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Impact of Enhanced Recovery Pathways and early urinary catheter removal on post-operative urinary retention

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ABSTRACT

Background: Post-operative urinary retention (POUR) is a common complication after colorectal surgery. Enhanced recovery pathways (ERP) typically include early catheter removal but may place patients at risk for POUR.

Methods: This is a retrospective cohort analysis of patients undergoing colorectal surgery at a single institution between April 2014 and November 2017. Patients were stratified into non-ERP and ERP cohorts and post-operative outcomes were compared.

Results: Of 284 patients studied, ERP was applied to 161 (57%) while the remaining 123 (43%) recovered under standard care. Median duration of indwelling Foleys was 1 day for ERP and 2 days for non-ERP patients ($p < 0.001$). ERP patients experienced higher rates of straight catheterization (22% vs 12%,$p = 0.036$), Foley reinsertion (14% vs 7%,$p = 0.07$), and initiation of alpha antagonists (12% vs 5%,$p = 0.04$). Significant independent predictors of POUR were age (OR 1.03, $p = 0.002$), male gender (OR 2.79, $p = 0.001$), surgery duration (OR 1.27, $p = 0.027$), and ERP (OR 1.96, $p = 0.025$).

Conclusion: ERP following colorectal surgery that include routine early Foley catheter removal on post-operative day one is associated with increased rates of POUR; however, this did not lead to increased rates of catheter-associated urinary tract infections during the index admission in the population studied.

Introduction

Post-operative urinary retention (POUR) and catheter-associated urinary tract infections (CAUTI) are common complications after colorectal surgery leading to longer hospital stays and increased costs.[1] POUR complicates up to 50% of patients undergoing colorectal procedures,[2] and has been shown to impede functional recovery, rendering patients less mobile and more susceptible to weight gain.[3] Additionally, CAUTI disproportionately affects colorectal surgery patients,[4] with rates that exceed those for other gastrointestinal surgeries.[5,6] Hospital systems have targeted efforts on reducing rates of postoperative CAUTIs since the Centers for Medicare and Medicaid Services deemed them as potentially preventable complications and stopped reimbursements for readmission in 2008.[7]

Early removal of indwelling Foley catheters is an effective strategy for preventing CAUTI that has led to nurse-driven protocols with proven success.[8] Furthermore, additional benefits of early removal include improved mobility, increased comfort, and

Abbreviations: AA-CCI, Age-adjusted Charlson Comorbidity Index; ASA, American Society of Anesthesiology physical status classification; BMI, body mass index; BPH, benign prostatic hyperplasia; CAUTI, catheter-associated urinary tract infection; CCI, Charlson Comorbidity Index; CRT, chemoradiation; ERP, enhanced recovery pathway; IQR, interquartile range; LOS, length of stay; PCA, patient-controlled analgesia; POD, post-operative day; POUR, post-operative urinary retention; SD, standard deviation; UTI, urinary tract infection.

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shorter hospital length of stay (LOS).[2,3,5,9] However, early catheter removal may lead to increased rates of POUR; thus, the optimal duration for Foley catheter drainage and timing for removal remains controversial.[1,10]

Enhanced Recovery Pathways (ERP) after surgery are novel multidisciplinary approaches to peri-operative care that have demonstrated improved LOS and outcomes in colorectal cohorts.[11] Pathways recommend early removal of indwelling catheters which have been shown to decrease CAUTIs and LOS.[9] However, the impact of ERP on POUR and the interaction between early catheter removal and other ERP recommendations on post-operative outcomes has not been determined. As ERP reduce opioid consumption and improve intraoperative and postoperative fluid balances, as well as encourage early catether removal, we believe that it is important to study POUR in the era of ERP. The objective of this study was to investigate a cohort of institutional colorectal surgery patients and evaluate our institutional ERP pathway, which includes routine early Foley removal on postoperative day (POD) 1, and its impact on POUR, compared to historical non-ERP controls. We hypothesized that ERP would be associated with higher rates of POUR, leading to greater rates of re-catheterization compared to non-ERP patients recovering under traditional care. Our secondary aim is to examine if ERP and POUR lead to increased rates of CAUTI.

