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Perioperative bladder management: Assessment of residual pre-operative bladder volume to mitigate post-operative urinary retention

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Abstract

Background: Effective perioperative bladder management aims to limit post-operative urinary retention and its complications. Catheterisation, a standard treatment for post-operative urinary retention, can cause urinary tract infections and trauma. This study aimed to assess pre-operative bladder volume, compare nurse-documented and patient-reported last void times, and evaluate the influence of known risk factors, including urinary symptoms, on pre-operative bladder volume, as well as potentially identifying interventions to reduce post-operative urinary retention.

Method: Over three months, bladder ultrasound scans were performed on 200 pre-operative patients at a public hospital in Perth, Western Australia. The study followed the Standards for quality improvement reporting (SQUIRE) guidelines, and the SQUIRE checklist is declared in the materials and methods section.

Results: Most patients (79%, n = 158) had bladder volumes below 150 ml; the remainder (21%, n = 42) had volumes exceeding this threshold. Male patients had significantly higher bladder volumes than females, and there was a weak positive correlation between age and pre-operative bladder volume. Older male patients (≥55 years) were more likely to have a bladder volume of more than 150 ml than younger male patients (<55 years). No significant difference was found between nurse-documented and patient-reported last void times, validating the accuracy of nursing records. Female gender and existing urinary symptoms were not significantly associated with pre-operative bladder volumes over 150 ml.

Conclusion: Male patients aged over 55 are at increased risk of having pre-operative bladder volumes equal to or exceeding 150 ml and therefore require proactive bladder management to prevent post-operative urinary retention and reduce the need for catheterisation, which may result in infection and trauma. This study highlights the effectiveness of bladder ultrasound scans and accurate nursing documentation in assessing the risk of post-operative urinary retention, promoting informed clinical decision-making and reducing avoidable patient harm.

Impact: This study underscores the importance of pre-operative bladder volume assessment in reducing the risk of post-operative urinary retention thus minimising the need for catheterisation and the incidence of related complications, including infection and trauma.

Patient contribution: Patients reviewed and improved the written information consent form, enhancing the clarity and effectiveness of the consent process.

Keywords: bladder management, bladder ultrasound scans, pre-operative bladder volume, post-operative urinary retention, residual bladder volume, catheter-associated urinary tract infection

Introduction

Effective bladder management in the perioperative period aims to limit the incidence and complications of post-operative urinary retention (POUR) and reduce avoidable patient harm. Urinary catheterisation is a common treatment for POUR and is associated with complications, including catheter-associated urinary tract infection (CAUTI) and urinary tract trauma[1–3]. Assessment of pre-operative bladder volume by ultrasound may identify patients at risk of high post-operative bladder volume and POUR and reduce unnecessary urinary catheterisation, reducing the incidence of CAUTI and the risk of urinary tract trauma[4–8].

POUR is generally described as the inability to void in the presence of a full bladder within four hours of surgery[4,9–11]. Symptoms may include abdominal discomfort, pain and a feeling of fullness accompanied by a palpable bladder[4,9,11]. However, POUR may go unnoticed by a patient for some time, creating the necessity for vigilance in monitoring and a proactive response to evolving signs of the onset of POUR[4,12].

The prevalence of POUR in patients within the first 24 hours following surgery is reported in the range of 5 to 84 per cent, differing across surgical specialities. It is influenced by patient-related factors including age, gender and existing urinary symptoms[4,13–16]. In the general surgical population, the incidence is cited as between 3.8 and 13 per cent, increasing to 52 per cent in the colorectal surgical population and rising as high as 84 per cent in some subspecialties of orthopaedic surgery[4,15,17,18]. The reported variance in POUR is influenced by the disparity in definitions, making it challenging to extricate an authentic source of variation across factors[3,4,16,19].

Risk factors of POUR include age, benign prostatic hypertrophy, existing urinary symptoms and extended time of procedure[4,12,15,17,20,21]. Increasing age is a significant risk factor for POUR due to age-related changes such as reduced detrusor muscle contractility and increased comorbidities affecting the lower urinary tract[4,15,17,20–22]. The POUR risk may be further accentuated by additional intra- and post-operative factors, including volume and type of intravenous fluid administered, anaesthetic agents, analgesics and procedure-specific medications[3,4,15,17,20,23–25].

