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Original Article

Use and duration of antibiotic prophylaxis and the rate of urinary tract infection after radical cystectomy for bladder cancer: Results of a multicentric series

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Abstract

Objectives: To assess the rate of urinary tract infection (UTI), the characteristics of the bacterial aetiological agents involved, the type and duration of antibiotics used, and the clinical risk factors of UTI in a multi-institutional cohort of patients who had undergone radical cystectomy (RC).

Patients and methods: The pre- and postoperative characteristics of patients who had undergone open RC at 1 of 3 institutions between 2009 and 2015 were analyzed by means of the patient charts. Patients were classified according to the presence or absence of UTI. Analysis of the severity of UTI was based on the EAU/EAU Section of Infections in Urology (ESIU) classification system. The bacterial aetiological agents and their antibiotic susceptibility were also assessed. Factors predicting postoperative UTI were identified using univariable and multivariable logistic regression analysis.

Results: Of 217 patients, 42 (19.4%) had developed postoperative UTI, of whom 50% had urosepsis or uroseptic shock. Multivariable analysis showed continent urinary derivation as the only significant predictor of UTI with an odds ratio of 5.03 (95% confidence interval 2.12−11.9, $P < 0.001$). The duration of perioperative antibiotic prophylaxis was not associated with an increased risk of UTI. *Enterococcus* was the most commonly isolated bacteria (25.7%), but this species is not covered by the recommended antibiotic prophylaxis.

Conclusion: Patients with continent urinary diversion after RC have a significantly higher risk of developing UTI. Prolonged perioperative administration of antibiotics does not seem to reduce the risk of UTI. *Enterococcus* as the most commonly isolated bacteria is not covered by most recommended antibiotic prophylaxis regimens. Therefore different antibiotic regimens should be considered for high-risk patients.

Keywords: Urinary tract infection; Cystectomy; Antibiotic therapy; Urinary diversion; Antibiotic prophylaxis

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1. Introduction

Antibiotic prophylaxis is widely used before urologic procedures to prevent infectious complications. Recommendations based on international guidelines are available, but both the bacterial spectrum and susceptibility patterns show regional differences [1].

According to the Global Prevalence of Infections in Urology study, the prevalence of hospital-associated urinary tract infections (UTI) found in departments of urology was 10.5% in a cohort in which 41.0% of the patients had undergone open surgery [1]. The prevalence of antibiotic intake in urology wards was rather high (59.6%), and prophylaxis was the predominant (47.7%) reason for the administration of antibiotics.

Radical cystectomy (RC) because of muscle-invasive and high-risk non−muscle-invasive bladder cancer is associated with significant morbidity (up to 60% at 90 days), which is the highest rate of all urological interventions [2,3]. Infectious complications after RC are one of the most prevalent (20%−40%) causes of morbidity. The necessity of additional treatment for such infections may prolong hospital stay and contribute to deterioration in clinical and patient outcomes [3−7].

RC involves opening of both the urinary and the gastrointestinal tract. The ileum is the most commonly used intestinal segment for building a urine reservoir. Unfortunately, most evidence supporting the recommendations on antibiotic prophylaxis for this complex procedure derives from studies on colorectal procedures [8], which somewhat diminishes the quality of these recommendations for RC.

An appropriate antibiotic prophylactic regime needs to be defined for patients undergoing RC. This study provides evidence on the incidence of UTI after RC and the related risk factors as well as information on the bacterial etiological agent.

2. Patients and methods

2.1. Data collection

After the approval by the Institutional Review Board (2016-2670 Laval University), we generated a database of patients who had undergone open RC at 1 of 3 tertiary-care urology centers (University Medical Centre Regensburg, Germany; Laval University, Québec, Canada; and General Hospital of Bolzano, Italy) between 2009 and 2015. Inclusion criteria were RC due to urothelial bladder cancer and a patient’s age of 18 years or higher. RCs for other reasons (i.e., trauma, urinary incontinence, chronic pelvic pain syndrome, etc.) or RCs in a nonelective/emergency setting were excluded. Clinicopathological variables collected for each patient were age, sex, body mass index, American Society of Anesthesia (ASA) score and the clinical and pathological tumor stage according to the American Joint Committee on Cancer TNM Classification of Malignant Tumors (TNM) classification, 7th edition [9].

