Bladder | **2018** | Vol. 5(3) | e35
DOI: 10.14440/bladder. 2018.722

ARTICLE

# Antibiotic prophylaxis is not associated with reduced urinary tract infection-related complications after cystectomy and ileal conduit

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Competing interests: The authors have declared that no competing interests exist.

Abbreviations used: AMP, antimicrobial prophylaxis; ASA, American Society of Anesthesiologists; CCI, Charlson comorbidity index; CKD, chronic kidney disease; CFU, colony-forming units; CFU/ml, colony-forming units per milliliter; CT, computed tomography; eGFR, estimated glomerular filtration rate; MRI, magnetic resonance imaging; OR, odds ratio; PLND, pelvic lymph node dissection; RC, radical cystectomy; SD, standard deviation; UTIs, urinary tract infections

Received April 2, 2018; Revision received June 21, 2018; Accepted June 26, 2018; Published August 23, 2018

## ABSTRACT

**OBJECTIVES:** Majority of complications after ileal conduit urinary diversion with cystectomy are related to urinary tract infections (UTIs). Controversy exists regarding use of prophylactic antibiotics after surgery. We determined if prophylactic antibiotic use during ureteral stent placement after ileal conduit urinary diversion decreased incidence of UTI-related complications.

**METHODS:** We retrospectively identified 75 consecutive patients who underwent ileal conduit urinary diversion with cystectomy at our institution from 2010 to 2016. Patients were stratified based on presence or absence of a UTI-related complication in the 90-day postoperative period. Means were compared with independent *t*-test and proportions with chi-square analysis. Multivariate logistic regression was performed to determine independent predictors of UTI-related complications.

**RESULTS:** Forty-five patients (60%) were prescribed prophylactic antibiotics after surgery. Mean duration of antibiotic use was 15 d, and mean duration of ureteral stenting was 25 d. Most common antibiotics used included fluoroquinolones ($n$ = 23, 30.7%) followed by sulfamethoxazole-trimethoprim ($n$ = 14, 18.7%). Rate of 90-day UTI-related complications was 36% ($n$ = 27), and 90-day UTI-related readmission rate was 14.7% ($n$ = 11). On bivariate and multivariate analysis, prophylactic antibiotic use was not associated with reduced 90-day UTI-related complications ($P > 0.05$). Patients prescribed prophylactic antibiotics had increased incidence of *Clostridium difficile* infections in the 90-day postoperative period compared to controls (20% *vs*. 3.3%; $P = 0.038$).

**CONCLUSIONS:** Prophylactic antibiotic use after ileal conduit urinary diversion with cystectomy was not associated with reduced UTI-related complications, and rate of *Clostridium difficile* infections was higher in this patient cohort. The effect of early removal of ureteral stents on UTI risk still has to be elucidated.

**Keywords:** cystectomy, ileal conduit, urinary tract infection, complications, antibiotics

## INTRODUCTION

Radical cystectomy (RC) and urinary diversion is the standard-of-care treatment for muscle-invasive urothelial carcinoma of the bladder along with neoadjuvant chemotherapy [1-4]. It is also utilized as a treatment option for non-malignant conditions such as neurogenic bladder, post-trauma or post-surgical complications, birth defects, or intractable hematuria [5]. Traditionally, RC involves removal of the bladder, adjacent organs such as the prostate and seminal vesicles in males and the uterus, ovaries, and fallopian tubes in females, and a bilateral pelvic lymph node dissection in the setting of malignancy [6,7]. Urinary diversion is then performed with a percutaneous ileal conduit, continent cutaneous urinary diversion using a portion of large bowel, or orthotopic ileal neobladder.

**How to cite this article:** Kirkpatrick C, Haynes A, Sharma P. Antibiotic prophylaxis is not associated with reduced urinary tract infection-related complications after cystectomy and ileal conduit. *Bladder* 2018;5(3):e35. DOI: 10.14440/bladder.2018.722

Ileal conduit urinary diversion is the common form in patients undergoing RC, owing to its low complication rates, minimal long-term burden of care, and quicker intraoperative construction minimizing anesthesia time especially in the patients with multiple, significant medical comorbidities. In this technique, a 15–20 cm segment of terminal ileum is isolated, the ureters are anastamosed to the proximal stump, and the distal segment is exteriorized to the skin in the form of a stoma (*i.e.*, urostomy), through which urine flows [8-10].