In addition to the increased risk of CAUTI and urinary tract trauma, complications of POUR include over-distension of the bladder which, if not relieved, may lead to longer-term detrusor muscle damage and voiding dysfunction[6,7,12,20,26]. POUR may also trigger an autonomic response resulting in increased heart rate and blood pressure and cardiac arrhythmias, which are potentially harmful to patients with existing cardiovascular pathology[6,27].

Prevention, education, early diagnosis and prompt evidence-based treatment are essential to prevent long-term harm and minimise potential complications of POUR. Regular and repeated use of bladder ultrasound scans supported by evidence-based bladder management protocols have been shown to reduce unnecessary urinary catheterisation, CAUTI and urinary tract trauma by promoting bladder emptying prior to surgery[3,4,15,28].

Aims

The study aims were to:

- identify the pre-operative bladder volume in patients transferred to the operating theatres
- identify any significant variation between nurse-documented and patient-reported time of the last void
- identify the prevalence of patients attending operating theatres with identified risk factors for POUR.

Materials and methods

Study design

A prospective observational methodology was employed. This study followed the Standards for quality improvement excellence (SQUIRE) guidelines. Institutional approval was obtained for this study as a low-risk activity (GEKO#50218).

Recruitment and consent

Patients attending operating theatres were approached in the admission ward before transfer to the operating theatre and provided verbal and written information about the study's objectives and procedures. After transferring to the pre-operative unit holding area, patients were approached again and asked if they consented to participate in the study. If they agreed, this was considered verbal consent and was documented by the researcher. Patients were excluded if they met any of the following criteria.

Exclusion criteria

Patients were excluded from the study if they:

- had an indwelling urinary catheter
- performed intermittent self-catheterisation
- had a urinary stoma
- required an emergency procedure
- reported abdominal pain
- appeared visibly distressed.

Bladder ultrasound scan

Three experienced registered nurses competent in bladder ultrasound scanning conducted the scans using BladderScan® PRIME non-invasive bladder volume instrument with ImageSense™ deep learning technology. With the patient lying in a supine position and with the abdominal muscles relaxed, the patient's pubic bone was palpated. An ample quantity of ultrasound gel was applied midline on the patient's abdomen, approximately three centimetres above the pubic bone.

The probe was gently pressed onto the lower abdomen through the gel. The probe cable was oriented at 90 degrees to the sagittal plane of the patient, and the head of the image on the probe's LCD screen was pointing toward the patient's head. When scanning an obese patient, abdominal adipose tissue was lifted out of the way of the probe and more pressure was applied. With live B-mode enabled, the scan was activated after aligning the probe to display the bladder within the optimal target area on the display screen. After reviewing the scan result, repeat scanning was performed as necessary to adjust the aim or confirm the initial measurement.

All scan results were documented in the data audit tool. Where the scan result identified a bladder volume over 150 ml, the allocated pre-operative unit nurse was informed of the scan result and it was documented on the perioperative chart. Patients were encouraged to empty their bladder, and a second residual bladder ultrasound scan was performed and recorded. The pre-operative unit nurse communicated the findings of the scans to the anaesthetist or nurse who was receiving the patient for surgery.

Audit tool and data collection

The audit tool was developed using Research Electronic Data Capture (REDCap) with field validation active to ensure that the entered data met specific standards. The data collected included patient age, gender, surgery type, expected length of operation, pre-existing urinary tract symptoms, the nurse-documented time of last void, the patient-reported time of last void, the time the pre-operative bladder ultrasound scan was performed, the pre-operative bladder volume, the time of repeated scan (if performed) and the residual pre-operative bladder volume following second scan.

In this study, a residual bladder volume of 150 ml, or greater, prior to surgery was a threshold for notification and intervention. The reasoning for this volume is that adult urine production is between 0.5 to 1.0 ml per kilogram per hour, depending on hydration status and renal function[30]. Adding urine produced during the average operation time to a pre-operative residual bladder volume of 150 ml, or greater, will result in a post-operative bladder volume of 200 to 400 ml. Residual urine of more than 250 ml is significant, while more than 350 ml puts the patient at risk of upper urinary tract dilatation and renal insufficiency[30].

The data was downloaded to IBM SPSS® Statistics (Statistical package for the social sciences) for Windows, version 29.0, for analysis after two team members had carefully cleaned the data to remove any errors or inconsistencies.

