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Early Removal of Urinary Catheter after Surgery Requiring Thoracic Epidural: A Prospective Trial

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Abstract

OBJECTIVES—To prevent urinary retention, urinary catheters are commonly removed only after thoracic epidural discontinuation following thoracotomy. However, prolonged catheterization increases the risk of infection. The purpose of this study was to determine the rates of urinary retention and catheter-associated infection following early catheter removal.

DESIGN—This study describes a prospective trial instituting an early urinary catheter removal protocol, compared to a historical control group of patients.

SETTING—The protocol was instituted at a single, academic thoracic surgery unit.

PARTICIPANTS—Participants comprised of patients undergoing operations requiring thoracotomy who received an intraoperative epidural for postoperative pain control.

INTERVENTIONS—An early urinary catheter removal protocol was instituted prospectively, with all catheters removed on or before postoperative day 2. Urinary retention was determined by bladder ultrasound, and treated with re-catheterization.

MEASUREMENTS/MAIN RESULTS—The primary outcomes were urinary retention rate, defined as bladder volume greater than 400 ml, and urinary tract infection rate. Results were compared to a retrospective cohort of 210 consecutive patients who underwent surgery before protocol initiation. Among the 101 prospectively-enrolled patients, urinary retention rate was higher (26.7% vs 12.4%, $p = 0.003$), while urinary tract infection rate improved moderately (1% vs 3.8%, $p = 0.280$).

CONCLUSIONS—Early removal of urinary catheters with thoracic epidurals in place is associated with a high incidence of urinary retention. However, an early catheter removal protocol

may play a role in a multi-faceted approach to reducing the incidence of catheter-associated urinary tract infections.

Keywords

Epidural Anesthesia; Thoracic Surgical Procedures; Urinary Tract Infections; Urinary Retention; Urinary Catheterization; Critical Care Standards

INTRODUCTION

Bladder catheterization during thoracic surgery allows accurate assessment of urinary output. Because bladder contractile response to muscarinic stimulation may be impaired following involuntary obstruction, intraoperative catheterization also prevents this adverse effect by allowing consistent decompression during prolonged operations (1). Following prolonged operations, indwelling catheters are often left in place to reduce the incidence of postoperative urinary retention (POUR), as patients often cannot sense bladder distention after general anesthesia (2,3). Risk factors for POUR include age, male gender, prostatic hypertrophy, type of operation, and duration of general anesthesia (4,5). Although POUR is classically associated with anorectal, orthopedic, and inguinal surgery (6), it is a not infrequent complication of thoracic operations as well. Thoracic operations are often lengthy, and postoperative pain control often involves epidural and parenteral opioid analgesia, both of which can contribute to POUR (7).

By impairing transmission of action potentials to and from the bladder, lumbar epidural and intrathecal analgesia have been associated with POUR in a dose-dependent manner (8), particularly when epidural infusions include local anesthetics (such as bupivacaine) in conjunction with opioids (such as hydromorphone) (9,10). Complications of POUR include prolonged hospital length of stay, cystitis, and patient discomfort (11,12). The incidence of POUR with thoracic epidurals, whether continuous or patient-controlled, has received increased attention as urinary tract infections have become one of the most common postoperative complications of thoracic surgery (13). It is generally well-accepted that prolonged indwelling catheterization is associated with higher incidences of catheter-associated urinary tract infections (CAUTI) (14,15). Early postoperative removal of indwelling urinary catheters before discontinuation of thoracic epidural analgesia may decrease the incidence of CAUTI's, but may also result in increased bladder retention (16). The most common treatment for POUR—intermittent catheterization—is associated with its own infectious risk as well as patient discomfort (17). The Surgical Care Improvement Project instituted nation-wide quality guidelines for urinary catheter removal on or before postoperative day 2 (18), however, the impact of this practice on thoracic surgery patients with epidurals is not yet clear. The goal of this study was to prospectively evaluate the incidence of POUR and CAUTI following adoption of an early urinary catheter removal protocol among thoracic surgery patients who received an epidural for postoperative pain control.