Due to persistent colonization of this segment of ileum with bacteria even after dissociation and isolation from the rest of the small bowel and reconstruction into a urostomy, urinary tract infections (UTIs) and pyelonephritis are the most common complications both short-term (~20% postoperatively) and long-term after RC and ileal conduit urinary diversion [11,12]. The colonized ileal segment with attached ureters allows for bacterial contamination of the urinary tract with an easy passageway up the ureters into the kidneys, predisposing patients to UTIs and pyelonephritis. This is also exacerbating by the fact that most ureteroenteric anastomoses are refluxing with freely flowing urine passing back and forth across the connection point.

There are currently no accepted guidelines or recommendations in the urology literature advocating or discouraging the use of antibiotics in the perioperative period after RC and ileal conduit urinary diversion to minimize infectious complications. Prolonged antibiotic use postoperatively after major urologic surgery has also been linked to increased incidence of infections with *Clostridium difficile* in the gut [13]. In this study, we determined if prophylactic antibiotic use during ureteral stent placement after ileal conduit urinary diversion with cystectomy decreased the incidence of UTI-related complications in the 90-day postoperative period.

## PATIENTS AND METHODS

### Data collection

After institutional review board approval, we retrospectively identified 75 consecutive patients who underwent ileal conduit urinary diversion with cystectomy at our institution (Texas Tech University Health Sciences Center) between January 2010 and December 2016. We excluded patients on baseline chronic antibiotics prior to surgery, patients with multiple (≥ 3) antibiotic allergies, patients who had other forms of urinary diversion, patients with clinical evidence of metastatic malignancy, and patients who underwent palliative ileal conduit urinary diversion without cystectomy.

Sociodemographics and comorbidity indicators (Charlson Comorbidity Index [CCI]) were abstracted from the Urology clinic visit just before surgery, and American Society of Anesthesiologists (ASA) score was assessed preoperatively on the date of surgery. The presence of diabetes was based on the patient's active problem list prior to surgery. Creatinine level and degree of pre-operative hydronephrosis were recorded based on the most recent blood work and imaging, respectively, prior to surgery with chronic kidney disease (CKD) defined as an estimated glomerular filtration rate (eGFR) < 60 ml/min/1.73 $m^2$. Pathology was confirmed by central histopathological review based on the RC specimen. A standard pelvic lymph node dissection (PLND) during surgery was defined as removal of all lymphatic nodal tissue in the obturator, internal iliac, and external iliac regions, and an extended PLND included common iliac and presacral nodal packets.

Postoperative 30- and 90-day complications were assigned according to the Clavien-Dindo classification with high-grade complications defined as Clavien ≥ IIIa [14]. UTI-related complications were defined as any postoperative complication associated with a positive urine culture, clinical evidence of UTI, or suspected infection/sepsis with a primary urinary source. Systemic inflammatory response syndrome criteria (temperature > 38°C or < 36°C, heart rate > 90, respiratory rate > 20, white blood cell count > 12000/$mm^3$, < 4000/$mm^3$, or > 10% bands) were used to determine clinical suspicion or evidence of UTI. Similar definitions and criteria were used for UTI-related readmissions.

A positive urine culture was defined as > 10000 colony-forming units (CFU) per milliliter (CFU/ml) of one or more organisms in a symptomatic patient or > 100000 CFU/ml of one or more organisms in an asymptomatic patient. A positive blood culture was defined as > 1000 CFU/ml of one or more organisms in a symptomatic or asymptomatic patient in at least two separate specimens drawn concurrently. For patients with multiple organisms on a positive urine or blood culture, the one with the highest counts was assigned.

### Clinical management

A subset of patients were placed on antibiotic prophylaxis during ureteral stent placement after ileal conduit urinary diversion with cystectomy. Antibiotic prophylaxis was initiated on the day of hospital discharge until the day of ureteral stent removal in the Urology clinic 2–4 weeks postoperatively. Bilateral single-J stents were used for all ileal conduit urinary diversion reconstructions. Preoperative antimicrobial prophylaxis for the surgery was done in all included patients according to American Urological Association guidelines with either a single preoperative dose of a $2^{nd}/3^{rd}$ generation cephalosporin, gentamicin + metronidazole, or a fluoroquinolone [15]. Patients did not routinely receive bowel preparation prior to surgery.