Data analysis

Data were analysed using IBM SPSS® Statistics, version 29.0. Descriptive statistics were calculated and reported as means with standard deviation (SD) for continuous, normally distributed data. Medians and interquartile ranges (IQRs) were reported for continuous, non-normally distributed data. Categorical data were summarised using counts and percentages. Differences between groups for continuous data were assessed using t-tests, while chi-square tests were used for categorical variables. Pearson's correlation coefficient was used to evaluate linear correlations. Statistical significance was set at a 95 per cent confidence level.

Ethical considerations

This study received institutional approval as a Quality Activity (GEKO#50218) from Royal Perth Bentley Group on 3 October 2023.

Results

Between November 2023 and March 2024, 200 patients scheduled for surgical procedures across 13 surgical specialities consented to participate in the study. There was approximately twice as many males (64%, n = 128) as females (36%, n = 72). The age of participants ranged from 18 to 90 years (mean = 55.09, SD±17.816). For sub-analysis, patients were categorised into two age brackets based on whether their age was less than the mean age of 55 years (44%, n = 88) or equal to or greater than 55 years (56%, n = 112).

Surgical specialty and age bracket

Table 1 shows the distribution of patients between surgical specialties. The most common specialities in the study were orthopaedic surgery (26.0%, n = 52), plastic surgery (23.5%, n = 47) and general surgery (13.5%, n = 27). Higher proportions of patients in the older age bracket were found in

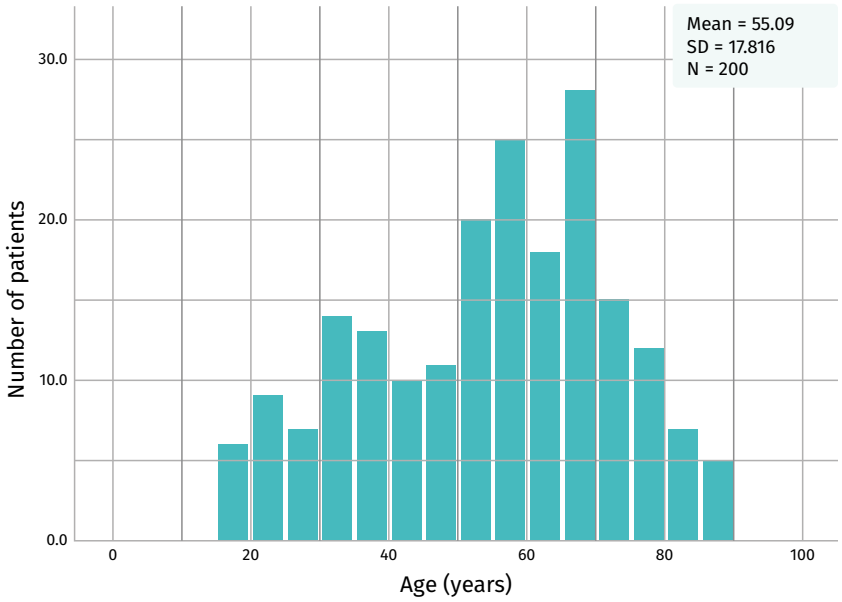

Figure 1: Age distribution of participants

Table 1: Surgical specialty and age bracket

Surgical specialty	Age < 55 years	%	Age ≥ 55 years	%
Orthopaedics (n = 52)	30	57.69	22	42.31
Plastics (n = 47)	22	46.81	25	53.19
General surgery, including breast surgery (n = 27)	13	48.15	14	51.85
Urology (n = 17)	5	29.41	12	70.59
Vascular (n = 15)	1	6.67	14	93.33
Ear, nose and throat (n = 11)	5	45.45	6	54.55
Ophthalmology (n = 10)	3	30.00	7	70.00
Maxilla facial (n = 6)	5	83.33	1	16.67
Gastroenterology (n = 5)	1	20.00	4	80.00
Respiratory (n = 3)	2	66.67	1	33.33
Colorectal (n = 3)	1	33.33	2	66.67
Endocrine (n = 2)	0	0.00	2	100.00
Gynaecology (n = 2)	0	0.00	2	100.00
Total	88		112	

vascular surgery (93.3%, n = 14 of 15), gastroenterology (80.0%, n = 4 of 5) and urological surgery (70.6%, n = 12 of 17).

