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Incidence and risk factors for urinary retention in critically ill patients

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ABSTRACT

Background: The removal of an indwelling urinary catheter is indicated as soon as possible to prevent complications. However, acute urinary retention is little studied among intensive care patients.

Aims: The aim of this study was to determine the incidence and risk factors for acute urinary retention after the removal of an indwelling urinary catheter in critically ill patients.

Design: This single-centre prospective study included adult critically ill adult surgical and medical patients.

Methods: All patients had an indwelling catheter for more than 48 h and indication of its removal by the attending physician. Acute urinary retention was defined as a bladder volume greater than 400 mL determined by ultrasound or intermittent urinary catheterization. A multivariate logistic regression was performed to analyse the possible risk factors for acute urinary retention.

Results: We included 85 patients from July 2014 to May 2015, most of them surgical (71·8%). Acute urinary retention occurred in 26 patients (30·6%). The use of hypnotics (midazolam or propofol given as continuous infusion) [OR 14·87 (95% CI 1·32–167·79); $p = 0·029$], indwelling catheterization for more than 7 days [OR 9·87 (95% CI 2·97–32·85); $p < 0·001$] and bed restraint [OR 9·43 (95% CI 1·07 to 83·33); $p = 0·043$] were all independent risk factors for acute urinary retention.

Conclusion: The incidence of acute urinary retention is high, and the main risk factors for its occurrence are prolonged use of urinary indwelling catheter, bed confinement and the use of hypnotics.

Relevance to Clinical Practice: Patients with risk factors should be kept under surveillance after the removal of indwelling urinary catheter for early identification of acute urinary retention and thus prevention of related complications.

Key words: Hypnotics and sedatives • Indwelling catheters • Intensive care units • Urinary retention • Urination

BACKGROUND

Urinary catheterization is a common procedure in clinical practice. Approximately 15–25% of hospitalized patients receive a short-term indwelling urinary catheter (IUC) (Gould *et al.*, 2010; Mitchell *et al.*, 2011). In the intensive care unit (ICU), several indications for urinary catheterization include urine output monitoring, bladder irrigation, medication administration and treatment for acute urinary retention (AUR) (Marklew, 2004; Baldini *et al.*, 2009b). However, urinary catheterization is associated with potential complications, including infection, urethral trauma and prostatitis (Marklew, 2004; Baldini *et al.*, 2009b).

Urinary tract infection (UTI) accounts for more than 13–20% of hospital-acquired infections (Gould *et al.*, 2010; Magill *et al.*, 2014). Among critically ill patients, 70% of cases are related to urinary catheterization, resulting in longer hospital stay and higher costs (Schaberg *et al.*, 1976; Saint, 2000; Conway and Larson, 2012). IUC duration is one of the main risk factors for UTI development; the risk of UTI increases two or three times with an IUC duration longer than 1 week (Saint, 2000; Baldini *et al.*, 2009b; Conway and Larson, 2012). For this reason, several guidelines recommend establishing protocols for early IUC removal as soon as it is no longer indicated (Hooton *et al.*, 2010; Mitchell *et al.*, 2011; Conway and Larson, 2012).

AUR, defined as the presence of a filled bladder combined with the inability to pass urine (Newman, 2007), is a complication of IUC removal in intensive care settings. In one study, the attempts to remove IUCs after non-urological surgery failed in 32·5% of the patients after 5 days of IUC (Lee *et al.*, 2011). This condition is associated with a higher morbidity and need for urinary catheterization. Potentially harmful urinary retention should be suspected in the presence of severe pain, bradycardia, hypotension or hypertension, heart dysrhythmias or vomiting (Kamphuis *et al.*, 1998). Ultrasound is

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the most accurate method for AUR detection at the bedside; a bladder urine volume greater than 400 mL is indicative of catheterization (Lamonerie *et al.*, 2004; Hansen *et al.*, 2011; Daurat *et al.*, 2015). In surgical patients, the main risk factors for AUR are age > 50 years old; male gender; duration of anaesthesia > 2 h; spinal anaesthesia; intermittent catheterization; orthopaedic or gynaecological surgery; past history of pelvic surgery; neurological abnormalities; pain; and use of medications such as opioid analgesics, hypnotics, anticholinergic agents, beta blockers and sympathomimetic drugs (Fernandes *et al.*, 2007; Joelsson-Alm *et al.*, 2009; Mago *et al.*, 2010; Hansen *et al.*, 2011; Lee *et al.*, 2011; Bjerregaard *et al.*, 2015; Mason *et al.*, 2016).