METHODS

Data were collected while an early urinary catheter removal protocol was implemented within the University of Virginia's division of thoracic surgery. As a quality-improvement measure, this study was considered exempt from full review by the Institutional Review Board. Adult patients who underwent surgery through a thoracotomy incision and who required a thoracic epidural for postoperative pain control were included. Exclusion criteria were postoperative hemodynamic instability (mean arterial pressure less than 65 mmHg), lung transplants, prolonged postoperative intubation (greater than 2 days), need for urologic consultation, traumatic catheter insertion, or preoperative presence of an indwelling catheter. All epidurals were placed by qualified anesthesiologists in the preoperative unit. The standard anesthetic solution was comprised of hydromorphone (6 or 10 mcg/ml) and bupivacaine (0.0625 or 0.125%), and initial infusion rate was determined per the discretion of the acute pain division of anesthesiology. For the duration of epidural use, twice-daily adjustments were made to infusion rates using visual analog pain scores, again at the discretion of the acute pain service. Epidurals were removed once pain was adequately controlled with oral and/or parenteral analgesia after 12 to 24 hours of withheld epidural infusion. The most common analgesic regimen following epidural removal consisted of 10 mg oxycodone, alternating with 10–650 mg oxycodone-acetaminophen every two hours, with 25 mcg fentanyl available for breakthrough pain.

Indwelling urinary catheters were placed in the operating room by trained technicians using standard sterile technique following induction of general anesthesia. All indwelling catheters were removed on or before postoperative day 2. Patients who failed to spontaneously void within 8 hours of catheter removal received one intermittent bladder catheterization if sensation of bladder distention was present, or received a bladder ultrasound evaluation if no symptoms were present. If ultrasound revealed bladder volume greater than 400 ml, intermittent catheterization was performed. If the patient subsequently failed to spontaneously void within another 8 hours, an indwelling catheter was reinserted (Figure 1). Data were collected prospectively by the anesthesia pain service and by thoracic surgery physician's assistants. Auditing was performed using nursing questionnaires submitted with each patient discharge. Questionnaires assessed epidural type and composition, patient demographics, duration of catheterization, bladder scan results, recatheterizations, urinalyses, and urine cultures during the postoperative course. Diagnoses of benign prostatic hypertrophy (BPH) were determined through patient questioning and chart review at the time of postoperative admission.

Urine samples were not routinely collected for all patients. Indications for urinalysis with microscopy included temperature greater than 38 °C, increasing leukocytosis greater than 12,000 cells/ μ L, suprapubic tenderness, or dysuria. A urinalysis was considered positive if there were > 5 WBC/hpf, if it was positive for leukocyte esterase and/or nitrite, or if microorganisms were visible on Gram's stain. Urine cultures were obtained for all positive urinalyses, and a urinary tract infection was diagnosed if there were 10^3 CFU/ml on culture in the setting of a positive urinalysis. Diagnoses of CAUTI were based on guidelines from the Center for Disease Control and Prevention (CDC): indwelling catheter in place for 2

days and positive urine culture within 2 days of removal (19). Primary outcomes of this study were need for re-catheterization and incidence of CAUTI.

To assess outcomes of the early catheter-removal protocol group, a retrospective control group was identified at a ratio of 2 controls for every 1 prospective patient. The control group was comprised of consecutive patients fulfilling inclusion and exclusion criteria prior to institution of the new protocol. There were no practice changes between the retrospective and prospective groups regarding techniques for urinary catheter placement or postoperative epidural management. Retrospective chart reviews of daily progress notes, culture records, and discharge summaries were used to determine rates of re-catheterization and CAUTI incidence, as well as baseline demographic characteristics and existing diagnoses of BPH.

For both the control and prospective groups, nonparametric variables are reported using median and interquartile range (IQR), and categorical variables are reported using frequency and percentiles. Univariate analyses were performed on demographic and process of care variables potentially associated with POUR using the Chi-squared test for categorical variables and Wilcoxon rank-sum test for nonparametric continuous variables. A threshold of $p = 0.05$ was used to determine statistical significance. All analyses were performed using SAS 9.1.3 software (SAS Institute, Cary, NC).