Pre-operative bladder volume, gender and age bracket

Pre-operative bladder volumes ranged from zero to 900 ml (mean = 86.89, SD ± 134.895). There was a significant difference (p = 0.004) in mean bladder volumes between males (104.62 ml) and females (55.36 ml). There was a positive, weak correlation between pre-operative bladder volumes and age, suggesting pre-operative bladder volume increases with age (r = 0.209, p = 0.003). Of the 128 males in this study, 56 (43.8%) were less than 55 years old, and nine (16.1%) of these had a pre-operative bladder volume equal to or greater than 150 ml. Of the 72 (56.2%) males who were 55 or older, 23 (31.9%) had a pre-operative bladder volume equal to or greater than 150 ml. We found, in our cohort, that males aged 55 years or older were more than twice as likely to have a bladder volume of 150 ml or greater than their younger co-participants (OR 2.45, 95%CI:1.029,5.841, p = 0.043).

Of the 72 females in this study, 32 (44.4%) were less than 55 years old, and five (15.6%) of these had a pre-operative bladder volume equal to or greater than 150 ml. Of the 40 females who were 55 or older, five (12.5%) had a pre-operative bladder volume equal to or greater than 150 ml. There was no statistically significant association between age and female bladder volume.

Table 2: Pre-existing urinary symptoms and bladder volume

Patient-reported, pre-existing urinary symptoms	Urine volume < 150 ml	Urine volume ≥ 150 ml
Retention (n = 1)	1	0
Obstructed voiding (n = 5)	3	2
Enlarged prostate (n = 13)	12	1
Urinary stress incontinence (n = 4)	4	0
Urinary incontinence (n = 13)	11	2
Colovesical fistula, with pneumaturia (n = 1)	0	1
None (n = 163)	127	36
Total	158	42

Pre-existing urinary symptoms and bladder volume

Pre-existing urinary symptoms were reported by 37 patients (18.5%) and six (16.2%) of these had volumes equal to or greater than 150 ml (see Table 2).

There was no relationship between presence of pre-existing urinary symptoms and bladder volume of 150 ml or greater (p = 0.323). Similarly, there was no relationship between absence of pre-existing urinary symptoms and bladder volume of 150 ml or greater (p = 0.508). There were 36 patients with bladder volume of 150 ml or greater who had not reported pre-existing urinary symptoms. Of these, 25 patients had moderate pre-operative bladder volume ranging from 150 ml to 295 ml and the remaining 11 patients had a concerning and significant pre-operative bladder volume ranging from 388 ml to 830 ml.

Nurse-documented times of last void and patient reported-time of last void

The nurse-documented time of the last void was compared with the patient-reported time of the last void, and no statistically significant difference was found between the two (p = 0.733).

Surgical specialty and expected length of procedure

The majority of procedures (77.5%, n = 155) had an estimated length of less than two hours. Thirty-nine procedures (19.5%) had an expected length between two and four hours, and only six (3.0%) had an expected length of more than four hours (see Table 3).

Discussion

Our findings in this study revealed a need to properly assess pre-operative bladder volumes in order to protect patients from potential urinary tract injury, particularly male patients older

Table 3: Surgical specialty and expected length of procedure

Surgical specialty	< 2 hours	%	2–4 hours	%	> 4 hours	%
Orthopaedics (n = 52)	42	21.0	10	5.0	0	0.0
Plastics (n = 47)	44	22.0	2	1.0	1	0.5
General surgery, including breast surgery (n = 27)	18	9.0	6	3.0	3	1.5
Urology (n = 17)	12	6.0	5	2.5	0	0.0
Vascular (n = 15)	9	4.5	5	2.5	1	0.5
Ear, nose and throat (n = 11)	4	2.0	6	3.0	1	0.5
Ophthalmology (n = 10)	9	4.5	1	0.5	0	0.0
Maxilla facial (n = 6)	3	1.5	3	1.5	0	0.0
Other (n = 15)	14	7.0	1	0.5	0	0.0
Total	155	77.5	39	19.5	6	3.0

55 years. Pre-operative bladder volumes were significantly smaller in females than males.

Age and benign prostatic hypertrophy have been identified as patient-related risk factors for POUR. This study identified a two-fold risk of older males having a higher pre-operative bladder volume, putting them at greater risk for POUR and the need for catheterisation. The possible reason for this finding is that patients in this group have a high risk of having benign prostatic hypertrophy, which affects the ability to empty the bladder effectively[31], and is a patient-related risk factor for POUR. This benign condition is widespread in Australian males aged between 45 and 70 years, and is present in approximately half of all males aged over 65 years[32]. Older patients, particularly male patients, who have anaesthetics procedures, should be closely observed throughout their perioperative journey to avoid POUR.

