Original study Postoperative Urinary Retention: Risk Factors, Speed of Bladder Filling and Time of Catheterization: An Observational Study as Part of a Randomized Controlled Trial

Tammo Allie Brouwer (tammos@planet.nl)
Medisch Centrum Leeuwarden

Eric N van Roon
Medisch Centrum Leeuwarden

Cor J Kalkman
Universitair Medisch Centrum Utrecht - Locatie Wilhelmina Kinderziekenhuis

Nic Veeger
Medisch Centrum Leeuwarden

Research

Keywords: Anesthesia, Catheterization, Maximum Bladder Capacity, Postoperative, Risk Factors, Surgery, Urinary Retention

DOI: https://doi.org/10.21203/rs.3.rs-34604/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

Background

If risk factors for postoperative urinary catheterization are known adverse events to the lower urinary tract may be prevented. Therefore, postoperative surgical patients were assessed for risk factors for urinary catheterization, for speed of bladder filling and for time till catheterization or spontaneous voiding. The individual maximum bladder capacity was used as threshold for urinary catheterization.

Methods

In this prospective observational study 936 general surgical patients were analyzed for risk factors for urinary catheterization. Patients were 18 years or older and were operated under general or spinal anesthesia without the need for an intra-operative indwelling urinary catheter. The maximum bladder capacity was measured at home by voiding in a calibrated bowl after a strong urge that could no longer be ignored. Postoperatively bladder volumes were hourly assessed with ultrasound. Patients were catheterized after reaching their maximum bladder capacity and being unable to void. Speed of bladder filling and time to catheterization were then calculated.

Results

Spinal anesthesia was the main independent modifiable risk factor for urinary catheterization (hyperbaric bupivacaine RR 8.1, articaine RR 3.1). Unmodifiable risk factors were a maximum bladder capacity <500mL (RR 6.7), duration of surgery ≥60 minutes (RR 5.5), first scan at Post Anesthesia Care Unit ≥250mL (RR 2.1) and age ≥60 (RR 2.0). Urine production varied between 100mL to 200mL/hour. Catheterization or spontaneous voiding happened around 4 hours postoperatively.

Conclusion

Using the individual maximum bladder capacity, next to the other risk factors, identifies patients at risk for urinary catheterization. These factors should be taken in account whether or not to catheterize the patient to prevent unnecessary urinary catheterization. Considering urine production and maximum bladder capacities, the bladder should be scanned at least within 3 hours postoperatively to prevent overdistention and damage to the lower urinary tract.

Background

Post-Operative Urinary Retention (POUR) followed by urinary catheterization is a well-known and frequent complication after surgery under general or spinal anesthesia. Since the introduction of routine bladder ultrasound the definition of ‘POUR necessitating urinary catheterization’ has gradually changed. This definition changed from a time limit (= patient must have voided within a certain time period) into a volume limit (= scanned bladder volume in mL). In literature this volume limit can vary between 400 mL to 600 mL. In an earlier study we demonstrated a large interindividual variation in maximum bladder
volumes. This was independent of age, gender and BMI. The beneficial effect of the individual maximum bladder capacity (MBC), as a volume limit for POUR, was established in a large scale randomized controlled trial (RCT) (Risk Reduction 0.73, 95%CI 0.55 to 0.96; p = 0.025).

Urinary catheterization is the solution to prevent bladder overdistention. Still, urinary catheterization is an embarrassing procedure that most patients would like to avoid. It can cause urethral trauma, discomfort and urinary tract infection. On the other hand, bladder overdistention can bring temporary or permanent damage to the lower urinary tract (LUT). LUT dysfunction can vary from mild (frequent voiding), to moderate (recurrent urinary tract infections) and even to severe adverse events (permanent bladder damage ending in life-long self-catheterization). It is unknown how many patients are affected annually by complications of urinary catheterization or by a long-term overdistended bladder (over 3 hours). And next to this, it is a clinical reality that POUR is handled by the nursing staff, out of sight from the anesthesiologists and surgeons. These two facts together could be an explanation why there is a lack of urgency and why preventing urinary catheterization is not high on the surgeons and anesthesiologist priority list. Also, in some countries POUR is considered a surgical complication while in other countries anesthesiologists feel obliged to take responsibility for prevention and management of POUR. The American Society of Anesthesiologists (ASA) and the Dutch Society of Anesthesiologists (NVA) have no practice guidelines for management of POUR.