All robotic-assisted laparoscopic cystectomies were performed with an extracorporeal ileal conduit urinary diversion in a similar fashion and technique as the open approach through an infra-umbilical midline incision. All ureteroenteric anastomosis were refluxing Bricker-type at the proximal end of the ileal conduit.

Urinalysis was not routinely performed at the time of discharge, in the outpatient setting during the postoperative period, or during clinical suspicion of UTI. Urine cultures were also not routinely taken prior to discharge or during the postoperative period in the outpatient setting. All patients, however, with suspected UTI-related complications within 90 d of surgery had urine and blood cultures obtained. All urine specimens in both the inpatient and outpatient setting were obtained from a catheterized specimen of the ileal conduit and sent for culture and sensitivity for diagnosis and treatment. Cross-sectional imaging with ultrasound, computed tomography (CT) scan, or magnetic resonance imaging (MRI) was not routinely performed at the time of suspected UTI diagnosis to assess for pyelonephritis or hydronephrosis but was obtained in a subset of patients.

### Statistical analysis

Sociodemographic, comorbidity, and other relevant clinical variables were compared between patients based on our primary endpoint, which was the development of a UTI-related complication in the 90-day postoperative period. Secondary endpoints included UTI-related readmissions in the 90-day postoperative period, the overall complication rate, the high-grade complication rate, and the incidence of *Clostridium difficile* infections in the 90-day postoperative period.

Continuous variables were reported as means and standard deviations, and categorical variables were reported as frequency counts and percentages. We used the independent *t*-test to determine any differences in continuous variables between both groups and the chi-square test for categorical variables. Multivariate logistic regression analysis was performed to evaluate the association of reported variables with our primary endpoint, and odds ratios (OR) were reported. Factors analyzed included any variable with a significant association ($P \leq 0.1$) with our primary endpoint on bivariate analysis in addition to our variable of interest (use of antimicrobial prophylaxis during ureteral stenting in the postoperative period after ileal conduit urinary diversion).

Statistical analysis was performed with the Statistical Package for the Social Sciences software package (IBM Corporation, Armonk, New York). All tests were 2-sided, with $P < 0.05$ considered to be statistically significant.

## RESULTS

Relevant sociodemographics and clinical characteristics of our study population are shown in **Table 1**, and disease-specific characteristics are shown in **Table 2**. The vast majority of patients had a cystectomy with ileal conduit urinary diversion for some form of primary bladder malignancy (*N* = 59; 78.7%) while 16 patients (21.3%) had surgery for non-malignant causes. Utilization of neoadjuvant chemotherapy was poor (*N* = 3; 6.3%) for bladder carcinoma cases, and 30 patients (50.7%) required an intra-operative blood transfusion.