There are no published reports regarding the incidence of AUR among critically ill patients. Investigation of the AUR incidence following IUC removal and associated risk factors among critical patients is crucial for a better understanding of the genesis of this condition and the formulation of preventive measures against its significant complications.

LITERATURE REVIEW

We performed a Medline search using the following terms: ("critical care"[All Fields] OR "intensive care"[All Fields]) AND ("urinary retention"[All Fields] OR "acute urinary retention"[All Fields]) AND ("humans"[MeSH Terms] AND "adult"[MeSH Terms]). We completed the last updated search on 13 August 2017. The literature search yielded 84 records from 1991 to 2017. After title screening, we evaluated abstracts to identify studies that specifically examined AUR in critically ill patients after the removal of IUC. We did not find any study that addressed this topic.

AIMS AND OBJECTIVES

We aim to determine the incidence of AUR after IUC removal in critically ill patients, identifying the risk factors associated with its occurrence.

MATERIALS AND METHODS

This single-centre prospective cohort study was conducted from July 2014 to May 2015 at a 35-bed mixed ICU of a university hospital. We included medical and surgical patients older than 18 years with an IUC duration of more than 48 h and an indication for catheter removal by the attending physician. Patients under mechanical ventilation were also included. Patients presenting for gynaecological or urological surgery and those who had pelvic, genital or spinal cord injury or a history of urinary retention or prostatism were excluded. Neither patients with established acute kidney injury nor those with chronic kidney disease with oliguria were considered eligible.

We prospectively followed all participants for 48 h after catheter removal or the detection of AUR. Six hours after catheter removal, the patients without spontaneous diuresis or with a urinary output of less than 0·5 mL/kg/h were referred for urinary catheterization or suprapubic ultrasonography with measurement of the bladder urine volume. AUR was defined as an inability to pass urine combined with bladder volume over 400 mL. The test was repeated every 2 h for patients with a urine volume lower than 400 mL on ultrasound . Whenever ultrasound could not be performed and the urine volume was lower than 400 mL, the patients were reassessed 6 h later. Our definition of AUR was also consistent with previous publications as bladder volumes ranging from 400 to 600 mL have been used as cut-off values (Lamonerie *et al.*, 2004; Baldini *et al.*, 2009a; Hansen *et al.*, 2011).

We registered demographic data, clinical variables and laboratory results on the day of IUC removal. All medications administered were also assessed. We also determined severity scores, such as the Simplified Acute Physiology Score 3 (SAPS 3) at ICU admission and the Sequential Organ Failure Assessment (SOFA) on the day of IUC removal (Vincent *et al.*, 1998; Metnitz *et al.*, 2005; Moreno *et al.*, 2005). We defined hyperglycaemia as capillary blood glucose ≥180 mg/dL at any time on the day of IUC removal. The cut-off value adopted to define hyperglycaemia was based on the NICE sugar study and current guidelines (Finfer *et al.*, 2009; American Diabetes Association, 2016). Constipation was defined as the absence of bowel movements for three or more days. There is no consensus on the definition of intestinal constipation, so we used the ICU definition, which is consistent with previously published papers (Locke 3rd *et al.*, 2000; Azevedo *et al.*, 2009). We considered hypnosis to be the continuous intravenous administration of propofol or midazolam. Bed confinement was defined as the inability to get up from bed with or without assistance on the day of IUC removal.

Statistical analysis

Categorical variables were described as frequencies and continuous variables as the median (25th–75th percentiles) or mean (± standard deviation) according to their distribution as assessed by the Shapiro-Wilk test. We classified the participants according to the presence of AUR or not, and we compared all variables using Pearson's chi-square test, the Mann-Whitney test or Student's *t*-test, as appropriate.

We ran a multivariate stepwise regression analysis with a forward approach and calculation of likelihood ratios to identify risk factors independently associated with the occurrence of AUR after IUC removal. All variables with $p \leq 0{\cdot}05$ in the univariate analysis were included in the model. We excluded all variables with collinearity from the logistic regression model, leaving only the most relevant one. In order to include the duration of previous catheterisation in the model, we categorized this variable according to the receiver operating characteristic (ROC) curve; the cut-off point was set to 7 days. We tested the calibration of our model using the Hosmer-Lemeshow test considering $p > 0{\cdot}10$ adequate. The results were expressed as odd ratios with the corresponding 95% confidence intervals.