Aim of the study

To identify risk factors for urinary catheterization in a controlled setting. The strength of the risk factors may vary based on data which defines catheterization need. To this end, we used the data from the RCT where the individual MBC was used as a threshold for urinary catheterization, rather than using a fixed bladder volume limit. Next to these risk factors, we calculated the speed of bladder filling and analyzed time to spontaneous voiding and catheterization. The results of these analysis should help health care providers in preventing adverse events to the LUT.

Methods

Type of study

This is an observational study analyzing risk factors for urinary catheterization as part of an RCT.

Participating patients

All patients provided written informed consent, including permission to use data for additional analysis. Included patients were at least 18 years of age and scheduled to undergo a surgical intervention under general or spinal anesthesia. Peroperatively, there was no anticipated need for an indwelling urinary catheter. Patients were informed and asked to participate during their visit at the pre-assessment anesthesia clinic (PAC). After approval and informed consent patients were asked to go to the restroom to
assess the residual bladder volume by ultrasound. At home, the maximum bladder capacity was measured by postponing voiding as long as possible. When a strong urge occurred that no longer could be ignored, they had to void in a calibrated bowl (supplied by the hospital) to measure their maximum voided volume. They were asked to repeat this procedure three times at different moments during a week. The MBC was calculated as the largest voided volume at home minus the residual volume measured at the PAC. The MBC was recorded in the database.

Postoperatively, the bladder of each included patient was scanned every hour till the MBC was reached. At that moment, the patient was asked to void. When spontaneous voiding was not possible, urinary catheterization was performed by the nursing staff. A research assistant performed the bladderscan measurements using ultrasound (The BladderScan BVI 9400, Verathon, Bothell, WA, USA). The original aim was to evaluate the effect of using the MBC in prevention of urinary catheterization compared to a fixed bladder volume limit of 500 mL.

**Outcome**

Pre-planned secondary outcome consisted of analysis of risk factors for urinary catheterization, based on the data from the RCT. Only the data of the MBC group was used for analysis. These results were considered new data using a new definition for POUR and urinary catheterization. Of the 893 patients in the MBC group who were analyzed in the original RCT for IPSS/QoL (international Prostate Symptoms Score/ Quality of Life score) (Fig. 1), 43 patients were included with missing data but who could still be analyzed for risk factors (total 936 patients). Pre- and perioperative patient and procedural characteristics, prospectively collected in the original RCT, were considered as potential risk factors for the occurrence of urinary catheterization. Potential risk factors were divided in unmodifiable risk factors that could not be influenced by anesthesiologists and surgeons, and in modifiable risk factors that are under direct control of anesthesiologists (Table 1). Duration of surgery is not under direct control of anesthesiologists and is therefore considered not modifiable. For developing possible prediction models, speed of bladder filling in milliliters per hour was calculated and time till catheterization or spontaneous voiding was assessed.
### Table 1
Risk factors subdivided in unmodifiable and modifiable risk factors

| UNMODIFIABLE                                                                 | MODIFIABLE                                                                 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| **PREOPERATIVE**                                                             |                                                                            |
| Demographic variables such as gender, age and BMI, Maximum Bladder Capacity, Co-Morbidity (Hypertension and Diabetes) | Pre-medication with Benzodiazepines and/or NSAID’s,                         |
| Drugs used such as Beta blockers, Benzodiazepines and anti-Depressive/anti-Psychotic drugs. | Bladder volume/residual volume before start of surgery, Time since last voiding. |
| **PEROPERATIVE**                                                             |                                                                            |
| Type of Surgery, divided in Head-Neck, Thorax/Back/Breast, Lower Abdominal or Lower Extremities, Duration of Surgery. | Type of Anesthesia; General or Spinal (divided in short acting Articaine and long acting Bupivacaïne), Cardiovascular drugs such as Atropine, Ephedrine and/or Phenylephrine, Opioids. |
| **POSTOPERATIVE**                                                            |                                                                            |
|                                                                              | Bladder volume after arriving at PACU, Total sum of opioids needed, Drugs given such as cardiovascular drugs, opioids, anti-emetics, Total volume infused or taken. |

### Statistical analysis

Categorical data are presented as counts and percentages. Continuous variables are presented as mean with SD or medians with interquartile ranges, depending on normality of data. For each potential risk factor, differences in the incidence of postoperative urinary catheterization were estimated using a univariate log-binomial regression model. In case of failure to converge, a “modified Poisson” approach was applied with robust error variances to estimate crude relative risks and confidence intervals. After univariate analysis of all potential risk factors, those with a P-value < 0.10 were included in the initial multivariable model. A backward elimination strategy was used to achieve the most suitable model to estimate the adjusted relative risks with the final multivariable model, only including risk factors associated with postoperative urinary catheterization at a level of P < 0.05. In this, also first order interactions were taken into consideration. A two-tailed P-value < 0.05 was considered to indicate statistical significance. All analyzes were performed using SAS software, version 9.4 (SAS institute, Inc, Cary, NC).

