasound technique, 20 women were scanned twice a few minutes apart independent of micturition by two nurses in a blinded manner.

All collected data with date, time, and volumes were noted in a separate protocol for the study. Maternal age, newborn birth weight, parity, mode of delivery (vaginal delivery, caesarean section, or delivery with use of ventouse), use of epidural or spinal analgesia,

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duration of first and second stages of labour and duration of active pushing during the second stage of labour were recorded. Episiotomy and complications, such as perineal tears and bleeding were also reported in this study.

Sample size calculation showed that this study needed about 100 women in each group. Statistical package for social sciences (SPSS V.22.0 software) (SPSS, Chicago, Illinois, USA) was used for statistical analyses. Continuous variables are presented as means ± standard deviation. 95% confidence interval is given when appropriate. The Mann-Whitney U test was used to test differences among numerical variables, and the Fisher's exact test was used for binary variables. Univariable and stepwise multivariable logistic regression analyses were performed to assess the associations between obstetric characteristics and PVRBV ≥400 ml verified by catheterization. The difference in volume measurement between bladder scanning and catheterization was analysed using single regression analysis and a Bland-Altman diagram. P-values ≤0.05 were regarded as statistically significant. Two-sided tests were used throughout the study.

The ethical principles of respect for autonomy, non-maleficence, beneficence and justice were considered as stated in The Declaration of Helsinki. Verbal information about the study was given to each woman. The women gave their informed consent to take part in the study after verbal information. Based on the nature of the study as a quality improvement project, approval was not sought from the ethics committee. According to Swedish law of research ethics, a formal permission was not deemed necessary (Swedish Research Council, 2003).

RESULTS

There were no differences in obstetric characteristics between the experimental group and control group (Table 1). Forty women in the experimental group and 11 in the control group were catheterized because of suspected PUR ($p < 0.001$) based on bladder scanning results in the experimental group and clinical signs and symptoms in the control group. Twenty-one women in the experimental group were identified as having PUR verified by catheterization, 10 with open PUR and 11 with covert PUR. The latter group had a PVRBV of 400 to 1200 ml. Nine women in the control group were identified with PUR, and this was less than in the experimental group ($p < 0.05$). No woman who gave birth by caesarean section in the experimental group or control group developed PUR. The odds of being identified with PUR among women with vaginal delivery in the experimental group were 1/4 compared to 1/11 in the control group giving an effect size of 2.7. An average of four scanning procedures (range 2 to 12) was performed per woman in the experimental group. Fourteen women with PUR in the experimental group had PVRBV <200 ml within 6 h after delivery, and 20 had PVRBV <200 ml within 12 h after delivery. One woman in the experimental group and one in the control group were treated with an IUC at the time of discharge from the hospital.

Univariable logistic regression analyses were performed to assess risk indicators for post-void residual volume ≥400 ml verified by catheterization in women who delivered vaginaly in the experimental group (Table 2). Seven indicators of PUR were identified. Oxytocin infusion and perineal tears were independent risk indicators in a multivariable regression analysis. A comparison of obstetric characteristics between women with vaginal delivery and PVRBV ≥400 ml versus PVRBV <400 ml at catheterization in this group confirmed that women with PUR were more likely to have risk indicators than women without PUR (Table 3).

The PVRBV assessed by bladder scan was higher than the volume measured at catheterization (583±149 versus 416±331 ml; $p < 0.001$) in the experimental group (Figure 2). The ultrasound technique overestimated the volume compared with catheterization in women with bladder volumes less than 500 ml (Figure 3). However, there was only one woman with a false positive bladder scan among women with risk indicators for PUR in the experimental group. To assess the inter-observer variability, ultrasound scanning was performed twice in 20 women. There were no significant differences in estimated bladder volumes between the two observers (332±201 versus 319±192 ml).

DISCUSSION

To the best of this study, this is the first prospective, quasi experimental study design to compare two different regimens, systematic bladder scanning vs. assessment by clinical signs and symptoms, for the identification of women with postpartum urinary retention. The odds of identifying PUR by use of bladder scan were 2.7 times higher than diagnosis by clinical signs and symptoms in women with vaginal deliveries. No woman with a caesarean section developed PUR. Oxytocin infusion and perineal tear were strong independent risk indicators for PUR. Bladder scan overestimated the bladder volume compared to catheterization. However, only one woman with risk indicators for PUR in the experimental group had a false positive scan. All women except one with PUR in the experimental group recovered within 12 h.