Statistical analysis was performed using the software SPSS (Statistical Package for the Social Sciences) for Windows version 19 (SPSS, Inc., Chicago, IL, United States). The significance level was set to $p \leq 0{\cdot}05$.

ETHICAL AND RESEARCH APPROVALS

The study was approved by the institutional research ethics committee (no. 631618) on 30 April 2014. Written informed consent was obtained from all participants after a full explanation of the procedures. Patients able to provide written consent were included after consent from a legally acceptable representative.

RESULTS

From July 2014 through May 2015, we screened 156 non-consecutive patients. All of them had an IUC duration of at

Table 1 Patient characteristics according to occurrence of acute urinary retention after urinary catheter removal

Variables	Overall ($n = 85$)	With AUR ($n = 26$)	Without AUR ($n = 59$)	p-Value
Age (years)	59·0 (37–70)	62 (35·5–73·2)	58 (37·0–69·0)	0·457
Male gender	40 (47·1)	14 (53·8)	26 (44·1)	0·405
Admission type				0·981
Clinical	24 (28·2)	8 (30·8)	16 (27·1)	
Elective surgery	35 (41·2)	13 (50·0)	22 (37·3)	
Emergency surgery	26 (30·6)	5 (19·2)	21 (35·6)	
Reason for admission				0·339
Postoperative monitoring	42 (49·4)	10 (38·5)	32 (54·2)	
Sepsis	7 (8·2)	1 (3·8)	6 (10·2)	
Respiratory failure (without sepsis)	6 (7·1)	2 (7·7)	4 (6·8)	
Acute neurological disease	22 (25·9)	9 (34·6)	13 (22·0)	
Polytrauma	7 (8·2)	3 (11·5)	4 (6·8)	
Others	1 (1·2)	1 (3·8)	0	
SAPS 3 (points)	55·61 ± 10·26	60·9 ± 10·6	53·3 ± 9·3	0·001
SOFA on admission (points)	5 (3–7)	5·5 (3·7–9·2)	5·0 (3·0–6·0)	0·081
SOFA on the day of IUC removal (points)	3 (1–4)	4·0 (3·0–6·5)	2·0 (1·0–4·0)	<0·001
Comorbidities				
Arterial hypertension	16 (18·8)	8 (30·8)	8 (30·5)	0·981
Diabetes mellitus	10 (11·7)	4 (15·4)	6 (10·2)	0·492
COPD	5 (5·8)	3 (11·5)	2 (3·4)	0·141
Chronic kidney disease	4 (4·7)	2 (7·7)	2 (3·4)	0·388
Cerebrovascular disease	7 (8·2)	1 (3·8)	6 (10·2)	0·328
Obesity	6 (7·0)	3 (11·5)	3 (3·4)	0·141
Malignant neoplasm	9 (10·6)	1 (3·8)	8 (13·6)	0·328
Previous UTI admission	2 (2·3)	1 (3·8)	1 (1·7)	0·547
Glasgow Coma scale	14 (12–15)	11 (9·25–13)	15 (14·0–15·0)	<0·001
Mechanical ventilation	10 (11·7)	8 (30·8)	2 (3·4)	<0·001
Bed confinement	64 (75·2)	25 (96·2)	39 (66·1)	0·003
Hyperglycaemia	28 (32·9)	7 (26·9)	21 (35·6)	0·433
Constipation	11 (12·9)	4 (15·4)	7 (11·9)	0·656
IUC duration (days)	5 (3–9)	9·0 (5·7–12·2)	4·0 (3·0–6·0)	<0·001
IUC > 7 days	33 (38·8)	19 (73·1)	14 (23·7)	<0·001
Urine output (past 24 h, mL/kg/h)	1,2 (0,9–1,7)	1·2 (0·7–2·1)	1·12 (0·9–1·62)	0·977
Fluid balance (past 24 h, mL)	448·7 ± 1092·3	507·6 ± 1250·0	422·0 ± 1025·0	0·744
Hematuria	1 (1·2)	1·0 (3·8)	0 (0·0)	0·130
Use of medications				
Catecholamines	13 (15·3)	8 (30·8)	5 (8·5)	0·009
Amiodarone	9 (10·6)	5 (19·2)	4 (6·8)	0·086
Antidepressants	2 (2·3)	0 (0·0)	2 (3·4)	0·342
Levodopa	3 (3·5)	0 (0·0)	3 (5·1)	0·242
Antihistamines	1 (1·2)	0 (0·0)	1 (1·7)	0·504
Beta-blocker	12 (14·1)	5 (19·2)	7 (11·9)	0·369
Antihypertensives	12 (14·1)	4 (15·4)	8 (13·6)	0·824
Diuretics	16 (18·8)	8 (30·8)	8 (13·6)	0·061
Alpha-agonists	8 (9·4)	3 (11·5)	5 (8·5)	0·656
Anticholinergic drugs	8 (9·4)	2 (7·7)	6 (10·2)	0·719
Antibiotics	64 (75·3)	18 (69·2)	46 (78·0)	0·390
Antipsychotics	16 (18·8)	5 (19·2)	11 (18·6)	0·949
Hypnotics*	6 (7·0)	5 (19·2)	1(1·7)	0·004
Opioids	60 (70·6)	19 (73·1)	41 (69·5)	0·738
IV Morphine/PO methadone	12 (14·1)	5 (19·2)	7 (11·9)	0·369
Fentanyl	5 (5·9)	4 (15·4)	1 (1·7)	0·013
Laboratory variables				
Haemoglobin (g/dL)	9·2 (8·4–11·1)	9·5 (8·7–11·1)	10·6 (9·2–11·9)	0·074