### Results

The MBC group consisted of 936 surgical patients. The average MBC was 611 mL (SD ± 209 mL, range 150 to 1400 mL). The incidence of urinary catheterization was 9.1% (85/936) (Table 2).
| MBC group                          | N = 936 |
|-----------------------------------|---------|
| **Patient data**                  |         |
| Women, No. (%)                    | 493 (53)|
| Age, mean (SD), y                 | 47.9 (15)|
| Height, mean (SD), cm             | 176 (10)|
| Weight, mean (SD), kg             | 81.4 (17)|
| BMI, mean (SD), kg/m²             | 26.3 (5)|
| **Type of Surgery, No. (%)**      |         |
| Head/Neck                         | 209 (22)|
| Thoracic/Breast                   | 77 (8) |
| Spine                             | 33 (4) |
| Abdominal                         | 273 (29)|
| Extremities                       | 344 (37)|
| **Study Data**                    |         |
| MBC, mean (SD), ml                | 611 (209)|
| Residual volume, mean (SD), ml    | 33 (53) |
| Voided before surgery, No. (%)    | 877 (94)|
| Time before surgery, mean (SD), min| 59 (48)|
| Volume at Holding, mean (SD), ml  | 52 (81) |
| General Anesthesia, No. (%)       | 639 (68)|
| Spinal Anesthesia, No. (%)        | 297 (32)|
| Articaine, No. (%)                | 235 (79)|
| Bupivacaine, No. (%)              | 62 (21) |
| Total volume infused, mean (SD), ml| 1,492 (647)|
| Procedure time, mean (SD), minutes| 61 (40)|

BMI – Body Mass Index, MBC – Maximum Bladder Capacity, SD – Standard Deviation
Modifiable risk factors

Figure A displays all identified (un) modifiable risk factors potentially associated with urinary catheterization (p < 0.10). The strongest modifiable risk factor for urinary catheterization was spinal anesthesia. Coupled to spinal anesthesia, and therefore not displayed in Fig. 1A-C, was the regression of the sensory block. If the sensory block was higher than dermatome T12, voiding was difficult and 69% of these patients had to be catheterized (RR 12.8, 95%CI 8.4 to 18.3; p < 0.0001). When the sensory block had regressed below dermatome S3, the incidence was 5.7% (RR 0.8, 95%CI 0.4 to 1.6; p = 0.49). Another modifiable risk factor was a preoperative bladder volume of 150 mL or more (RR ≥ 150mL 2.4, 95%CI 1.6 to 3.5; p < 0.02). The total volume infused over 1 liter was not a significant risk factor for urinary catheterization (RR 0.7, 95%CI 0.4 to 1.1, p = 0.09). Also, not significant were the perioperative used drugs piritramide (i.v. or s.c.) (RR 1.0, 95%CI 0.7 to 1.6; p = 0.91); ephedrine (RR 1.3, 95%CI 0.8 to 2.0, P = 0.33) and atropine (RR 1.2, 95%CI 0.7–1.9, p = 0.5). For phenylephrine the numbers were too small to analyse.

Unmodifiable risk factors

A smaller MBC increased the incidence of urinary catheterization. Of the 300 patients with an MBC < 500 mL 14% were catheterized. Compared to 9% of the 398 patients with an MBC between 500 mL and 800 mL and 2% of the 199 patients with an MBC ≥ 800 mL (MBC<500mL RR 7.0, 95%CI 2.5 to 19.1; p < 0.001). Older age (≥ 60) was a risk factor for urinary catheterization (RR 3.3, 95%CI 2.2 to 4.9; p < 0.0001). Also, a higher IPSS was a risk factor in the univariate analysis. In patients with 'severe' symptoms (IPSS 20–35) the incidence of urinary catheterization was 22% (RR 2.7, 95%CI 1.5 to 5.2, p = 0.002).