RESULTS

Between July 2011 and May 2012, 106 consecutive patients were enrolled into the prospective study. Five patients were excluded due to incomplete auditing records. The historical control group was comprised of 218 consecutive patients who underwent surgery between May 2010 and July 2011. Of these, 8 were excluded due to hemodynamic instability, prolonged intubation, or presence of end-stage renal disease. Demographics for the 101 early-removal patients and the 210 control patients are shown in Table 1. There were no differences between groups in age, gender, operations received, rate of BPH, or cancer prevalence (Table 1). Operative interventions were primarily comprised of pulmonary resections, benign esophageal procedures and pleural space procedures. All patients received continuous epidural infusion at a rate of between 4–12 ml/hr, titrated twice-daily to pain scale. Epidural composition was largely uniform, comprised of a combination of bupivacaine and hydromorphone for 96% (97/101) of early-removal patients and 98% (206/210) of controls. Average infusion doses for each component initially and at the time of indwelling urinary catheter removal are presented in Table 1 for both groups. The prospective patient group had expectedly higher epidural infusion dosing for both local and opioid components at the time of bladder decatheterization ($p < 0.001$). For all but one patient in the early-removal group, indwelling catheters were removed on or before postoperative day 2, before epidural removal.

The need for re-catheterization, whether intermittent or indwelling, was significantly higher for early removal protocol patients compared to the control group (26.7% (27/101) vs. 12.4% (26/210), $p = 0.003$). Among prospective study patients requiring re-catheterization, 14 required intermittent catheterization and 22 required indwelling catheterization, with 9 requiring both. Age, gender, history of BPH, and dermatomal level of epidural placement

were not associated with rate of urinary retention. However, shorter indwelling catheter duration was associated with POUR (Table 2). Although not statistically significant, patients who developed POUR tended to have a higher rate of epidural infusion at the time of urinary catheter removal. Catheter-associated urinary tract infections were less frequent among the early-removal cohort, however this comparison did not reach statistical significance (1% (1/101) vs. 3.8% (8/210), $p = 0.280$). This translated to CAUTI rates of 9.71/1000 catheter days in the control group and 5.23/1000 catheter days in the early-removal group.

DISCUSSION

The benefits of epidural analgesia following thoracotomy are numerous, including augmentation of respiratory function and decrease in incidence of arrhythmias, renal failure, and respiratory infections (20). However, incidence of POUR has historically been high in the presence of thoracic epidurals. High-dose epidurals using bupivacaine 0.25% have been associated with POUR rates as high as 33% (21), while rates of less than 5% have been reported with lower doses (22). While the potentially harmful effects of bladder over-distention argue in favor of postoperative indwelling catheterization for the duration of epidural analgesic needs, the risk of CAUTI associated with prolonged catheterization makes a case for early catheter removal. Urinary catheter removal also promotes early mobilization, which is crucial to postoperative recovery following thoracic surgery.