Table 1 Continued

Variables	Overall ($n = 85$)	With AUR ($n = 26$)	Without AUR ($n = 59$)	p-Value
White blood cells (× 100/μL)	11·1 (8·4–14·5)	11·3 (8·2–14·1)	12·0 (7·9–13·1)	0·226
Creatinine (mg/dL)	0·9 (0·6–1·3)	0·7 (0·5–1·2)	0·8 (0·6–1·1)	0·644
Urea (mg/dL)	42 (29·5–69·5)	45·0 (29·7–69·0)	44·0 (32·0–59·0)	0·746
CRP (mg/dL)	59·0 (31·5–101·1)	83·4 (70·9–149·1)	53·5 (21·7–79·2)	0·039
Magnesium (mg/dL)	1·9 (1·8–2·1)	1·9 (1·7–2·1)	1·9 (1·8–2·2)	0·402
Potassium (mEq/L)	4·1 ± 0·62	4·05 ± 0·69	4·03 ± 0·55	0·929
Ionized calcium (mg/dL)	1·2 ± 0·01	1·19 ± 0·10	1·20 (0·08)	0·304
In-hospital mortality	9·0 (10·6)	4·0 (15·4)	5·0 (8·6)	0·340

AUR, acute urinary retention; SAPS, *Simplified Acute Physiology Score*; SOFA, *Sequential Organ Failure Assessment*; IUC, indwelling urinary catheter; COPD, chronic obstructive pulmonary disease; UTI, urinary tract infection; CRP, C-reactive protein.

*Continuous intravenous administration of propofol or midazolam. Results are expressed as the median (25th–75th percentiles), number (%) or mean ± standard deviation.

least 48 h and removal indicated by the attending physician. After applying the exclusion criteria, 85 patients remained in the sample (we excluded 71 patients: 21 with oliguria, 18 with history of chronic urinary retention, 13 transferred after IUC removal, 7 aged < 18 years, 5 who did not sign the informed consent form, 4 who underwent urological surgery and 3 with spinal cord injury). The majority of the patients were surgical ones, and the main indication for admission to ICU was postoperative monitoring (Table 1). The most frequently used medications were opioids. A total of 43 patients (71·6%) received tramadol, 12 received methadone or morphine (20%), and five received fentanyl (8·3%).

Twenty-six patients did not have spontaneous diuresis up to 6 h after IUC removal and required urinary catheterization, with a measured urine volume over 400 mL, characterizing AUR. In 12 of these 26 patients, AUR was diagnosed through ultrasound. AUR remained for up to 24 h in 19 patients (73·0%), who thus required two or more catheterizations or an indwelling catheter. In only one case, an indwelling catheter was placed for haemodynamic monitoring.

On univariate analysis, the group with AUR had higher SAPS 3 and SOFA scores, a longer IUC duration, a lower Glasgow Coma Scale and a higher frequency of mechanical ventilation (MV) and bed confinement. The C-reactive protein (CRP) levels were significantly higher in the group with AUR. The use of catecholamines, hypnotics and fentanyl were also associated with the occurrence of AUR (Table 1).