The strongest unmodifiable risk factor ‘related to surgery’ was the duration of surgery (RR<30min 4.5, 95%CI 1.8 to 11.3, RR><60min 5.1, 95%CI 2.1 to 12.8; p < 0.001). For the location of surgery, comparing head/neck/thoracic (general anesthesia), with surgery on the abdomen or extremity (general or spinal anesthesia) the incidence increased from 4.9–11.8% and 10.2% respectively (RR<abdomen 2.4, 95%CI 1.3 to 4.4; p < 0.004 and RR<lower extremity 2.1, 95%CI 1.1 to 3.7; p = 0.012). Another unmodifiable risk factor was the first scan ≥ 250 mL at the PACU (incidence 18.6% compared to 6.3% <250 mL (RR 3.0, 95%CI 1.9 to 4.4; p < 0.001).

Having no urge to void at the moment the MBC was reached turned out to be an unmodifiable risk factor. Of the 84 patients who were catheterised 60 patients had no urge to void (71%) (RR 4.8, 95%CI 3.1 to 5.9; p < 0.001). Gender (RR 0.8, 95%CI 0.5 to 1.2, p = 0.31) and preoperative known hypertension (RR 1.6, 95%CI 1.0 to 2.5, p = 0.07) did not reach statistical significance throughout all analysis. Anti-depressant drugs were used by 58 patients (6%) of which 18% was catheterized (RR 2.8; p < 0.001) and 61 patients used diazepam (6.5%) of which 23% was catheterized (RR 1.8; p = 0.02). For diabetes the number were too small to analyse (26 patients = 3.1%).

FULL MULTIVARIABLE ANALYSIS
In Figure B is displayed a full multivariable analysis for urinary catheterization in the MBC group including all potential risk factors with a level of $p < 0.10$ from univariate analysis. Using the backward elimination strategy, location of surgery and ‘severe’ IPSS were not identified as independent risk factors in the multivariable analysis.

FINAL MULTIVARIABLE ANALYSIS

In Figure C is displayed the final multivariable model. Spinal anesthesia was the main modifiable risk factor with a RR for hyperbaric bupivacaine of 8.1 and for articaine the RR was 3.1. The unmodifiable risk factors MBC (RR 6.7), duration of surgery (RR 5.5), first scan at PACU $\geq$ 250 mL (RR 2.1) and age $\geq$ 60 (RR 2.0) were identified as independent risk factors.

TIME OF VOIDING or CATHETERIZATION and SPEED of BLADDER FILLING

In Table 3 is calculated the time from the start of anesthesia till patients were able to void or were catheterized. The speed of bladder filling was estimated during this time period. This was done by subtracting the preoperative scanned bladder volume from the last scanned bladder volume before spontaneous voiding or catheterization. In both general and spinal anesthesia spontaneous voiding occurred after 280 min (4.5hrs). The scanned bladder volume was around 450 mL and the speed of bladder filling of 100 mL/u. Catheterization after general anesthesia happened significant later than after spinal anesthesia (352 ± 157 min versus 205 ± 74 min, $p < 0.001$). Spinal anesthesia patients who were catheterized (203 ± 94 mL/hour, $p = 0.005$) had a twice as high urine production than patients who voided spontaneously (107 ± 63 mL/hour).
Table 3
Time to catheterization/voiding after general or spinal anesthesia

|                      | N | MEAN  | STANDARD DEVIATION | MINIMUM | MAXIMUM |
|----------------------|---|-------|---------------------|---------|---------|
| **GENERAL ANESTHESIA** |   |       |                     |         |         |
| **Spontaneous**      |   |       |                     |         |         |
| Time (minutes)       | 580 | 282#  | ± 117               | 70      | 808     |
| Scan volume (mL)     | 595 | 412   | ± 206               | 0       | 1000    |
| Rate (mL/hour)       | 569 | 100   | ± 66                | 0       | 388     |
| **Catheter**         |   |       |                     |         |         |
| Time (minutes)       | 26  | 352*  | ± 157               | 178     | 710     |
| Scan volume (mL)     | 31  | 602   | ± 216               | 298     | 1000    |
| Rate (mL/hour)       | 25  | 137   | ± 84                | 32      | 317     |
| **SPINAL ANESTHESIA**|   |       |                     |         |         |
| **Spontaneous**      |   |       |                     |         |         |
| Time (minutes)       | 238 | 273^  | ± 82                | 99      | 712     |
| Scan volume (mL)     | 238 | 452   | ± 224               | 49      | 999     |
| Rate (mL/hour)       | 234 | 107&  | ± 63                | 11      | 379     |
| **Catheter**         |   |       |                     |         |         |
| Time (minutes)       | 44  | 205*  | ± 74                | 99      | 397     |
| Scan volume (mL)     | 52  | 626   | ± 179               | 330     | 999     |
| Rate (mL/hour)       | 43  | 203&  | ± 94                | 94      | 469     |