**Table 1. Patient sociodemographics and clinical characteristics.**

| | No 90-day UTI-related complication (*n* = 48) | 90-day UTI-related complication (*n* = 27) | Total (*n* = 75) | *P* value |
|---|---|---|---|---|
| Mean age, years (SD) | 63.0 (14.8) | 64.3 (16.6) | 63.5 (15.4) | 0.74 |
| Mean BMI, kg/m$^2$ (SD) | 26.8 (6.0) | 27.4 (7.0) | 27.0 (6.3) | 0.69 |
| Race, *n* (%) | | | | 0.66 |
| White | 36 (75.0) | 19 (70.4) | 55 (73.3) | |
| Non-white | 12 (25.0) | 8 (29.6) | 20 (26.7) | |
| Tobacco abuse, *n* (%) | | | | 0.94 |
| None | 23 (47.9) | 14 (51.9) | 37 (49.3) | |
| Former | 10 (20.8) | 5 (18.5) | 15 (20.0) | |
| Current | 15 (31.3) | 8 (29.6) | 23 (30.7) | |
| Charlson comorbidity index, *n* (%) | | | | 0.75 |
| ≤ 4 | 21 (43.8) | 10 (37.0) | 31 (41.3) | |
| 5–7 | 25 (52.1) | 15 (55.6) | 40 (53.3) | |
| ≥ 8 | 2 (4.2) | 2 (7.4) | 4 (5.3) | |
| ASA score, *n* (%) | | | | 0.30 |
| ≤ 2 | 12 (25.0) | 4 (14.8) | 16 (21.3) | |
| ≥ 3 | 36 (75.0) | 23 (85.2) | 59 (78.7) | |
| Diabetes, *n* (%) | | | | 0.84 |
| No | 40 (83.3) | 22 (81.5) | 62 (82.7) | |
| Yes | 8 (16.7) | 5 (18.5) | 13 (17.3) | |
| Mean creatinine, mg/dl (SD) | 1.1 (0.5) | 1.2 (0.4) | 1.1 (0.5) | 0.31 |
| CKD, *n* (%) | | | | 0.27 |
| No | 42 (87.5) | 21 (77.8) | 63 (84.0) | |
| Yes | 6 (12.5) | 6 (22.2) | 12 (16.0) | |
| Pre-op hydronephrosis, *n* (%) | | | | 0.34 |
| No | 40 (83.3) | 20 (74.1) | 60 (80.0) | |
| Yes | 8 (16.7) | 7 (25.9) | 15 (20.0) | |

In our study population, 45 patients (60%) received prophylactic antibiotic coverage with oral medical therapy from the time of hospital discharge until the time of ureteral stent removal in the Urology clinic postoperatively. Mean duration of antibiotic use was 15 d (standard deviation [SD]: 12.5 d) postoperatively, and mean duration of ureteral stenting was 25 d (SD: 6.2 d). The most common antibiotic medications used included fluoroquinolones (*n* = 23, 30.7%) followed by sulfamethoxazole-trimethoprim (*n* = 14, 18.7%) and cephalosporins (*n* = 6, 8.0%).

The overall complication rate was 57.3% (*n* = 43) in the 30-day postoperative period with a high-grade complication rate of 24% (*n* = 18) including 4 (5.3%) deaths. The overall complication rate was 66.7% (*n* = 50) in the 90-day postoperative period with a high-grade complication rate of 32% (*n* = 24) including 5 (6.7%) deaths. The overall 30- and 90-day readmission rate was 13.3% (*n* = 10) and 32%

($n$ = 24). The rate of 30- and 90-day UTI-related complications was 20% ($n$ = 15) and 36% ($n$ = 27), respectively, and the 30- and 90-day UTI-related readmission rate was 4% ($n$ = 3) and 14.7% ($n$ = 11). Mean time from initial hospital discharge until the development of a clinically suspected UTI was 26 d, and this was no different in patients receiving prophylactic antibiotics versus not (29 *vs*. 24 d, respectively; $P$ = 0.74).