Methods

Cohort and hospital setting

This is an observational retrospective analysis of patients undergoing colorectal surgery at a single academic tertiary referral hospital. All consecutive adult patients (>18 years) undergoing open or laparoscopic major abdominal surgery by the Division of Colon and Rectal Surgery at the University of Pittsburgh Medical Center between April 2014 and November 2017 were screened. Patients who required a Foley catheter placement intra-operatively and were admitted post-operatively were included. Major abdominal operations performed included: right colectomy, ileocecectomy, sigmoid colectomy, total abdominal colectomy with ileal pouch-anal anastomosis, total abdominal colectomy with end ileostomy, total proctocolectomy with end ileostomy, completion proctectomy (including resection of J-pouch) with end ileostomy, left colectomy, low anterior resection, small bowel resection, and ileostomy closure. Pediatric patients (<18 years), anorectal procedures, outpatient procedures, and operations that did not necessitate a Foley catheter being placed were excluded.

Enhanced recovery pathway

In July 2015, our institution launched ERPs amongst patients undergoing major abdominal surgery, as an evidence-based multimodal approach to peri-operative care with the goals of minimizing surgical stress, reducing complications, facilitating faster recovery, and enhancing patient satisfaction. The major tenets of our institutional protocol include limiting pre-operative oral fasting, prophylaxis against nausea and vomiting, intraoperative goal-directed intravenous fluid administration, multimodal analgesia with minimization of opioids, single shot intrathecal hydromorphone as neuraxial analgesia, early ambulation, and early post-operative enteral nutrition. Included in the protocol is routine Foley catheter removal on POD 1. Upon implementation of ERP, all major abdominal colorectal surgery patients were managed via the ERP. On an intention to treat basis, patients with operation dates prior to July 2015 were classified as “Non-ERP,” while those after July 2015 were classified as “ERP.”

Study outcomes

The primary outcome of interest was the incidence of POUR, defined as 1) the need for straight catheterization, 2) Foley reinsertion, or 3) the initiation of alpha-1a antagonists. Patients who were unable to void 8 h following Foley removal received a straight catheterization if their bladder volumes exceeded 300–400 mL based on bedside ultrasound scanner. After failing a second void trial 8 h later, a Foley catheter was reinserted. The secondary outcome of interest was the incidence of CAUTIs. Other immediate post-operative complications during the index operation admission were measured including: post-operative ileus, wound infections, and anastomotic leaks. Complications were categorized as minor (Clavien-Dindo I-II) or major (Clavien-Dindo III-IV). CAUTI was defined as urine cultures growing more than 10^5 colony forming units per mL and/or empiric treatment with antibiotics. Patients who were discharged home with a Foley catheter received an inpatient urology consultation to facilitate an outpatient void trial and additional follow-up.

Data collection and statistical analysis

Baseline characteristics, intra-operative variables, and post-operative outcomes were collected by querying a prospectively collected clinical database, and individual chart review. Descriptive statistics were used to compare baseline and peri-operative factors between ERP and non-ERP patients. Normally-distributed continuous data were summarized using means and standard deviation (SD) while non-normally-distributed data were summarized using medians and interquartile ranges (IQR). Categorical data were summarized using frequency and percentages. T-tests were used for continuous variables that were normally distributed, Mann-Whitney U-tests were uses for continuous variables that were non-normally distributed, Chi squared tests were used to compare categorical variables, and Fisher-exact tests were used to compare categorical variables with cell sizes $\leq$5. Multivariable binary logistic regression was used to determine the independent association of ERP with POUR after controlling for variables with a univariate association ($p < 0.05$) or shown previously in the literature to be a significant contributor. Variables that were statistically significant on univariate analysis ($p < 0.05$) were included in the multivariable analysis. Those that were not associated with POUR with statistical significance ($p > 0.05$) were not included in the multivariable analysis. All statistical tests were of two-sided nature with a P value of <0.05 to indicate statistical significance and completed using Stata 15.1 (StataCorp LLC, College Station, Texas). This study is part of a collaborative Quality Assurance and Quality Improvement (QA/QI) initiative between the UPMC Division of Colon and Rectal Surgery and the Wolff Center at UPMC, approved by the UPMC Total Quality Council (ID #990).