This prospective study analyzes the outcomes of an early catheter removal protocol in the setting of thoracic epidural use. Ladak et al previously demonstrated a re-intervention rate of 10% when defining bladder retention as ultrasound-assessed volume greater than 600 mL and when epidural rate is limited to 6 mL/h of 0.1% bupivacaine (17). However, there is evidence that detrusor contractility declines beyond 300 mL of bladder volume, and higher epidural rates are often necessary for post-thoracotomy pain control (23). Zaouter et al conducted an excellent prospective, randomized study in 2009 comparing early catheter removal to removal after epidural discontinuation among 100 patients, demonstrating a reduced rate of UTI and a POUR incidence of 16% (24). Although not achieving statistical significance, POUR incidence was four-fold higher within the early-removal group in that study. A follow-up study in 2012 reported an increase in post-void residual with first micturition and a prolonged time to reach residual < 200 ml among patients in the early-removal group (16). Within the present study, CAUTI incidence was relatively low (1% and 3.8%), precluding detection of statistically-significant differences. However, a trend toward improvement was noted in CAUTI rate (5.23 vs 9.71/1000 catheter days). Of note, incidence of POUR among early-removal patients was significantly higher than control patients, and was comparable to prior results from Baldini et al analyzing POUR following abdominal operations (4). There are several reasons which may explain this relatively high re-catheterization rate. Patients with a history of BPH were included, and a lower threshold for re-catheterization was used than in prior works (bladder volume of 400 ml). The pain control regimen to which patients were transitioned following epidural discontinuation routinely comprised of oral and parenteral opioids, which are also associated with urinary retention, although to a lesser extent than epidural administration (10,25). In concordance with the prior study by Ladak, there was no significant association between dermatomal level of epidural placement and incidence of POUR.

There are several limitations to this study. Because epidural rates were adjusted frequently according to pain scale, we could not draw conclusions regarding epidural rate and POUR. While the majority of patients received an epidural consisting of 0.125% bupivacaine and 10 mcg/mL hydromorphone at a rate of 10 mL/h, variations due to allergic profile and pain rating were allowed. However, all patients were managed by the same acute pain service and no significant differences were noted between the control and early-removal patient groups. Of note, because hydromorphone is more lipophilic than morphine, institutions which routinely use morphine epidurals may anticipate an even higher incidence of POUR (26). Secondly, there was no set schedule of bladder ultrasound assessments within the first 8 hours of catheter removal. The reported POUR rate may thus underestimate true incidence of POUR defined as bladder volume greater than 400 mL. Despite this, because many hospitals may lack adequate staff resources for frequent, scheduled bladder ultrasound assessments, results from this prospective protocol remain relevant. Finally, the present study was underpowered to detect a significant change in CAUTI rate between the early-removal and control groups due to a low rate of observation in the prospective group, and only in-hospital CAUTI's were reliably captured. However, in-hospital UTI is the standard quality metric currently being used in health care.

In conclusion, a protocol endorsing indwelling catheter removal within 48 hours postoperatively among patients receiving thoracic surgery with epidural analgesia is associated with a significantly higher rate of POUR. However, an early-removal protocol may contribute to a multi-faceted approach to reducing the rate of CAUTI's. When implementing such a protocol, providers must first consider the need for diligent and frequent monitoring for urinary retention.

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References

1. Kitada S, Wein AJ, Kato K, Levin RM. Effect of acute complete obstruction on the rabbit urinary bladder. *J Urol.* 1989; 141:166–169. [PubMed: 2562815]
2. Pavlin DJ, Pavlin EG, Fitzgibbon DR, Koerschgen ME, et al. Management of bladder function after outpatient surgery. *Anesthesiology.* 1999; 91:42–50. [PubMed: 10422927]
3. Lamonerie L, Marret E, Deleuze A, Lember N, et al. Prevalence of postoperative bladder distension and urinary retention detected by ultrasound measurement. *Br J Anaesth.* 2004; 92:544–546. [PubMed: 14977795]
4. Baldini G, Bagry H, Aprikian A, Carli F. Postoperative urinary retention: anesthetic and perioperative considerations. *Anesthesiology.* 2009; 110:1139–1157. [PubMed: 19352147]
5. Mulroy MF, Salinas FV, Larkin KL, Polissar NL. Ambulatory surgery patients may be discharged before voiding after short-acting spinal and epidural anesthesia. *Anesthesiology.* 2002; 97:315–319. [PubMed: 12151918]
6. Darrah DM, Griebing TL, Silverstein JH. Postoperative urinary retention. *Anesthesiol Clin.* 2009; 27:465–84. [PubMed: 19825487]
7. Koch CA, Grinberg GG, Farley DR. Incidence and risk factors for urinary retention after endoscopic hernia repair. *Am J Surg.* 2006; 191:381–385. [PubMed: 16490551]