Bladder scanning has been found to be a suitable method for identification of PUR, because it is non-invasive and has accurate agreement with catheterization. However, the clinical relevance of a systematic bladder scanning program in new delivered women has been considered to be ambiguous (Yip et al., 2002; Demaria et al., 2004; Van Os and Van der Linden, 2006; Lukasse et al., 2007; Buchanan and Beckmann, 2014; Mulder et al., 2014). The study identified more women with PUR using bladder scan than by analysis of clinical signs and symptoms alone. The results of this study are consistent with the study of Van Os and Van der Linden (2006). The data of this study, suggest that systematic use of ultrasound scanning appears necessary if PUR could be detected. The bladder scanning regimen was criticized by some patients and staff members who considered that too much attention was placed on bladder function instead of care for the mother, new born and breastfeeding. Is it feasible to

Table 1. Obstetric characteristics of the experimental group and control group.

Parameter	Experimental group n = 126	Control group n = 126
Maternal age, mean (SD), years	31 (5)	31 (5)
Birth weight, mean (SD), g	3484 (502)	3510 (581)
First pregnancy, n (%)	55 (44)	55 (44)
Spontaneously vaginal delivery, n (%)	95 (75)	101 (80)
Delivery with use of ventouse, n (%)	13 (10)	7 (6)
Acute caesarean section, n (%)	12 (10)	9 (7)
Elective caesarean section, n (%)	7 (6)	9 (7)
Oxytocin infusion, n (%)	42 (33)	48 (38)
Epidural analgesia, n (%)	38 (30)	37 (29)
Second stage of labour > 120 min, n (%)	23 (18)	21 (17)
Active pushing > 30 min, n (%)	18 (14)	20 (16)
Bleeding volume > 1000 ml, n (%)	6 (5)	7 (6)
Perineal tear 2^{nd}, n (%)	20 (16)	28 (22)
Perineal tear 3^{rd} – 4^{th}, n (%)	3 (2)	3 (2)
Episiotomy, n (%)	5 (4)	6 (5)

Table 2. Risk indicators for post-void residual bladder volume ≥400 ml verified by catheterization in women with vaginal delivery in the experimental group.

Parameter	Univariable analyses			Multivariable analyses		
	OR	95% CI	p	OR	95% CI	p
First pregnancy (n = 41)	4.4	[1.6 - 12.1]	0.005	2.4	[0.8 - 7.5]	0.120
Delivery with use of ventouse (n = 12)	5.3	[1.5 - 18.8]	0.012	-	-	-
Oxytocin infusion (n = 36)	7.7	[2.7 - 22.5]	<0.001	6.6	[2.2 - 19.8]	<0.001
Epidural analgesia (n = 34)	5.0	[1.8 - 13.8]	0.002	-	-	-
Second stage of labour >120 min (n = 21)	4.6	[1.6 - 13.3]	0.006	-	-	-
Active pushing >30 min (n = 18)	3.4	[1.1 - 10.3]	0.045	-	-	-
Perineal tear 2nd – 4th and/or episiotomy (n = 25)	4.3	[1.5 - 12.0]	0.008	3.3	[1.1 - 10.0]	0.036

CI =confidence intervals; OR = Odds ratio. Based on univariable logistic regression analyses and multivariable logistic regression analysis, final model.

Table 3. Obstetric characteristics of women with vaginal delivery and post-void residual bladder volume ≥400 ml or <400 ml in the experimental group.

Parameter	PVRBV ≥400 ml [n = 21]	PVRBV <400 ml [n = 86]	p
Birth weight, mean (SD), g	3600 (413)	3532 (504)	ns
First pregnancy, n (%)	14 (67)	27 (31)	0.01
Delivery with use of ventouse, n (%)	6 (29)	6 (7)	0.05
Oxytocin infusion, n (%)	15 (71)	21 (24)	< 0.001
Epidural analgesia, n (%)	13 (62)	21 (24)	0.01
Second stage of labour > 120 min, n (%)	9 (43)	12 (14)	0.01
Active pushing > 30 min, n (%)	7 (33)	11 (13)	0.05
Perineal tear 2^{rd} – 4^{th} and/or episiotomy, n (%)	10 (48)	15 (17)	0.01
No risk indicator for PUR, n (%)	2 (9)	37 (43)	0.01