We included in our multivariate model SAPS 3; SOFA on the day of IUC removal; use of hypnotics, fentanyl and catecholamines; IUC duration longer than 7 days; and bed confinement. The factors independently associated with AUR after IUC removal were a higher frequency of hypnotic use, IUC duration longer than 7 days and bed confinement (Table 2).

Table 2 Multivariate analysis corresponding to patients with acute urinary retention after removal of the indwelling urinary catheter

Variables	OR (95% CI)	p-Value
Use of hypnotics*	14·87 (1·32–167·79)	0·029
Urinary catheterization > 7 days	9·87 (2·97–32·85)	<0·001
Bed confinement	9·43 (1·07–83·33)	0·043

OR, odds ratio; CI, confidence interval.

*Continuous intravenous administration of propofol or midazolam. Forward LR stepwise multiple logistic regression model. Final model was tested with Hosmer-Lameshow Goodness-of-fit test ($p = 0·94$).

DISCUSSION

In this study, we were able to demonstrate a high incidence of AUR after IUC removal in a predominantly surgical population of ICU patients using bladder volume greater than 400 mL as the diagnostic criterion. AUR was associated with more frequent use of hypnotics, urinary catheterization for longer than 7 days and bed confinement.

Few studies have investigated AUR after IUC removal, most of them assessing postoperative patients in the post-anaesthesia care unit. They reported incidence rates varying from 0·5% to 66% (Lepor, 2005; Baldini *et al.*, 2009b; Hansen *et al.*, 2011). There are no published reports regarding the incidence of AUR among critically ill patients. This is a particularly relevant population as the requirement for urinary catheterization and the morbidity associated with this condition may lead to adverse events in these patients. Our high incidence of AUR may be due to a lack of knowledge of risk factors, which leads to early inadequate removal of the urinary catheter.

Previous studies in general population of hospitalized patients identified the most frequent risk factors to be surgery duration, type of anaesthesia, larger amounts of administered fluids, older age and male gender (Fernandes *et al.*, 2007; Joelsson-Alm *et al.*, 2009; Mago *et al.*, 2010; Hansen *et al.*, 2011; Lee *et al.*, 2011). There are no data on AUR risk factors among critical patients. We found that the duration of urinary catheterization was independently associated with a higher risk of AUR. Although our study was not designed to investigate causality, we can put forward some hypotheses. The bladder stretch receptors are activated when the bladder volume reaches 150–300 mL, giving rise to the urgency sensation and triggering the micturition reflex (Lepor, 2005; Baldini *et al.*, 2009b). Long periods without stimulation might lead to prolonged inactivation of the pelvic sensory pathways, with consequent impairment of the aforementioned physiological mechanism. However, studies conducted with non-critical patients subjected to urinary catheterization due to prostate disease have reported contradictory results. Djavan *et al.* (1998) found a lower prevalence of urinary

re-catheterization (51% versus 62%) among patients with a longer IUC duration (7 days versus 3 days) (Djavan *et al.*, 1998), whereas other authors did not find any impact of IUC duration on the AUR incidence (Taube and Gajraj, 1989; Emberton and Fitzpatrick, 2008; Lee *et al.*, 2011). As the mechanisms underlying urinary retention can be different, we excluded patients with obstructive urological diseases.

Hypnotics are commonly used in the ICU setting (Barr *et al.*, 2013). In our study, propofol and midazolam were the most frequently administered hypnotics through continuous infusion and were independently associated with the occurrence of AUR. Studies using animal models and evaluating children in whom these drugs were intermittently administered have not detected statistically significant abnormalities of the voiding ability on urodynamic testing, notwithstanding the trend for delayed micturition reflex associated with propofol use (Matsuura and Downie, 2000; Merguerian *et al.*, 2006; Herd *et al.*, 2006; Ozkurkcugil and Ozkan, 2010). In addition, hypnotics might inhibit the voluntary control of micturition triggered by interactions between the brain cortex and the pontine micturition centres, thus contributing to the occurrence of AUR (Lepor, 2005; Mitchell *et al.*, 2011).

Most of the patients in our study were confined to bed on the day the IUC was removed, and this often-neglected variable was an independent risk factor for AUR development. Patients admitted to the ICU often exhibit considerable motor restrictions related to their clinical condition. Prolonged supine positioning, which is common under these circumstances, might inhibit spontaneous micturition. This hypothesis was proposed by authors who found a higher frequency of AUR after orthopaedic surgery compared with other surgical procedures associated with fewer limitations to the patient's mobility (Mago *et al.*, 2010; Bjerregaard *et al.*, 2015). The reasons for this increase in the AUR rate are not well known. It has been suggested that patients, particularly the males, might have more difficulty urinating in the recumbent position (Riehmann *et al.*, 1998). Another explanation is the possible relationship between lack of mobility and patient severity. However, in the present study, we could not demonstrate an association between patient severity on the day of IUC removal (as assessed by SOFA) and occurrence of AUR.