8. Turner G, Blake D, Buckland M, Chamley D, et al. Continuous extradural infusion of ropivacaine for prevention of postoperative pain after major orthopaedic surgery. *Br J Anaesth.* 1996; 76:606–610. [PubMed: 8688255]
9. Finucane BT, Ganapathy S, Carli F, Pridham JN, et al. Prolonged epidural infusions of ropivacaine (2 mg/mL) after colonic surgery: the impact of adding fentanyl. *Anesth Analg.* 2001; 92:1276–1285. [PubMed: 11323362]
10. Dolin SJ, Cashman JN. Tolerability of acute postoperative pain management: nausea, vomiting, sedation, pruritus, and urinary retention. Evidence from published data. *Br J Anaesth.* 2005; 95:584–591. [PubMed: 16169893]
11. Martinez OV, Civetta JM, Anderson K, Roger S, et al. Bacteriuria in the catheterized surgical intensive care patient. *Crit Care Med.* 1986; 14:188–191. [PubMed: 3943334]
12. Petros JG, Rimm EB, Robillard RJ. Factors influencing urinary tract retention after elective open cholecystectomy. *Surg Gynecol Obstet.* 1992; 174:497–500. [PubMed: 1350689]
13. Kluytmans JA, Mouton JW, Maat AP, Manders MA, et al. Surveillance of postoperative infections in thoracic surgery. *J Hosp Infect.* 1994; 27:139–147. [PubMed: 7930541]
14. Givens CD, Wenzel RP. Catheter-associated urinary tract infections in surgical patients: a controlled study on the excess morbidity and costs. *J Urol.* 1980; 124:646–648. [PubMed: 7452793]
15. Nan DN, Fernandez-Ayala M, Farinas-Alvarez C, Mons R, et al. Nosocomial infection after lung surgery: incidence and risk factors. *Chest.* 2005; 128:2647–2652. [PubMed: 16236938]
16. Zaouter C, Wuethrich P, Miccoli M, Carli F. Early removal of urinary catheter leads to greater post-void residuals in patients with thoracic epidural. *Acta Anaesthesiol Scand.* 2012; 56:1020–1025. [PubMed: 22524633]
17. Ladak SS, Katznelson R, Muscat M, Sawhney M, et al. Incidence of urinary retention in patients with thoracic patient-controlled epidural analgesia (TPCEA) undergoing thoracotomy. *Pain Manag Nurs.* 2009; 10:94–98. [PubMed: 19481048]
18. Centers for Medicare and Medicaid Services (CMS). Specifications manual for national hospital inpatient quality measures, version 4.2b. 2014, 2013.
19. Centers for Disease Control and Prevention (CDC). Catheter-Associated Urinary Tract Infection (CAUTI) Event 2014. 2014.
20. Scott NB, Turfrey DJ, Ray DA, Nzewi O, et al. A prospective randomized study of the potential benefits of thoracic epidural anesthesia and analgesia in patients undergoing coronary artery bypass grafting. *Anesth Analg.* 2001; 93:528–535. [PubMed: 11524314]
21. Conacher ID, Paes ML, Jacobson L, Phillips PD, et al. Epidural analgesia following thoracic surgery. A review of two years' experience. *Anaesthesia.* 1983; 38:546–551. [PubMed: 6869713]
22. Senagore AJ, Delaney CP, Mekhail N, Dugan A, et al. Randomized clinical trial comparing epidural anaesthesia and patient-controlled analgesia after laparoscopic segmental colectomy. *Br J Surg.* 2003; 90:1195–1199. [PubMed: 14515286]
23. Joelsson-Alm E, Nyman CR, Lindholm C, Ulfvarson J, et al. Perioperative bladder distension: a prospective study. *Scand J Urol Nephrol.* 2009; 43:58–62. [PubMed: 18979281]
24. Zaouter C, Kaneva P, Carli F. Less urinary tract infection by earlier removal of bladder catheter in surgical patients receiving thoracic epidural analgesia. *Reg Anesth Pain Med.* 2009; 34:542–548. [PubMed: 19916208]
25. Elsamra SE, Ellsworth P. Effects of analgesic and anesthetic medications on lower urinary tract function. *Urol Nurs.* 2012; 32:60–7. quiz 68. [PubMed: 22690461]
26. Goodarzi M. Comparison of epidural morphine, hydromorphone and fentanyl for postoperative pain control in children undergoing orthopaedic surgery. *Paediatr Anaesth.* 1999; 9:419–422. [PubMed: 10447905]

Figure 1.