with their bladder filling rates.
Discussion

To our best knowledge this is the first study that uses the individual maximum bladder capacity (MBC) to establish risk factors for urinary catheterization after general or spinal anesthesia. The most important modifiable risk factor for postoperative urinary catheterization was spinal anesthesia. This is in accordance with literature. The risk to be catheterized after using hyperbaric bupivacaine was eight times more, and after articaine three times more, compared to general anesthesia. There is scarce literature available comparing general anesthesia with spinal anesthesia and its association with urinary catheterization. There are no recent studies about POUR or urinary catheterization after general anesthesia, let alone comparing their incidence with spinal anesthesia. Most studies about postoperative urinary catheterization are performed in orthopedic patients after spinal anesthesia. During spinal anesthesia the local anesthetics blocks the nerves necessary for spontaneous micturition (S2-S4). The spinal block has to regress till dermatome S3 before voluntary control over the external urethral sphincter has returned. Most patients are able to walk before spontaneous voiding is possible. For bupivacaine not being able to void may last up to eight hours. Therefore, if one wishes to modify and to reduce the risk for postoperative urinary catheterization (e.g. Day Care surgery), it may be justified to change the anesthesia technique. For example, using short acting local anesthetic for spinal anesthesia, or better if possible, use a regional technique (e.g. femoral or popliteal nerve block), or choose general anesthesia.

An MBC smaller than 500 mL was an unmodifiable risk factor for urinary catheterization (RR 6.7). Bjerregaard et al, studying orthopedic patients after fast track hip or knee surgery, compared a threshold for POUR of 800 mL versus 500 mL. They found an incidence of 13.4% versus 32.2%. They concluded that a threshold of 800 mL can be set safely, without increasing urological complications. Although their patient group consisted of ‘older’ patients, they did not know their MBC and their voiding history. A threshold of 800 mL may lead to complications in patients with smaller MBC’s (e.g. <500 mL) or in patients with already complaints of the LUT. In general, a strict POUR protocol should be used to prevent
bladder overdistention. When the MBC is known, the chance of urinary catheterization can be predicted and this may prevent unnecessary urinary catheterization, not too early and surely not too late.

Duration of surgery was in all analysis a strong unmodifiable risk factor (RR 5.1), consistent with similar studies.19–21 This could be due to the use of more anaesthetic drugs, longer unnoticed bladder filling or, in the case of using long acting spinal anesthesia, an impossibility to void for over eight hours. Shorter surgery time (for example a fast surgeon) can help to lower the incidence of urinary catheterization.

Not voiding before the start of surgery is considered a modifiable risk factor for POUR followed by urinary catheterization. In the univariate analysis a preoperative bladder volume ≥ 150 mL was a significant risk factor. In the final multivariable model this significance disappeared. Joelsson-Alm found in her prospective study about bladder distention in orthopedic surgery, that a higher preoperative bladder volume is a risk factor for POUR and urinary catheterization.22 She concluded that encouraging patients to void before leaving for the operating theatre does not necessarily mean an empty bladder at the start of surgery. This is confirmed in our results. Patients who already had a considerable bladder filling at the start of surgery were at risk for large bladder volumes postoperatively. Measuring bladder volumes at the holding area and urging patients to void if needed, can prevent large postoperative bladder volumes. Indeed, a postoperative bladder volume ≥ 250 mL after the first scan at the PACU was an important unmodifiable risk factor.23–25 Also, having no urge to void does not mean an empty bladder, 71% of the patients who were catheterized had no urge to void.

In patients ≥ 60 years of age the incidence of urinary catheterization was 18.5%, compared to 5.7% when age < 60 years. Older age is a well-known unmodifiable risk factor for postoperative urinary catheterization (RR 2.0)1–4,26–28 This could be due to higher IPSS scores in older patients. Or possibly to the different types of surgery performed in older patients: surgery on lower abdomen or lower extremity with longer operation times and the use of long acting spinal anesthesia, with or without the use of ephedrine/atropine. This effect was confirmed in the univariate analysis but disappeared in the final multivariable analysis (Figure A and C).