Results

Between April 2014 and November 2017, 284 patients underwent major abdominal colorectal procedures requiring intra-operative Foley placement followed by inpatient admission and met inclusion criteria. Of this cohort, 161 (57%) received the ERP and 123 (43%) recovered under traditional care. Median age at time of surgery was 59.5 (IQR 47–70) and 53% were male. Baseline clinical characteristics that were equivalent between non-ERP and ERP patients (Table 1), included BMI (28 vs 27, $p = 0.330$), median age-adjusted Charlson Comorbidity Index (3 vs 2, $p = 0.437$), and rates of malignancy (37% vs 35%, $p = 0.729$). Importantly, there were also similar proportions of patients with a history of benign prostatic hypertrophy (2.4% vs 6.8%, $p = 0.09$) and on pre-operative

Table 1
Baseline characteristics.

	All (N = 284)	Non-ERP (N = 123)	ERP (N = 161)	P
Age, year, median (IQR)	59.5 (47, 70)	60 (49, 70)	59 (45, 70)	0.770
Sex, n (%)				0.911
Male	149 (52.5)	65 (52.9)	84 (52.2)	
Female	135 (47.5)	58 (47.1)	77 (47.8)	
BMI, kg/m,^{2} median (IQR)	28 (24, 31)	28 (24, 32)	27 (23, 31)	0.330
Obesity (BMI $\geq$ 30), n (%)	105 (37.0)	47 (38.2)	58 (36.0)	0.705
Pre-operative albumin, median (IQR)	3.7 (3.3, 4.2)	3.7 (3.2, 4.1)	3.8 (3.3, 4.2)	0.229
ASA				0.306
1-2, n (%)	131 (46.1)	61 (49.6)	70 (43.5)	
3-4, n (%)	153 (53.9)	62 (50.4)	91 (56.5)	
CCI, median (IQR)	0 (0, 2)	0 (0, 2)	0 (0, 2)	0.604
AA-CCI, median (IQR)	2 (1, 5)	3 (1, 5)	2 (1, 4)	0.437
Prior colorectal or prostate surgery, n (%)	52 (18.3)	13 (10.6)	39 (24.2)	**0.003**
Prostate, n (%)	6 (2.1)	2 (1.6)	4 (2.5)	0.701
Sigmoid, n (%)	46 (16.2)	11 (8.9)	35 (21.7)	**0.004**
Rectal, n (%)	19 (6.7)	6 (4.9)	13 (8.1)	0.285
History of BPH, n (%)	14 (4.9)	3 (2.4)	11 (6.8)	0.090
Pre-op alpha-blockers or related medication, n (%)	6 (2.1)	2 (1.6)	4 (2.5)	0.701
Malignancy, n (%)	103 (36.3)	46 (37.4)	57 (35.4)	0.729
Neoadjuvant CRT, n (%)	17 (6.0)	8 (6.5)	9 (5.6)	0.748

*Bolded denotes p-values <0.05 IQR = interquartile range.

alpha-1a antagonists (1.6% vs 2.5%, p = 0.701). ERP patients were more likely to have a history of prior sigmoid surgery (22% vs. 8.9%, p = 0.004) but no difference in prostate or rectal surgery history.