Pre-existing urinary symptoms are also considered to be risk factors for POUR. Surprisingly, there was a lack of association between patient-reported, pre-existing urinary symptoms and pre-operative bladder volumes over 150 ml. A notable proportion of patients without pre-existing urinary symptoms (18%, n = 36) had pre-operative bladder volumes exceeding 150 ml. It became apparent during data collection that a proportion of male participants aged over 55 years did not perceive they had urinary retention or any lower urinary tract symptoms. Accordingly, this highlights the need for objective screening and avoidance of relying on patient-reported symptoms.

There are limited reports that examine pre-operative bladder volume in a mixed patient cohort such as our study. One study, of orthopaedic patients admitted through the emergency department, supported the need for regular pre-operative bladder scanning to prevent post-operative bladder distension and the need for catheterisation[33]. We found no relationship between pre-operative bladder volume and surgery type in our study. This may be because there were many surgical specialities in our study, and the procedures were deemed elective; therefore, our patient group did not match the at-risk group identified in the previous study[33].

Our study did not identify a significant difference between the time of the last void, as documented by the nurse, and the time reported by patients. Nursing documentation must be sufficiently relied upon to accurately capture the patient's voiding times. Precise documentation is essential in determining the risk of POUR and making timely decisions about bladder management. This will ensure timely patient care and safe clinical outcomes in the peri-operative environment.

There is a commonality within the literature regarding the definition of post-operative bladder distention at 500 ml or above[3, 4,15]. Identifying an acceptable and safe upper limit of pre-operative bladder volume is not as clear cut. In this study, we selected a volume of 150 ml based on the average adult urine production of 0.5 to 1.0 ml per kilogram per hour[29]. However, this would be highly variable and dependent on age, renal function, hydration status, medication and fluid administration. Joelsson-Alm et al.[33] used a pre-operative bladder volume threshhold of 200 ml when screening patients. Presently, no agreed safe pre-operative bladder volume is identified to ensure a patient will not develop bladder distension in the post-operative period. We would suggest that ongoing screening throughout the perioperative journey is vital in order to prevent POUR in patients who start their operation with over 150 ml in their bladder.

POUR poses significant economic and logistical challenges to service providers[6,7]. Patients diagnosed with POUR account for 20 to 25 per cent of unplanned hospital admissions following ambulatory general surgical procedures and have a comparatively longer hospital stay[12,34]. Managing POUR requires additional time and resources, potentially increasing health care costs and diverting staff from other critical aspects of patient care[24]. Additionally, patients with POUR may re-present to the emergency department following discharge and require additional outpatient follow-up with specialist services[12].

A potential positive proposition is to incorporate routine bladder ultrasound scanning into peri-operative protocols for male patients over 55, particularly before and after more prolonged surgical procedures and where patients have not been catheterised during their procedure. The insights from this study can inform the development of age-specific clinical guidelines and health care policies, ultimately enhancing the quality of care for ageing populations and reducing patient harm.

Limitations

We conducted this study with a sample size of 200 patients from a single tertiary public hospital in Perth, Western Australia. While this provided valuable site-specific insights, the relatively small sample and single-site focus may limit generalisation of our findings to broader

populations or settings. While we found no significant difference between nurse-documented and patient-reported times of last void, minor discrepancies may exist. The study focused on measuring pre-operative bladder volumes without post-operative follow-up to assess the incidence of POUR, urinary catheterisation and urinary tract trauma. Therefore, we recommend that future studies consider a longitudinal design to track post-operative patient outcomes.

Conclusion

Detection of high pre-operative bladder volumes can be used to identify patients at risk of developing POUR so proactive bladder management can be implemented to prevent the need for catheterisation, thereby reducing patient harm. Our study found a significant positive correlation between age and bladder volume in males, indicating that bladder volume increases with age in this group. In contrast, no such correlation was found in females, highlighting a potential gender difference in bladder volume dynamics.

Our findings support targeted pre-operative bladder ultrasound scans in male patients over 55 to identify those at potential risk of undiagnosed chronic urinary retention and to tailor bladder management strategies accordingly.

Declaration of conflicting interests

The authors have declared no competing interests with respect to the research, authorship and publication of this article.

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