PVRBV: Post-void residual bladder volume; No of risk indicator for PUR, that is, absence of risk indicators for postpartum urinary retention presented in Table 2. The Mann-Whitney U test was used to test differences among numerical variables, and the Fisher's exact test was used for binary variables.

reduce the number bladder scan controls? While seven risk indicators for PUR were identified. Prolonged labour, instrument-assisted delivery, epidural or regional anaesthesia and perineal lacerations has shown to be

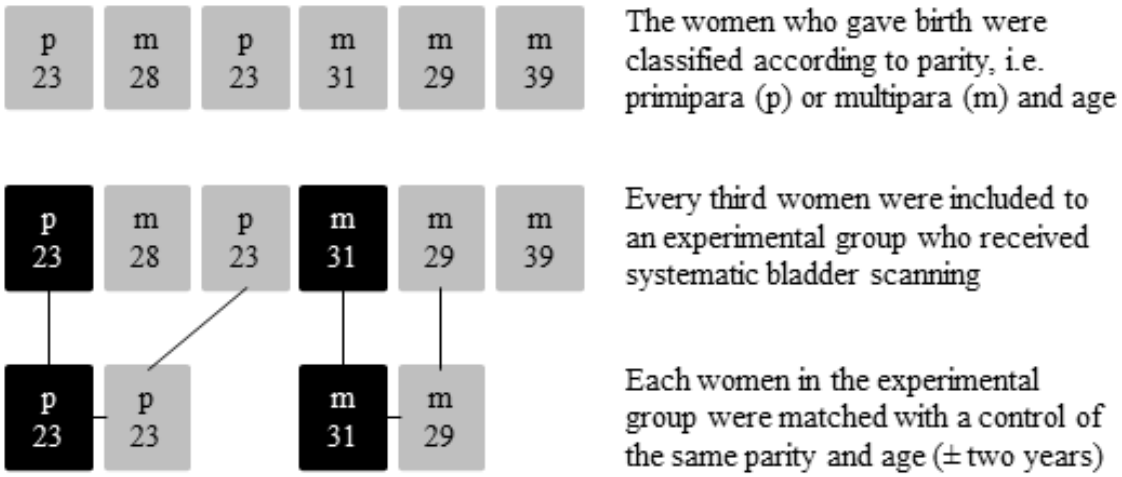

Figure 1. The patient´s enrolment of the study.