Intra-operative variables for the two groups are displayed in Table 2. Of 284 operations, 245 (86%) were performed electively and 191 (67%) were accomplished laparoscopically. There were similar proportions of patients who had rectal pathology in both non-ERP and ERP cohorts (35% vs 37%, p = 0.769) and who required pelvic dissections (28% vs 32%, p = 0.462). As expected, non-ERP patients received more intra-operative intravenous fluids (1.831 vs 1.006 L/kg/hr, p < 0.001) and lower rates of intrathecal analgesia (4.9% vs. 84%, p < 0.001).

The majority of patients on an ERP had their Foley catheters removed on POD 1 (ERP 77% vs. non-ERP 37%) while most non-ERP patients had catheters removed on POD 2 or later (non-ERP 63% vs. ERP 23%, p < 0.001). The median length of indwelling catheters was 1 day for ERP vs. 2 days for non-ERP (p < 0.001). ERP patients had higher rates of POUR compared to non-ERP patients (Table 3). Specifically, there were higher rates of re-catheterization (24.8%, vs 15.5.% p = 0.05) and initiation of alpha-blocker medication (12% vs. 4.9%, p = 0.041). There was no statistically significant difference in proportion of patients discharged home with an indwelling foley between the two groups (6.2% vs 3.3%, p = 0.280). There was a trend towards higher rates of POUR amongst patients with pelvic dissections vs non-pelvic dissection (32.9% vs. 23.6%, p = 0.103). Amongst pelvic dissections, ERP was not associated with increased rates of POUR (35.3% vs. 29.4%, p = 0.572). Meanwhile, amongst non-pelvic dissections, ERP was associated with increased rates of POUR (30.0% vs 15.7%, p = 0.018).

Post-operatively, there were no differences in major or minor Clavien-Dindo complications between ERP and non-ERP cohorts (Table 3), and in particular, no differences in CAUTI (1.6% vs. 1.2%, p = 0.998). There was no difference in CAUTI amongst patients with POUR between ERP and non-ERP groups (3.9% vs. 4.2%, p = 0.999). Patients with POUR experienced longer median post-operative LOS (6 vs. 4 days, p = 0.006) and total LOS (6 vs. 5 days, p = 0.004). However, ERP patients had shorter median post-operative LOS (4 vs. 5 days, p < 0.001).

On univariate analysis, risk factors for urinary retention included increasing age, male gender, history of benign prostatic hyperplasia, duration of surgery, and care via an ERP (Table 4). On multivariate analysis, history of BPH was no longer significantly associated with POUR. Significant independent predictors of POUR included age (OR 1.03, p = 0.002), male gender (OR 2.79, p = 0.001) and duration of surgery (OR 1.27, p = 0.027). ERP was independently associated with a nearly two-fold increased odds of POUR (OR 1.96, p = 0.025).

Table 2
Intra-operative variables.

	All (N = 284)	Non-ERP (N = 123)	ERP (N = 161)	P
Surgical Approach, n (%)				0.178
Open	93 (32.8)	35 (28.5)	58 (36.0)	
Laparoscopic	191 (67.2)	88 (71.5)	103 (64.0)	
Elective indication, n (%)	245 (86.3)	99 (80.5)	146 (90.7)	**0.013**
Pelvic dissection, n (%)	85 (29.9)	34 (27.6)	51 (31.7)	0.462
Surgery type, n (%)				0.769
Small bowel and colon	182 (64.1)	80 (65.0)	102 (63.4)	
Rectal	102 (35.9)	43 (35.0)	59 (36.6)	
Intraoperative fluid balance, L/kg/hr median (IQR)	1350 (785, 2050)	1830.5 (1155, 2460)	1005.5 (645, 1625)	**<0.001**
Surgery duration, minutes, median (IQR)	145 (102, 200.5)	144 (103, 204)	148 (97, 198)	0.520
Estimated Blood Loss (mL), median (IQR)	50 (25, 100)	50 (25, 100)	50 (25, 100)	0.829
EBL >500 mL, n (%)	10 (3.5)	4 (3.3)	6 (3.7)	0.830
Intrathecal analgesia, n (%)	141 (49.6)	6 (4.9)	135 (83.8)	**<0.001**

*Bolded denotes p-values <0.05 IQR = interquartile range.