The modifiable risk factor ‘volume infused and taken orally’ over one liter looked as it had a small risk reducing effect, but this was not significant (RR 0.7, p < 0.09). Patients had received on average 1.5 liter of fluid at the time of voiding or catheterization. In literature, the amount of volume infused was often considered a modifiable risk factor for urinary catheterization.23–25 Recent studies showed that the amount of fluids given or taken perioperatively is not a significant risk factor for urinary catheterization.1,16,21

Possible modifiable risk factors are drugs given peroperatively.2,3,28 Opioids can have a dual effect on voiding, direct- by partially inhibiting the parasympathetic nerves that innervate the bladder, and indirect - by decreasing the awareness of a full bladder and the sensation of urge. Our results could not confirm that piritramide had an effect on the incidence of urinary catheterization (RR 1.0, p = 0.91). We did not registered pain scores as they were titrated below a VAS of 4 (Visual Analogue Scale) following protocol.
Cardiovascular drugs may also have an effect on bladder function by interaction with the sympathetic and parasympathetic nerve system. For atropine and ephedrine this effect was not significant. However, the at home used anti-depressant drugs and diazepam did have a significant effect on POUR, although their numbers were relatively small. These patients need to be monitored closely.

To estimate the speed of bladder filling after surgery, the time from the start of anesthesia till catheterization or spontaneous voiding was calculated (Table 3). This had been done before by Kreutziger et al. They studied time of voiding and catheterization in 86 patients after spinal anesthesia. Catheterization happened after ± 200 minutes (2hrs and 20 min) and voiding after ± 270 minutes (3.5hrs), comparable with our results for spinal anesthesia. In our study catheterization happened much later after general anesthesia: only after ± 350 minutes (after almost 6hrs)! This difference in time to catheterization between spinal and general anesthesia can possibly be explained by the difference in speed of bladder filling. In patients who were catheterized, the speed of bladder filling during spinal anesthesia was ± 70 mL/hour more than during general anesthesia (203 mL/h versus 137 mL/h). The speed of bladder filling does not only depend on anesthesia technique but probably also depends on factors such as age, fluid infused, antidiuretic hormone production, blood pressure, and is probably not linear. More studies are necessary to confirm our results. Still, with urine production and time of catheterization in mind: to prevent bladder overdistention it can be advised to scan the bladder at least within 3 hours (180 minutes) after the end of surgery. Some patients may then have reached their MBC, resulting in bladder volumes between 300 mL to 540 mL. This is a safe margin for urinary catheterization if the MBC is unknown, maybe too early, but surely not too late. A full bladder extended beyond the maximum bladder capacity for 2 to 3 hours can damage the detrusor muscle and should whenever possible be avoided.

In conclusion, in the present study we identified important independent risk factors for urinary catheterization. We used the individual maximum bladder capacity as the cut-off bladder volume limit for catheterization. The most important modifiable risk factor was spinal anesthesia, and the most important unmodifiable risk factors were an MBC < 500 mL, duration of surgery ≥ 60 minutes, the first scan at the PACU ≥ 250 mL and age ≥ 60 years. Knowledge of these risk factors for POUR can help anesthesiologist, surgeons and nursing staff to decide when catheterization is deemed necessary. On average, voiding or catheterization happened four hours after surgery and the speed of bladder filling varied between 100 mL to 200 mL per hour, depending on anesthesia technique. To prevent adverse events to the lower urinary tract a simple algorithm can be: (1) preoperatively, at the pre-assessment clinic, ask patients at risk to measure their MBC at home; (2) this individual MBC should be used as a postoperative bladder volume limit; (3) at the holding area, check if patients have voided before surgery and eventually measure the residual bladder volume; (4) if possible, prevent long acting spinal anesthesia; (5) postoperatively, estimate when the MBC will be reached, knowing the speed of bladder filling; and (6) use a POUR protocol at the PACU and the surgical ward, until spontaneous voiding or urinary catheterization is deemed necessary. Anesthesiologists and surgeons together, should raise awareness among the nursing staff how to recognize POUR and when to perform urinary catheterization when necessary.
List Of Abbreviations

RCT Randomized Controlled Trial
POUR Postoperative Urinary Retention
LUT Lower Urinary Tract
MBC Maximum Bladder Capacity
PAC Pre-assessment Anesthesia Clinic
PACU Post Anesthesia Care Unit
IPSS International Prostate Symptoms Score
QoL Quality of Life

Declarations

Ethical approval and consent to participate:
The RCT was approved by the Ethical Review Board of the Medical Center Leeuwarden on May 14th, 2008 [protocol no. TPO 523]. The RCT was registered in the Current Controlled Trials database no: ISRCTN97786497 (https://doi.org/10.1186/ISRCTN97786497).