Our results did not show an association between AUR occurrence and classic risk factors for this condition among non-critical patients, such as opioid use, older age, male gender and diabetes mellitus (Kamphuis *et al.*, 1998; Lamonerie *et al.*, 2004; Fernandes *et al.*, 2007; Baldini *et al.*, 2009b; Joelsson-Alm *et al.*, 2009; Mago *et al.*, 2010; Hansen *et al.*, 2011; Lee *et al.*, 2011). The urodynamic changes caused by opioids *via* the blockade of muscarinic receptors μ and δ are very well known (Fernandes *et al.*, 2007; Baldini *et al.*, 2009b). Our failure to detect this association might be due to selection bias. Notably, the decision to remove an IUC was made by the attending physician, who often waited until the discontinuation of opioids, fentanyl in particular. Consequently, the number of patients using fentanyl was low, which did not allow for an adequate statistical analysis of the association. Age over 50–60 years was associated with approximately 2·5 times higher odds of AUR occurrence in a general population (Baldini *et al.*, 2009b). One of the potential explanations was the presence of muscle abnormalities and prostate disease among the male patients. Other studies also reported higher incidences of AUR among males (Kamphuis *et al.*, 1998; Lamonerie *et al.*, 2004; Baldini *et al.*, 2009b; Hansen *et al.*, 2011). The lack of association with age and male gender in our study might be a consequence of the exclusion of patients with prostate disease or history of chronic urinary retention. Another potential explanation is the critical care setting, where there are many other variables interfering with the risk of AUR and, thus, lowering the impact of gender and age. Our small sample size may have not been sufficient to demonstrate this association. Similarly, the lack of association between AUR occurrence and comorbidities such as diabetes mellitus and neurological disease are possibly due to the small sample size.

Our study has several strengths. We assessed AUR in a specific population of critically ill patients, thus contributing new data to obtain better knowledge of this condition. We collected all data prospectively, using a well-defined criterion for re-catheterization, and performed a careful assessment of various potential risk factors. We included non-consecutive patients, mainly because of unavailability of the study investigators.

LIMITATIONS

We included non-consecutive patients mainly because of unavailability of the study investigators. As an exploratory study, we did not estimate the sample size. Given the relatively small sample size, as may be noted by the wide confidence intervals, the power of the study might have been compromised. Moreover, the single-centre nature of our research and specific institutional practices could limit generalizability. The lack of a specific protocol for IUC removal might have led to some biases, such as the small number of patients using fentanyl. Finally, as the study ICU has a strict routine with daily assessment for possible IUC removal, the AUR incidence might have been overestimated compared with other services that apply more restrictive criteria for catheter removal.

IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

The prolonged use of IUCs in critically ill patients can lead to many complications, most commonly catheter-associated UTIs. Thus, interventions to minimize the use of IUC should be encouraged. However, AUR after the removal of an IUC is common in this population. The main risk factors of its occurrence are prolonged use of IUC, bed confinement and the use of hypnotics. Patients with these risk factors should be kept under surveillance for early identification of AUR, thus preventing related complications.

CONCLUSION

In this single-centre prospective study in a predominantly surgical population of ICU patients that had an IUC for more than 48 h and indication of its removal by the attending physician, the incidence of AUR was high. In a multivariate logistic regression, the risk factors of AUR were prolonged use of IUC, bed confinement and the use of hypnotics.

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WHAT IS KNOWN ABOUT THIS TOPIC ?

- Several guidelines recommend establishing protocols for early indwelling urinary catheter removal as soon as it is no longer indicated.
- There are no published reports regarding the incidence and risk factors for acute urinary retention after the removal of a short-term indwelling urinary catheter among critically ill patients.

WHAT THIS PAPER ADDS ?

- This study demonstrated that the incidence of acute urinary retention is high.
- The risk factors are prolonged use of indwelling urinary catheter, bed confinement and the use of hypnotics.

REFERENCES

American Diabetes Association. (2016). 13. Diabetes Care in the Hospital. *Diabetes Care*; **39**(Suppl. 1): S99–104.