Table 3
Post-operative outcomes.

	All (N = 284)	Non-ERP (N = 123)	ERP (N = 161)	P
POD catheter removal, n (%)				**<0.001**
POD 0-1	179 (59.9)	46 (37.4)	124 (77.0)	
POD >1	58 (40.1)	77 (62.6)	37 (23.0)	
Overall, median IQR	1 (1, 2)	2 (1, 3)	1 (1, 1)	**<0.001**
Straight catheterization, n (%)	51 (18.0)	15 (12.2)	35 (21.7)	**0.036**
Foley reinsertion, n (%)	32 (11.3)	9 (7.3)	23 (14.3)	0.066
Urinary Retention, n (%)	75 (26.4)	24 (19.5)	51 (31.7)	**0.021**
Initiation of alpha-blockers or related medication, n (%)	25 (8.8)	6 (4.9)	19 (11.8)	**0.041**
Discharged with Foley, n (%)	14 (4.9)	4 (3.3)	10 (6.2)	0.280
Urology consult, n (%)	18 (6.3)	6 (4.9)	12 (7.5)	0.377
†Any re-catheterization, n (%)	59 (20.8)	19 (15.5)	40 (24.8)	0.053
PCA use, n (%)	119 (41.9)	96 (78.1)	23 (14.3)	**<0.001**
Total days, median (IQR)	3 (2, 5)	3 (2, 5)	3 (1, 6)	0.439
CAUTI, n (%)	4 (1.4)	2 (1.6)	2 (1.2)	0.998
Ileus, n (%)	48 (16.9)	20 (16.3)	28 (17.4)	0.801
Wound infection, n (%)	10 (3.5)	7 (5.7)	3 (1.9)	0.110
Anastomotic leak, n (%)	9 (3.2)	5 (4.1)	4 (2.5)	0.506
Any Complication, n (%)	106 (37.3)	50 (40.7)	56 (34.8)	0.311
Clavien-Dindo I-II (minor)	80 (75.5)	39 (78.0)	41 (73.2)	0.568
Clavien-Dindo III-IV (major)	26 (24.5)	11 (22.0)	15 (26.8)	
Hospital LOS, median days (IQR)	5 (3, 8)	6 (4, 9)	4 (3, 7)	**0.002**
Postoperative LOS, median (IQR)	3 (5, 7)	5 (4, 8)	4 (3, 6.5)	**<0.001**

*Bolded denotes p-values <0.05 †Straight catheterization or Foley reinsertion IQR = interquartile range.

Discussion

This is a single-institution retrospective review comparing colorectal surgery patients who had early Foley catheter removal as part of an ERP, compared to a historical non-ERP cohort. ERP patients had a 41% increased rate of POUR compared to non-ERP patients, with a 39% increased rate of re-catheterization after Foley removal. However, this did not lead to greater rates of CAUTIs or other complications. In addition to increasing age and male gender being independent predictors of POUR on multivariate analysis, ERP was associated with two-fold increased odds of POUR following colorectal surgery. Amongst patients undergoing pelvic dissections, there was no increased rates of recatheterization after early Foley removal. There was an increased, albiet statistically insignificant, overall proportion of open operations in the ERP group (36% vs. 29%) which may have led to greater pain control requirements. However, rates of PCA use were significantly lower in the ERP group (14% vs. 78%, $p < 0.001$), and for patients who did use a PCA, mean total days of use were equivalent to those in the non-ERP group.