Consent for publication:
Not applicable

Availability of data and materials:
The datasets used and analyzed during the current study are available from the corresponding author on reasonable request (t.brouwer@mcl.nl).

Competing interest:
The authors (TAB, ENR, CJK, NV) declare that they have no competing interests.

Funding:
No external funding was provided.
The original RCT was funded by Department of Science, MCL Academia, Medical Center
Authors’ contributions:

TB - data analysis, interpretation of data, writing manuscript

ENR - interpretation of data, writing manuscript

CJK - writing manuscript

NV - data analysis, interpretation of data, writing manuscript

All authors read and approved the final manuscript

Leeuwarden, The Netherlands 8500£ (10000€) and Verathon Medical™, Europe, IJsselstein, The Netherlands 21400£ (25000€).

Acknowledgements:

none

Authors information:

This study is part of the thesis “Postoperative Urinary Retention”. It is an investigator driven PhD project by TB, anesthesiologist, with support of ENR and NV as co-promotors, and CJK as promotor.

References

1. Brouwer TA, Rosier PF, Moons KG, Zuithoff NP, van Roon EN, Kalkman CJ. Postoperative Bladder Catheterization Based on Individual Bladder Capacity: A Randomized Trial. Anesthesiology. 2015; 122: 46–54.

2. Baldini G, Bagry H, Aprikian A, Carli F. Postoperative Urinary Retention: Anesthetic and Perioperative Considerations. Anesthesiology. 2009; 110: 1139-57.

3. Darrah DM, Griebling TL, Silverstein JH. Postoperative Urinary Retention. Anesthesiology Clin. 2009; 27: 465 – 84.

4. Choi S, Awad I. Maintaining Micturition in the Perioperative Period: Strategies to avoid Urinary Retention. Curr Opin Anaesthesiol. 2013; 26: 361–367.

5. Wyndaele JJ, De Wachter S. Cystometrical Sensory Data from a Normal Population: Comparison of two Groups of Young Healthy Volunteers Examined with 5 Years Interval. Eur Urol. 2002; 42:34–8.
6. Pavlin DJ, Pavlin EG, Gunn HC, Taraday JK, Koerschgen ME. Voiding in patients managed with or without ultrasound monitoring of bladder volume after outpatient surgery. Anesth Analg. 1999; 89:90 – 7.

7. Brouwer TA, Eindhoven GB, Epema AH, Krijnen HJ, Henning RH. Validation of an Ultrasound Scanner for Determining Urinary Volumes in Surgical Patients and Volunteers. J Clin Monit. 1999: 379 – 85.

8. Mason SE, Scott AJ, Mayer E, Purkayastha S. Patient-Related Risk Factors for Urinary Retention following Ambulatory General Surgery: A Systematic Review and Meta-analysis. AM J Surg. 2016; 211: 1126–1134.

9. Dreyer B, Moller MH, Bartholdy J. Post-Operative Urinary Retention in a General Surgical Population. Eur J Anaesthesiol. 2011; 28: 190–194.

10. Umer A, Ross-Richardson C, Ellner S. Incidence and Risk Factors for Postoperative Urinary Retention: A Retrospective, Observational Study with a Literature Review of Preventive Strategies. Conn Med. 2015; 79: 587–592.

11. Wu AK, Auerbach AD, Aaronson DS. National Incidence and Outcomes of Postoperative Urinary Retention in the Surgical Care Improvement Project. Am J Surg. 2012; 204: 167–171.

12. Nevo A, Haider AM, Navaratnam A, Humphreys M. Urinary Retention Following Non-Urologic Surgery. Current Bladder Dysfunction report. Sept 2019; 14: 157–167.

13. Bjerregaard LS, Bagi P, Kehlet H. Postoperative Urinary Retention (POUR) in Fast-Track Total Hip and Knee Arthroplasty: A Challenge for Orthopedic Surgeons. Acta Orthop. 2015; 86: 183–188.

14. Fernandez MA, Karthikeyan, Wyse M, Foguet P. The Incidence of Postoperative Urinary Retention in Patients Undergoing Elective Hip and Knee Arthroplasty. Ann R Coll Surg Engl. 2014; 96: 462–465.