Protocol for intermittent re-catheterization and indwelling catheter re-insertion following early postoperative removal of urinary catheters.

Table 1

Patient characteristics and outcomes across study groups

	Early Removal N (%) Median (IQR)	Control Group N (%) Median (IQR)	p-value
Demographics			
N	101	210	
Age	61 (49 – 68)	61 (52 – 68.8)	0.578
Female	55 (54.5)	91 (43.3)	0.060
BPH	8 (7.9)	12 (5.7)	0.466
Malignancy	75 (74.2)	133 (63.3)	0.074
Operative			0.128
Pulmonary resection	72 (71.3)	143 (68.1)	
Benign esophageal	12 (11.9)	16 (7.6)	
Decortication/Pleural	6 (5.9)	23 (11.0)	
Other	11 (10.9)	28 (13.3)	
Epidural			
Epidural duration (days)	4 (3 – 5)	4 (3 – 5)	0.983
Epidural level			0.203
T5-6	0	2 (1.0)	
T6-7	8 (8.1)	35 (16.7)	
T7-8	44 (44.4)	90 (42.9)	
T8-9	39 (39.4)	63 (30.0)	
T9-10	8 (8.1)	16 (7.6)	
T10-11	0	4 (1.9)	
Hydromorphone			
Initial rate (mcg/h)	80 (80 – 100)	80 (80 – 100)	0.661
Decath rate (mcg/h)	80 (60 – 100)	0 (0 – 80)	<0.001
Bupivacaine			
Initial rate (mg/h)	10 (7.5 – 12.5)	10 (10 – 12.5)	0.689
Decath rate (mg/h)	10 (6.3 – 12.5)	0 (0 – 7.5)	<0.001
Urinary Catheter			
Catheter duration (days)	1.8 (1.1 – 2.1)	3 (2 – 5)	<0.001
Recatheterization	27 (26.7)	26 (12.4)	0.003
Urinary tract infection	1 (1.0)	8 (3.8)	0.280

SD: standard deviation BPH: benign prostatic hyperplasia IQR: interquartile range

Table 2

Characteristics of patients with postoperative urinary retention (POUR)

	POUR (+)	POUR (-)	
	N (%)	N (%)	
	Median (IQR)	Median (IQR)	p-value
Demographics			
N	53	258	
Age	62 (48 – 70)	60 (51 – 68)	0.724
Female	25 (47.2)	121 (46.9)	0.971
BPH	1 (1.9)	10 (3.9)	0.697
Postoperative			
Epidural level			0.964
T5-6	0	2 (0.8)	
T6-7	6 (11.3)	25 (9.7)	
T7-8	24 (45.3)	109 (42.2)	
T8-9	20 (37.7)	95 (36.8)	
T9-10	3 (5.7)	25 (9.7)	
T10-11	0	2 (0.8)	
Hydromorphone (mcg/h)			
Initial	80 (80 – 100)	80 (80 – 100)	0.963
Decath	80 (48 – 80)	60 (0 – 82.5)	0.273
Bupivacaine (mg/h)			
Initial	10 (10 – 12.5)	10 (10 – 12.5)	0.598
Decath	10 (5 – 10)	5 (0 – 11.9)	0.255
Epidural duration (days)	4 (3 – 5)	4 (3 – 5)	0.668
Catheter duration (days)	2 (1.8 – 2.3)	2.7 (1.8 – 4)	0.002

BPH – benign prostatic hypertrophy