Our results are supported by Okrainec et al. who studied 2927 patients across 15 academic hospitals and found that patients who had colonic operations and were compliant with their institutional ERP catheter removal guideline were more likely to have their catheters reinserted compared to patients who were not compliant.[9] After multivariable analysis, compliance with catheter removal similarly had an over two-fold increase risk of catheter reinsertion (RR 2.51, 95% CI 1.82–3.46), in addition to age and male sex being independent risk factors. However, Okrainec's rates of catheter reinsertion were lower; 4.9% in his compliant colon surgery group vs. 14% in our ERP group. This is likely explained by Okrainec's higher bladder residual threshold for re-catheterization (600 mL vs. 300–400 mL) and removal guidelines based on operation; colon procedures had catheters removed by 24 h and rectal procedures had catheters removed by 72 h post-operatively. After rectal operations, he found no differences in recatheterization rates amongst compliant vs. non-compliant patients. This was likely facilitated by the 72-h limit, though we feel that three days for routine drainage may be unnecessarily prolonged. Further, this group assumes that the adage that pelvic dissections lead to higher rates of urinary retention is true and subjects all rectal surgery patients to prolonged urinary catheterization, which could increase CAUTI rates.

In a recent single-center prospective study of 113 patients undergoing elective laparoscopic colorectal surgery, Eriksen et al.

Table 4
Univariate and multivariate analysis for post-operative urinary retention.

Variable	Univariate Analysis OR (95% CI)	p-value	Multivariate Analysis[b] OR (95% CI)	p-value
Age	**1.02 (1.01–1.04)**	**0.008**	**1.03 (1.01–1.05)**	**0.002**
Male gender	**2.84 (1.61–5.00)**	**<0.001**	**2.79 (1.51–5.15)**	**0.001**
History of BPH	**4.04 (1.35–12.06)**	**0.012**	1.73 (0.54–5.62)	0.356
Pelvic dissection	1.59 (0.91–3.10)	0.104	–	–
Rectal surgery	1.26 (0.74–2.18)	0.391	–	–
Intrathecal analgesia	1.41 (0.83–2.40)	0.201	–	–
Prior surgery[a]	1.16 (0.59–2.27)	0.659	–	–
Charlson index	1.12 (0.98–1.31)	0.103	–	–
Open approach	1.67 (0.97–2.89)	0.066	–	–
Surgery duration (hours)	**1.25 (1.03–1.52)**	**0.024**	**1.27 (1.03–1.58)**	**0.027**
Intra-op fluid balance	1.23 (0.96–1.58)	0.109	–	–
ERP	**2.02 (1.14–3.54)**	**0.014**	**1.96 (1.09–3.54)**	**0.025**

*Bolded denotes p-values <0.05.
[a] Prior prostate, sigmoid, or rectal surgery.
[b] Includes variables that were significantly associated with POUR on univariate analysis.

observed a POUR rate of 9% after 95% of patients had their catheter removed within 24 h post-operatively. While their results more closely approximate our results, they, similar to Okrainec, used a high re-catheterization threshold of 800 mL.[12] They similarly found no differences between colon versus rectal operations. Together, these studies suggest that re-catheterization thresholds of 600–800 mL is safe and may reduce unnecessary re-catheterizations.

In our study, the use of intrathecal analgesia did not impact the incidence of POUR in the ERP cohort (OR 1.41 $p = 0.201$) despite previous studies that show the contrary.[13,14] Specifically, Grass et al. found a significant association between thoracic epidural analgesia and POUR (OR 2.6, $p < 0.001$) amongst 513 patients recovering from colorectal surgery on an ERP.[3] The lower incidence of POUR in the current study may be attributed to the fact that only a single dose of intrathecal hydromorphone was used, compared to spinal anesthesia or epidural analgesia that use lidocaine, which has been shown to markedly increase rates of POUR.[15]

Of the 51 ERP patients who experienced POUR in our cohort, 19 (37%) were initiated on alpha-1a antagonist medication. In a prospective randomized noninferiority trial amongst pelvic colorectal surgery patients comparing catheter removal on postoperative day one and day three, patients who were randomized to early catheter removal were administered an alpha-1a antagonist 6 h before catheter removal.[2] Patel et al. found no differences in overall retention rate between early vs. standard catheter removal, and additionally reported lower rates of CAUTI and shorter hospital stays in the early removal group. While our practice is unlikely to routinely begin alpha-1a antagonists on all post-operative patients, a more liberal initiation strategy for higher risk patients (male gender and advanced age) may reduce our POUR rates closer to the 9.2% reported by Patel. Additionally, reducing the need for recatheterization may further reduce the CAUTI rates in ERP patients.