15. Alaa Abdel aziz Niazi, Mohamed Abdel aziz Taha. Postoperative Urinary Retention After General and Spinal Anesthesia in Orthopedic Surgical Patients. Egyptian J Anesthesia. 2015; 31: 65–69

16. Scholten R, Kremers K, van de Groes SAW, Somford DM, Koeter S. Incidence and Risk Factors of Postoperative Urinary Retention and Bladder Catheterization in Patients Undergoing Fast-Track Total Joint Arthroplasty: A Prospective Observational study on 371 Patients. J Arthroplasty. 2018; 33: 1546–1551.

17. Kamphuis ET, Ionescu TI, de Gier J, van Verrooij GE, Boon TA. Recovery of Storage and Emptying Functions of the Urinary Bladder after Spinal Anesthesia with Lidocaine and with Bupivacaine in Men. Anesthesiology. 1998; 88: 310–316.

18. Bjerregaard LS, Hornum U, Ttroldborg C, Bogoe S, Bagi P, Kehlet H. Postoperative Urinary Catheterization Thresholds of 500 mL versus 800 mL after Fast-track Total Hip and Knee Arthroplasty: A Randomized, Open-label, Controlled Trial. Anesthesiology. 2016 June; 124:1256-64

19. Ringdal M, Borg B, Hellstrom AL. A Survey on Incidence and Factors that may influence first Postoperative Urination. Urol Nurs. 2003; 23: 341-6, 354.

20. Alsaidi M, Guanio J, Basheer A, Schultz L, Abdulhak M, Nerenz D, et al. The Incidence and Risk Factors for Postoperative Urinary Retention in Neurosurgical Patients. Surg Neurol Int. 2013; 4: 61–
21. Miller AG, McKenzie J, Greenky M, Shaw E, Gandhi K, Hozack WJ, Parvizi J. Spinal Anesthesia: Should Everyone receive a Urinary Catheter? A Randomized, Prospective Study of Patients Undergoing Total Hip Arthroplasty. J Bone Joint Surg Am. 2013; 95: 1498–1503.

22. Joelsson-Alm E, Nyman CR, Lindholm C, Ulfvarson J, Svensen C. Perioperative Bladder Distension: a prospective Study. Scand J urol Nephrol. 2009; 43: 58–62.

23. Shadle B, Barbaro C, Waxman K, Connor S, Von Dollen K. Predictors of Postoperative Urinary Retention. Am Surg. 2009; 75: 922–924.

24. Kowalik U, Plante MK. Urinary Retention in Surgical Patients. Surg Clin North Am. 2016; 96: 453–467.

25. Keita H, Diouf E, Tubach F, Brouwer T, Dahmani S, Mantz J, Desmonts JM. Predictive Factors of Early Postoperative Urinary Retention in the Postanesthesia Care Unit. Anesth Analg. 2005; 101: 592-6.

26. Kreutziger J, Frankerberger B, Lugur TJ, Richard S, Zbinden S. Urinary Retention after Spinal Anesthesia with Hyperbaric Prilocaine 2% in an Ambulatory Setting. Br J Anaesth. 2010; 104: 582–586.

27. Luger TJ, Garoscio I, Rehder P, Oberladstatter J, Voelckel W. Management of Temporary Urinary Retention after Arthroscopy Knee Surgery in Low Dose Spinal Anesthesia: Development of a Simple Algorithm. Arch Orthop Trauma Surg. 2008; 128: 607–612.

28. Verhamme KMC, Sturkeboom MCJM, Stricker BHCh, Bosch R. Drug Induced Urinary Retention: Incidence, Management and Prevention. Review Article. Drug safety 2008; 31: 373–388.

29. Gosling JA, Kung LS, Dixon JS, Horan P, Whitbeck C, Levin RM. Correlation Between the Structure and Function of the Rabbit Urinary Bladder following Partial Outlet Obstruction. J Urol. 2000; 163: 1349–1356.

30. Dal Mago AJ, Helayel PE, Bianchi E, Kozuki H, de Oliveira Filho GR. Prevalence & Predictive Factors of Urinary Retention Assessed by Ultrasound in the Immediate Post-Anesthesia Period. Rev Bras Anestesiol. 2010; 60: 383–390.

Figures

Figure 1

A. Univariate model. B. Full multivariable model. Relative Risks with 95% Confidence Intervals C. Final multivariable model. Relative Risks with 95% Confidence Intervals

Supplementary Files
This is a list of supplementary files associated with this preprint. Click to download.

- PROTOCOLPOURMAY2020.pdf