Azevedo RP, Freitas FG, Ferreira EM, Machado FR. (2009). Intestinal constipation in intensive care units. *Revista Brasileira de Terapia Intensiva*; **21**: 324–331.

Baldini G, Bagry H, Aprikian A, Carli F. (2009a). Postoperative urinary retention: anesthetic and perioperative considerations. *Anesthesiology*; **110**: 1139–1157.

Baldini G, Bagry H, Aprikian A, Carli F. (2009b). Postoperative urinary retention anesthetic and perioperative considerations. *The Journal of the American Society of Anesthesiologists*; **110**: 1139–1157.

Barr J, Fraser GL, Puntillo K, Ely EW, Gelinas C, Dasta JF, Davidson JE, Devlin JW, Kress JP, Joffe AM, Coursin DB, Herr DL, Tung A, Robinson BR, Fontaine DK, Ramsay MA, Riker RR, Sessler CN, Pun B, Skrobik Y, Jaeschke R. (2013). Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit. *Critical Care Medicine*; **41**: 263–306.

Bjerregaard LS, Bogø S, Raaschou S, Troldborg C, Hornum U, Poulsen AM, Bagi P, Kehlet H. (2015). Incidence of and risk factors for postoperative urinary retention in fast-track hip and knee arthroplasty. *Acta Orthopaedica* **86**: 183–188.

Conway LJ, Larson EL. (2012). Guidelines to prevent catheter-associated urinary tract infection: 1980 to 2010. *Heart & Lung: The Journal of Acute and Critical Care*; **41**: 271–283.

Daurat A, Choquet O, Bringuier S, Charbit J, Egan M, Capdevila X. (2015). Diagnosis of postoperative urinary retention using a simplified ultrasound bladder measurement. *Anesthesia & Analgesia*; **120**: 1033–1038.

Djavan B, Shariat S, Omar M, Roehrborn C, Marberger M. (1998). Does prolonged catheter drainage improve the chance of recovering voluntary voiding after acute urinary retention (AUR). *European Urology*; **33**: 110.

Emberton M, Fitzpatrick JM. (2008). The Reten-world survey of the management of acute urinary retention: preliminary results. *BJU International*; **101**: 27–32.

Fernandes MCB, Costa VV, Saraiva RÂ. (2007). Postoperative urinary retention: evaluation of patients using opioids analgesic. *Revista Latino-Americana de Enfermagem*; **15**: 318–322.

Finfer S, Chittock DR, Su SY, Blair D, Foster D, Dhingra V, Bellomo R, Cook D, Dodek P, Henderson WR, Hebert PC, Heritier S, Heyland DK, McArthur C, McDonald E, Mitchell I, Myburgh JA, Norton R, Potter J, Robinson BG, Ronco JJ. (2009). Intensive versus conventional glucose control in critically ill patients. *The New England Journal of Medicine*; **360**: 1283–1297.

Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. (2010). Guideline for prevention of catheter-associated urinary tract infections 2009. *Infection Control and Hospital Epidemiology*; **31**: 319–326.

Hansen B, Søreide E, Warland A, Nilsen O. (2011). Risk factors of post-operative urinary retention in hospitalised patients. *Acta Anaesthesiologica Scandinavica*; **55**: 545–548.

Herd DW, McAnulty KA, Keene NA, Sommerville DE. (2006). Conscious sedation reduces distress in children undergoing voiding cystourethrography and does not interfere with the diagnosis of vesicoureteric reflux: a randomized controlled study. *American Journal of Roentgenology*; **187**: 1621–1626.

Hooton TM, Bradley SF, Cardenas DD, Colgan R, Geerlings SE, Rice JC, Saint S, Schaeffer AJ, Tambayh PA, Tenke P. (2010). Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 international clinical practice guidelines from the Infectious Diseases Society of America. *Clinical Infectious Diseases*; **50**: 625–663.

Joelsson-Alm E, Nyman CR, Lindholm C, Ulfvarson J, Svensén C. (2009). Perioperative bladder distension: a prospective study. *Scandinavian Journal of Urology and Nephrology*; **43**: 58–62.

Kamphuis ET, Ionescu TI, Kuipers PW, de Gier J, van Venrooij GE, Boon TA. (1998). Recovery of storage and emptying functions of the urinary bladder after spinal anesthesia with lidocaine and with bupivacaine in men. *The Journal of the American Society of Anesthesiologists*; **88**: 310–316.