Despite an increased incidence of POUR, there was no difference in CAUTI rates between ERP and non-ERP cohorts (1.2% vs.1.6%, $p = 0.786$). We suspect this is partially explained by the overall low rates of CAUTI. With only 4 incidents of CAUTI, 3 (75%) occurred in patients with POUR vs. 1 (25%) in patients without POUR ($p = 0.058$) though the small numbers make this difficult to interpret. Even before the implementation of ERP, Foleys were removed by our providers as early as clinically reasonable. Despite having longer periods of indwelling catheters than the ERP group, historic catheters were removed after a mean of only 3.8 days which approximates some modern institutional ERP protocols of catheter removal at 3 days.[9] These results are consistent with Weiner et al. who similarly did not detect an increase in CAUTI following colorectal surgery in 351 institutional ERP patients compared to historical non-ERP controls.[1] The study did however, detected a *decrease* in POUR amongst their ERP cohort (8% vs. 13%, $p < 0.05$). The biggest difference in methodology is their historical control which consisted of a cohort of patients from the National Surgical Quality Improvement Program. We believe that our institutional non-ERP cohort before the hospital-wide implementation of ERP provides a more reliable control as it can eliminate some bias from nuanced variations in provider and institutional practices.

This study had several limitations. An inherent limitation of this study is that it was a retrospective study. Nuanced baseline characteristics such as pre-operative bladder function and sensitivity to opioids are unable to be assessed and may have confounded the results. While ERP was launched for all colorectal procedures beginning in July 2015, compliance to all protocol components was not consistent. Variability in provider practices introduced bias, and in fact 77% of ERP patients had their catheters removed by POD 1. Thresholds for straight catheterization (though outlined in the ERP orders), re-insertion of Foleys, and initiation of alpha-1a antagonists is dependent on surgeon and trainee preferences and makes our results difficult to generalize and compare to other published studies. As a single institutional study, the results are also limited by a lack of statistical power to detect small differences in infrequently-occurring events; only a total of four CAUTIs occurred in all patients. This may have hindered the ability to detect a change in rates of CAUTI associated with ERP. Despite these limitations, this study shows that ERP following colorectal procedures leads to shorted hospital stays without an increase in complications.

Conclusion

In conclusion, the results of this study show that ERP that include routine early Foley catheter removal on POD1 do not lead to increased rates of CAUTI during the index admission in the population studied. However, one in four ERP patients will require re-catheterization for POUR. Strategies to reduce re-catherization may include a higher residual bladder volume of 600–800 mL before intervention. Additionally, more liberal initiation of alpha-1a antagonists in selected at risk patients may facilitate early catheter removal without need for reinsertion, especially in patients of male sex and older age, which have been shown to be independent risk factors for POUR. Amongst these higher risk patients, clinical discretion on indwelling catheter duration is advocated over routine early removal to reduce rates of re-catheterization but not infection. While other studies have evaluated the relationships between ERP with POUR and CAUTI, this study is unique as Foley removal on POD1 is recommended. In select patients, we believe this management strategy is safe with benefits to patient-centered and hospital outcomes.

Author contributions

Conception and Design: VT, WL, RS, DM, JC, AW, JHM.

Data acquisition, analysis, interpretation: VT, WL, KM, RV, RS, BM, JHM.

Drafting and revising: VT, WL, DM, JC, AW, JHM.

Final approval: VT, WL, KM, RV, RS, BM, DM, JC, AW, JHM.

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