**Table 2. Patient disease-specific characteristics.**

| | No 90-day UTI-related complication (*n* = 48) | 90-day UTI-related complication (*n* = 27) | Total (*n* = 75) | *P* value |
|---|---|---|---|---|
| Neoadjuvant chemotherapy, *n* (%) | | | | 0.10 |
| No | 45 (93.8) | 22 (81.5) | 67 (89.3) | |
| Yes | 3 (6.3) | 5 (18.5) | 8 (10.7) | |
| Mean EBL, ml (SD) | 986 (964) | 1354 (1038) | 1121 (1001) | 0.13 |
| Mean OR time, min (SD) | 499 (105) | 525 (96) | 508 (102) | 0.30 |
| Intra-operative blood transfusion, *n* (%) | | | | 0.04 |
| No | 28 (58.3) | 9 (33.3) | 37 (49.3) | |
| Yes | 20 (41.7) | 18 (66.7) | 38 (50.7) | |
| Surgical approach, *n* (%) | | | | 0.09 |
| Open | 37 (77.1) | 25 (92.6) | 62 (82.7) | |
| Robotic-assisted | 11 (22.9) | 2 (7.4) | 13 (17.3) | |
| Extent of PLND, *n* (%) | | | | 0.65 |
| None | 9 (18.8) | 7 (25.9) | 16 (21.3) | |
| Standard | 33 (68.8) | 18 (66.7) | 51 (68.0) | |
| Extended | 6 (12.5) | 2 (7.4) | 8 (10.7) | |
| Histology, *n* (%) | | | | 0.08 |
| Benign | 9 (18.8) | 7 (25.9) | 16 (21.3) | |
| Urothelial carcinoma | 31 (64.6) | 20 (74.1) | 51 (68.0) | |
| Non-urothelial carcinoma | 8 (16.7) | 0 (0.0) | 8 (10.7) | |
| Pathological tumor stage, *n* (%) | | | | 0.28 |
| Benign | 9 (18.8) | 7 (25.9) | 16 (21.3) | |
| ≤ T1 or Tis | 6 (12.5) | 7 (25.9) | 13 (17.3) | |
| T2 | 11 (22.9) | 3 (11.1) | 14 (18.7) | |
| T3–T4 | 22 (45.8) | 10 (37.0) | 32 (42.7) | |
| Pathological nodal stage, *n* (%) | | | | 0.54 |
| NX | 9 (18.8) | 7 (25.9) | 16 (21.3) | |
| N0 | 28 (58.3) | 16 (59.3) | 44 (58.7) | |
| N1 | 3 (6.3) | 0 (0.0) | 3 (4.0) | |
| N2–N3 | 8 (16.7) | 4 (14.8) | 12 (16.0) | |
| Prophylactic antibiotic use, *n* (%) | | | | 0.92 |
| No | 19 (39.6) | 11 (40.7) | 30 (40.0) | |
| Yes | 29 (60.4) | 16 (59.3) | 45 (60.0) | |

The characteristics of 90-day postoperative UTI-related complications in our study population are shown in **Table 3**. The vast majority of patients had clinical signs and symptoms such as fevers, chills, sweats, foul smelling urine, pyuria, stomal pain or burning, or flank pain ($n$ = 25/27, 92.6%). Positive urine cultures were seen in 22/27 (81.5%) patients with 5/27 (18.5%) having negative urine cultures in the setting of clinical signs and symptoms. Most positive urine cultures were secondary to a single organism (19/22, 86.4%) with 3/22 (13.6%) growing more than one organism. The most common organisms isolated included *Escherichia coli* (8/22, 36.4%), *Enterococcus* (5/22, 22.7%), *Staphylococcus epidermidis* (3/22, 13.6%), *Streptococcus* (2/22, 9.1%), *Pseudomonas* (2/22, 9.1%), *Klebseilla* (1/22, 4.5%), and *Proteus* (1/22, 4.5%). Positive blood cultures were seen in 7/27 (25.9%) patients with 20/27 (74.1%) having negative blood cultures. The same organism was isolated in the vast majority of patients with positive urine and blood cultures (6/7, 85.7%). Cross-sectional imaging was obtained in 13/27 (48.1%) patients at the time of suspected UTI diagnosis with 9/13 (69.2%) receiving a CT scan of the abdomen/pelvis and 4/13 (30.8%) receiving a renal ultrasound. The vast majority of imaging was benign (9/13, 69.2%) with the most common findings being pyelonephritis

(3/13, 23.1%) and worsening hydronephrosis (1/13, 7.7%). No patient, however, was found to have a renal abscess postoperatively.

**Table 3. Characteristics of 90-day postoperative UTI-related complications (*n* = 27).**

| | *n* (%) |
|---|---|
| Clinical symptoms | |
| No | 2 (7.4) |
| Yes | 25 (92.6) |
| Urine culture | |
| Negative | 5 (18.5) |
| *Enterococcus* | 5 (18.5) |
| *Escherichia coli* | 8 (29.6) |
| *Klebseilla* | 1 (3.7) |
| *Proteus* | 1 (3.7) |
| *Pseudomonas* | 2 (7.4) |
| *Staphylococcus epidermidis* | 2 (7.4) |
| *Streptococcus* | 3 (11.1) |
| Blood culture | |
| Negative | 20 (74.1) |
| Positive | 7 (25.9) |
| Concordance between urine and blood cultures | |
| No | 1 (3.7) |
| Yes | 6 (22.2) |
| N/A | 20 (74.1) |
| Cross-sectional imaging obtained at UTI diagnosis | |
| None | 14 (51.9) |
| CT scan abdomen/pelvis | 9 (33.3) |
| Renal ultrasound | 4 (14.8) |