Lamonerie L, Marret E, Deleuze A, Lembert N, Dupont M, Bonnet F. (2004). Prevalence of postoperative bladder distension and urinary retention detected by ultrasound measurement. *British Journal of Anaesthesia*; **92**: 544–546.

Lee KS, Lim KH, Kim SJ, Choi HJ, Noh DH, Lee HW, Cho MC. (2011). Predictors of successful trial without catheter for postoperative urinary retention following non-urological surgery. *International Neurourology Journal*; **15**: 158–165.

Lepor H. (2005). Managing and preventing acute urinary retention. *Reviews in Urology*; **7**: S26.

Locke GR 3rd, Pemberton JH, Phillips SF. (2000). American Gastroenterological Association medical position statement: guidelines on constipation. *Gastroenterology*; **119**: 1761–1766.

Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM, Thompson DL, Wilson LE, Fridkin SK. (2014). Multistate point-prevalence survey of health care-associated infections. *The New England Journal of Medicine*; **370**: 1198–1208.

Mago AJD, Helayel PE, Bianchini E, Kozuki H, GRd OF. (2010). Prevalence and predictive factors of urinary retention assessed by ultrasound in the immediate post-anesthetic period. *Revista Brasileira de Anestesiologia*; **60**: 387–390.

Marklew A. (2004). Urinary catheter care in the intensive care unit. *Nursing in Critical Care*; **9**: 21–27.

Mason SE, Scott AJ, Mayer E, Purkayastha S. (2016). Patient-related risk factors for urinary retention following ambulatory general surgery: a systematic review and meta-analysis. *The American Journal of Surgery*; **211**: 1126–1134.

Matsuura S, Downie J. (2000). Effect of anesthetics on reflex micturition in the chronic cannula-implanted rat. *Neurourology and Urodynamics*; **19**: 87–99.

Merguerian PA, Corbett ST, Cravero J. (2006). Voiding ability using propofol sedation in children undergoing voiding cystourethrograms: a retrospective analysis. *The Journal of Urology*; **176**: 299–302.

Metnitz PG, Moreno RP, Almeida E, Jordan B, Bauer P, Campos RA, Iapichino G, Edbrooke D, Capuzzo M, Le Gall JR. (2005). SAPS 3--from evaluation of the patient to evaluation of the intensive care unit. Part 1: Objectives, methods and cohort description. *Intensive Care Medicine*; **31**: 1336–1344.

Mitchell B, Ware C, McGregor A, Brown S, Wells A, Stuart RL, Wilson F, Mason M. (2011). ASID (HICSIG)/AICA position statement: preventing catheter-associated urinary tract infections in patients. *Healthcare Infection*; **16**: 45–52.

Moreno RP, Metnitz PG, Almeida E, Jordan B, Bauer P, Campos RA, Iapichino G, Edbrooke D, Capuzzo M, Le Gall JR. (2005). SAPS 3--from evaluation of the patient to evaluation of the intensive care unit. Part 2: development of a prognostic model for hospital mortality at ICU admission. *Intensive Care Medicine*; **31**: 1345–1355.

Newman DK. (2007). The indwelling urinary catheter: principles for best practice. *Journal of Wound Ostomy & Continence Nursing*; **34**: 655–661.

Ozkurkcugil C, Ozkan L. (2010). Effects of anesthetics on cystometric parameters in female rats. *International Urology and Nephrology*; **42**: 909–913.

Riehmann M, Bayer WH, Drinka PJ, Schultz S, Krause P, Rhodes PR, Heisey D, Bruskewitz RC. (1998). Position-related changes in voiding dynamics in men. *Urology*; **52**: 625–630.

Saint S. (2000). Clinical and economic consequences of nosocomial catheter-related bacteriuria. *American Journal of Infection Control*; **28**: 68–75.

Schaberg DR, Weinstein RA, Stamm WE. (1976). Epidemics of nosocomial urinary tract infection caused by multiply resistant gram-negative bacilli: epidemiology and control. *The Journal of Infectious Diseases*; **133**: 363–366.

Taube M, Gajraj H. (1989). Trial without catheter following acute retention of urine. *British Journal of Urology*; **63**: 180–182.

Vincent JL, de Mendonca A, Cantraine F, Moreno R, Takala J, Suter PM, Sprung CL, Colardyn F, Blecher S. (1998). Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. Working group on "sepsis-related problems" of the European Society of Intensive Care Medicine. *Critical Care Medicine*; **26**: 1793–1800.