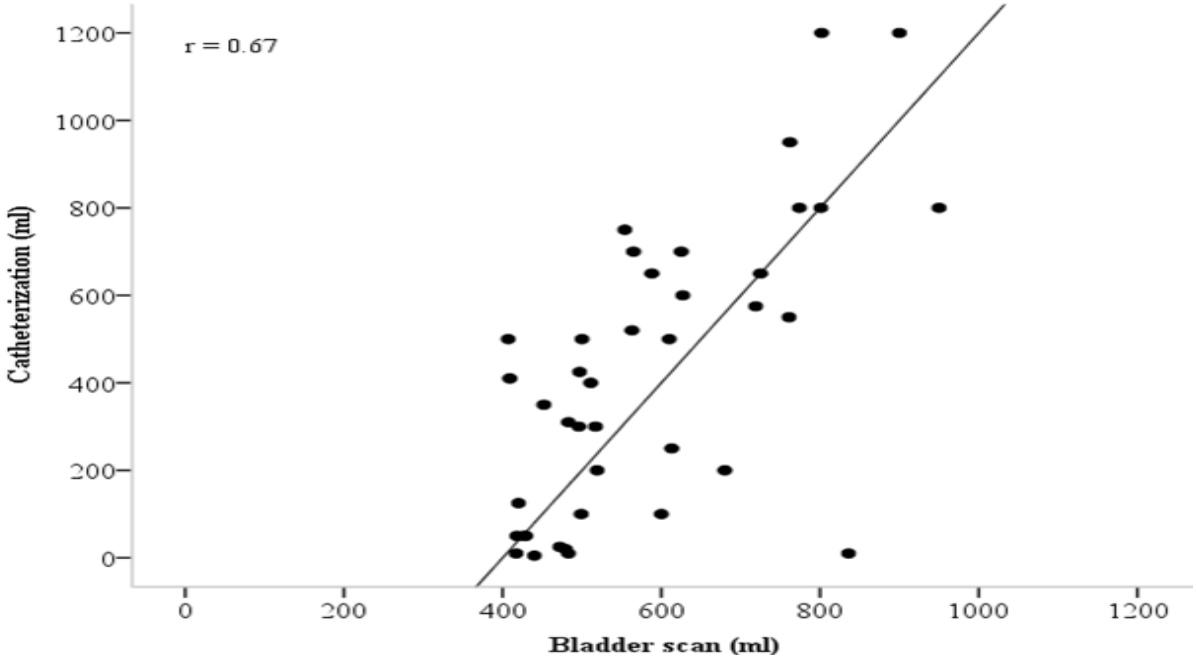

Figure 2. The relation between post-voided residual bladder volume assessed by bladder scan and catheterization in 40 women in the experimental group. The regression line and correlation coefficient are presented.

independent risk factors for PUR (Carley et al., 2002; Liang et al., 2002; Musselwhite et al., 2007; Oh et al., 2015). Oxytocin infusion and perineal tears were independent risk indicators in this study. The result differs slightly from previous studies. The reason may be due to variations in obstetric procedures, complications and, definition and management of postpartum urinary retention between the studies. However, it is not surprising that oxytocin was a risk indicator since the urine secretion may increase considerably after completion of the infusion. The results indicate that screening for increased PVRBV by use of bladder scan in women with vaginal delivery and risk indicators for PUR is necessary.

The study had a number of false positive bladder scanning results and bladder scan estimated a higher PVRBV than catheterization, especially in women with bladder volumes less than 500 ml. These results differ from three previous studies (Demaria et al., 2004; Van Os and Van der Linden, 2006; Lukasse et al., 2007).

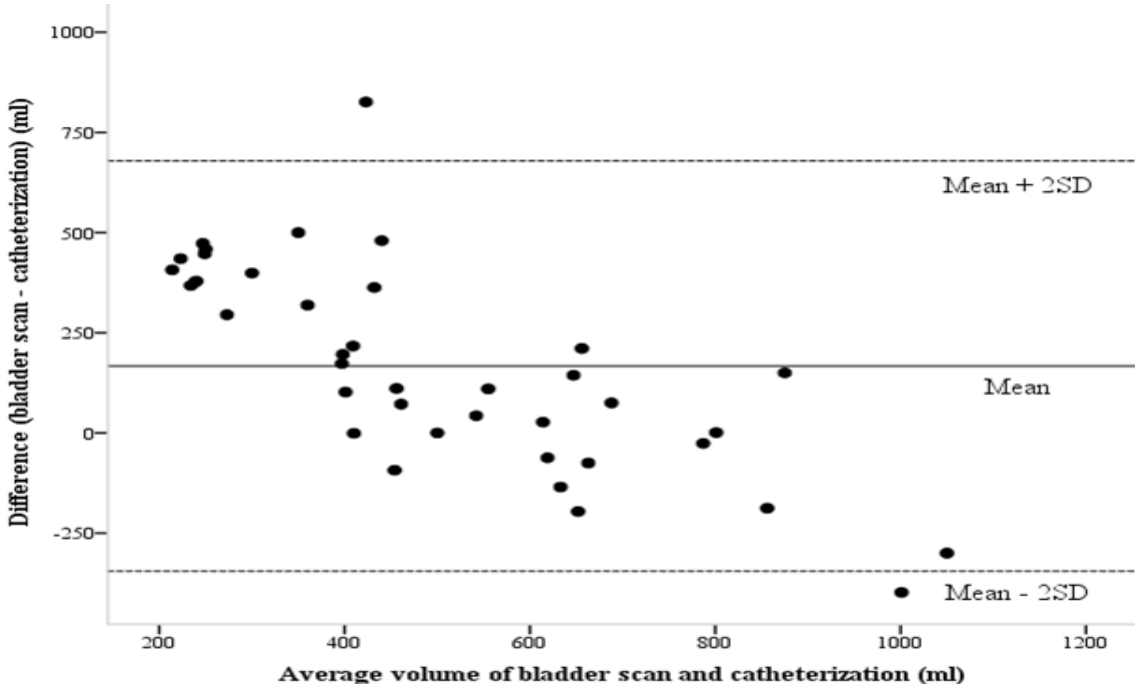

Figure 3. The differences in estimated bladder volume between bladder scan and catheterization are plotted against the average of the two (Bland-Altman plot). The upper and lower dotted lines show the limits of agreement (mean ± 2 standard deviation), and the middle line shows the mean difference.