On bivariate and multivariate analysis (**Table 4**), prophylactic antibiotic use was not a predictor or associated with reduced 90-day UTI-related complications ($P > 0.05$). Prophylactic antibiotic use was also not a predictor or associated with reduced 90-day UTI-related readmissions ($P > 0.05$). Patients prescribed prophylactic antibiotics during ureteral stenting after ileal conduit urinary diversion had a much higher rate of *Clostridium difficile* infections in the stool based on polymerase chain reaction testing compared to patients not taking antibiotics after surgery (9/36 = 20% *vs*. 1/29 = 3.3%). This difference was statistically significant ($P = 0.038$).

## Discussion

The use of antibiotic prophylaxis to prevent UTI-related complications after ileal conduit urinary diversion with or without cystectomy is still controversial. The findings in our study cohort suggest that antimicrobial prophylaxis (AMP) has no clinical benefit for patients after surgery with no significant impact on UTI-related complications or readmissions in the 90-day postoperative period.

Prior data on this topic is conflicting. Hara *et al*. retrospectively evaluated 77 patients with bladder cancer who underwent RC and ileal conduit urinary diversion examining postoperative infectious complication rates in the setting of AMP [16]. Patients were divided into two groups: patients who received AMP on the day of surgery alone, and patients that received AMP on the day of surgery plus 3 or more days postoperatively. The authors found no clinically significant difference in the rate of febrile UTIs, surgical site infections, or pneumonia in these two groups based on AMP.

A recent study, however, has shown a potential benefit to continuing AMP in the postoperative period. Werntz *et al*. enacted a Department Quality Initiative to reduce the incidence of UTIs after RC with urinary diversion [17]. As a part of this initiative, all postoperative patients were discharged home on AMP for 30 d following a postoperative urine culture obtained during hospitalization. The last 42 patients from before the initiative were compared to the first 42 patients after the initiative to evaluate its effectiveness, and ureteral stents were kept for three weeks postoperatively in both groups. The authors reported a 12% incidence of UTI in the AMP group during the 30-day post-discharge period versus a 36% incidence of UTI in the no AMP group ($P < 0.004$). The median time to UTI in the Werntz *et al*. study was 19 d, and the most common organism was Enterococcus (32%) [17]. A total of 1 (2%) patient in the AMP group was readmitted for urosepsis whereas 7 (17%) patients in the no AMP group were admitted for urosepsis ($P = 0.02$). There was no association noted between urine culture at discharge and the development of UTI in the 30-day post-discharge period ($P = 0.75$). Thirty percent of patients not receiving AMP developed a UTI one day after ureteral stent removal, but no patients had a UTI following stent removal in the AMP group, and no adverse antibiotic-related events were noted.

Krasnow *et al*. performed a large population-based analysis using the Premier Hospital Database to describe the contemporary use of antibiotic prophylaxis in RC and urinary diversion patients across the United States between 2003 and 2013 [18]. The authors found that in a weighted cohort of 52349 patients, the overall infectious event rate was 25% with cefazolin being the most commonly used antibiotic (16% of cases). Ampicillin/sulbactam had the lowest odds of infectious events (odds ratio [OR]: 0.34, $P < 0.001$), and a penicillin-based regimen with a β-lactamase inhibitor was also associated with decreased length of stay (−1.3 d, $P = 0.016$). The receipt of AMP for more than 24 h up to 4 d postoperatively, however, was not associated with any change in the infectious event risk on crude analysis (25% *vs*. 26%, $P = 0.4$) or on adjusted analysis (OR: 1.01, 95% confidence interval [CI]: 0.88–1.17, $P = 0.9$) when compared to less than 24 h administration alone. Additionally, while on extended duration AMP, *Clostridium difficile* infection developed in 2.6% of patients compared to 2.0% of those exposed to less than 24 h of AMP (OR: 1.51, 95% CI: 1.05–2.17, $P = 0.028$).