Bladder scanning tended to underestimate bladder volumes compared to that of catheterization in the studies of Lukasse et al. (2007) and Demaria et al. (2004) but there was no differences in the estimated bladder volumes between the two methods in the studies of Van Os and Van Der Linden (2006). Differences between bladder scanning and catheterization could be due to technical problems. The uterine shape and size or blood in the uterus may be mistaken for urine in the bladder (Teng et al., 2005; Altschuler and Diaz, 2006; Saint et al., 2009). Although, bladder scanning is considered to be a reliable method for assessing PVRBV in women who recently delivered, the estimated volume may differ between bladder scanning and catheterization (Van Os and Van der Linden, 2006; Lukasse et al., 2007).

A threshold of 400 ml for catheterization was used in this study. The threshold used in the immediate postpartum period varies in the literature from 150 to 500 ml (Glavind and Bjork, 2003; Van Os and Van der Linden, 2006; Buchanan and Beckmann, 2014). A low threshold may result in unnecessary catheterizations. In addition to discomfort, there is risk of urinary tract infection. Catheterization is not the only way to treat PUR. The midwife has an important role to instruct women to void frequently and with good amounts of urine (Rogers and Leeman, 2007; Saint et al., 2009; Leach, 2011). There are some management recommendations in the literature to aid voiding. These include early administration of oral analgesic and analgesic ointment, providing privacy, and helping the patient to stand and walk after delivery (Yip et al., 2004; Leach 2011). One study reports that 50% of women with PUR could void with these simple management procedures (Kerr-Wilson et al., 1984). Catheterization should not be performed until these methods have been attempted (Yip et al., 2004).

There are some limitations to this study. A quasi experimental design was chosen since a true randomized trial had been practically difficult to implement. There are obviously some operator errors among the bladder scanning results in this study. The staff members were trained on how to use the bladder scan before the study but the discrepancies between the bladder scanning and catheterization results were higher in this study compared to those in previous reports (Demaria et al., 2004; Van Os and Van der Linden, 2006; Lukasse et al., 2007). Training in bladder scanning techniques improves the accuracy for determining low bladder volumes (Oh-Oka and Fujisawa, 2007). The training program might have been too short but the study had on the other hand no significant inter-observer variability. The study did not catheterize all women in the experimental group and therefore, it is unclear if there were any false negative bladder scanning results. However, bladder scan tended to overestimate and not underestimate bladder volumes <500 ml compared to catheterization and therefore, it is unlikely that the study had false negative results. This study had no follow-up data for the women. This study did not know if the women who had PVRBV ≥400 ml but

lacked clinical signs and symptoms of PUR would have had injuries if they had not been catheterized. The long-term consequences of PUR are largely unknown (Mulder et al., 2014). PUR might be a transient problem; however, evidence that it is harmful is lacking and PUR should be regarded as a serious condition due to the possible complications (Mulder et al., 2014). A regimen based on clinical signs and symptoms alone fails to detect many women with covert PUR and a more frequent and systematic use of catheterization instead of bladder scanning is a worse alternative.

Conclusion

This prospective study shows that oxytocin infusion and perineal tears are strong risk indicators for PUR in women with vaginal delivery. The odds of identifying women with PUR are 2.7 times higher by use of bladder scan than by use of clinical signs and symptoms. It is suggest that there should be a regimen based on bladder scanning, especially in women with vaginal delivery and risk indicators, to select those who need support to void or catheterization. Further studies are needed to test the design and efficiency of such a regimen and the long-time consequence of PUR.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENTS

The authors would like to thank the staff at the Department of Obstetrics and Gynecology, County Hospital Ryhov, Jönköping, Sweden for their help and assistance. Statistical assistance was provided by Mats Nilsson. The study was supported by grants from Futurum, the Academy for Health Care, Jönköping County Council, Jönköping, Sweden.

Abbreviations: PUR, Postpartum urinary retention; **PVRBV,** post-void residual bladder volume; **IUC,** indwelling urinary catheter; **Ns,** not statistically significant; **R,** correlation coefficient; **OR,** odds ratio; **CI,** confidence interval.

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