Our study similarly found that AMP had no impact on UTI-related complications or readmissions after ileal conduit urinary diversion. We also found that AMP use significantly increased the risk of *Clostridium difficile* infections. This is consistent with studies that linked prolonged antibiotic use postoperatively after major urologic surgery to increased incidence of infections with *Clostridium difficile* in the gut [13]. At face value, these results indicate that AMP not only does not benefit the patient by reducing the risk of UTI, but it also increases the risk for adverse events and increased cost for the patient and the healthcare system. A study that looked at 6686 patients with bladder cancer who underwent RC and urinary diversion determined that the most common complication that increased hospital length of stay, cost, and mortality was septicemia and bacterial infections [19]. Interestingly, this study reported the cost, on average, of caring for patients that developed septicemia after RC and urinary diversion was almost three times higher than patients that did not have septicemia ($161277 *vs*. $58560). While the study by Davies *et al*. had several limitations, including not differentiating between the type of urinary diversion patients received, not identifying the source of the infection/septicemia, and not determining what antibiotic regimens were used, it should be commended for providing a glimpse as to how much infectious complications can increase the cost in our healthcare system, especially in the post-cystectomy population [19].

**Table 4. Predictors of 90-day postoperative UTI-related complications.**

| | Multivariate | | | |
|---|---|---|---|---|
| | OR | 95% CI | | *P* value |
| | | Lower | Upper | |
| Neoadjuvant chemotherapy (reference: no) | – | – | – | 0.99 |
| Intra-operative blood transfusion (reference: no) | 2.17 | 0.63 | 7.49 | 0.22 |
| Robotic-assisted surgical approach (reference: open) | 0.16 | 0.02 | 1.56 | 0.11 |
| Histology | | | | |
| Urothelial carcinoma (reference: benign) | 1.14 | 0.33 | 3.99 | 0.83 |
| Non-urothelial carcinoma (reference: benign) | – | – | – | 0.99 |
| Prophylactic antibiotic use (reference: no) | 1.60 | 0.48 | 5.34 | 0.44 |

There are several limitations to our study including its retrospective nature, the potential for missed or under-reported UTI-related events (especially if patients presented to other hospitals or clinical care settings that were not captured), unmeasured confounding variables, and lack of randomization. One of the specific factors we were unable to control was ureteral stent time duration. Shabeena *et al*. had shown that leaving indwelling ureteral stents longer increases the risk for bacterial colonization [20]. Varying length of stent placement within our study population may have been a confounding factor in our results. Additionally, a smaller sample size and grouping patients that had surgery for non-malignant causes with patients who had surgery for malignant causes may have also been confounding factors. One of the concepts we were unable to address is the growing use of "targeted" AMP only around the time of ureteral stent removal (*i.e.*, the day before, the day of, and the day after planned stent removal) since AMP in our study was given from the date of hospital discharge until the date of ureteral stent removal. Finally, we were unable to address the effect of AMP on the incidence of postoperative UTI-related complications for non-ileal loop urinary diversions such as orthotopic neobladders or continent cutaneous reservoirs since only patients who underwent ileal conduit urinary diversions were included in our study. Moving forward, a randomized, prospective study with a larger sample size would help eliminate bias and elucidate the potential benefits of AMP in the post-cystectomy and urinary diversion population. Future prospective trials could also examine the potential benefits of "targeted" AMP around the time of ureteral stent removal or the routine use of urinalysis or urine culture at the time of initial hospital discharge, in the outpatient setting, or at the point of care to prevent UTI-related complications postoperatively. This could potentially answer the question of whether a positive urinalysis or urine culture at the time of discharge can lead to the subsequent development of a postoperative UTI-related complication.

In conclusion, despite colonization of the urine tract with bacteria after ileal conduit urinary diversion (*i.e.*, bacteriuria), antibiotic prophylaxis was not associated with any reduction in 90-day postoperative UTI-related complications or readmissions during ureteral stent placement. The incidence of *Clostridium difficile* infections was also higher in patients on antibiotics after surgery, negating any potential benefit. Utilization of enhanced recovery after surgery protocols is probably the most effective, literature-based method to reduce complications in this patient population. Minimizing the duration of ureteral stent placement after RC and ileal conduit urinary diversion may be an alternative technique to decrease postoperative UTI risk, but this hypothesis has to be further elucidated.

## Acknowledgments

The authors wish to acknowledge the contribution of the Texas Tech University Health Sciences Center Clinical Research Institute for their assistance with this research.

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