For preoperative staging, 1 center used FDG-PET-CT while the other 2 used abdominal, pelvic, and thoracic CT-scan and bone scans. During the RC procedure, extended lymphadenectomy (external, internal to the common iliac vessels and paravesical nodes) is routinely performed. We routinely reimage the patients 3 months after surgery and every 3 to 6 months according to their risk factors according to EAU and Canadian Urological Association (CUA) guidelines.

Clean catch urine samples had been obtained according to standard protocols, and antimicrobial susceptibility was tested before cystectomy. Suspected UTI after cystectomy was tested with urine cultures. Patients with positive preoperative urine cultures were treated upon availability of the results but at least 24 hours before undergoing cystectomy. Patients with negative urine tests received antibiotic therapy only at the induction of anesthesia, and the antibiotic regimen was continued according to the guidelines of the respective institute [10]. Infectious events were recorded from the day of surgery to 30 days postoperatively—regardless of discharge from hospital and readmission in between.

The type of urinary diversion was classified as either incontinent (ileal, colon conduit, or ureterocutaneostomy) or continent (neobladder or continent cutaneous reservoir). We also recorded the presence of variables that may have been related to a higher risk of infection, such as urinary catheter before RC (nephrostomy, ureteral stent, and indwelling bladder catheter), neo-adjuvant chemotherapy, previous radiotherapy on the pelvis for other types of cancer than bladder cancer and prolonged steroid therapy before surgery. Polyethylene glycol (Colyte MD) or sodium picosulfate (Pico-Salax MD) had been administered as bowel preparation according to the protocol of the respective institution.

2.2. Study outcomes

Primary outcome was the in-hospital incidence of UTI after RC within 30 days. Secondary outcomes were identification of risk factors of UTI, the respective bacterial aetiological agent isolated from urine culture, its sensitivity to different classes of antibiotics and the total duration of antibiotic therapy.

UTI was defined by means of a positive urine culture with $\geq 10^5$ colony forming unit (CFU) in the presence of clinical signs and symptoms of UTI. The grade of infection was classified according to the EAU/EAU Section of Infections in Urology (ESIU) clinical definition: mild (PN-2) or severe (PN-3) pyelonephritis, simple or systemic inflammatory response syndrome (SIRS = US-4), severe urosepsis (US-5), and uroseptic shock (US-6) [11]. Bacteriuria without any signs and symptoms or therapeutic intervention was considered asymptomatic bacteriuria. If a culture showed multiple different organisms, each organism was accounted for in the categories of individual species, but only 1 single infection was included in the analysis of UTI incidence.

2.3. Statistical analyses

Data analysis was done with SPSS version 22 (IBM Corporation, Armonk, NY, USA). Categorical and continuous variables were assessed with descriptive statistics. Skewed continuous variables were displayed with medians and interquartile ranges (IQR). The association between all baseline variables and the incidence of UTI was explored with binary univariable and multivariable logistic regression analysis. Variables eligible for multivariable model were significant in univariable analysis, previously published risk factors of UTI, and/or variables of special clinical and scientific relevance. The provided P values are 2-sided with the level of significance set to $P < 0.05$.

3. Results

The baseline characteristics of the study population of 217 patients are shown in Table 1. The majority of patients were men (78.3%), and median age was 72 years (IQR 64−78.5). Of all patients, 45.6% had a comorbidity ASA score of 3 to 4, but only 6.9% of the patients had received neo-adjuvant chemotherapy. Prior to RC, 38.7% of the patients had an indwelling urinary catheter (ureteral stents, nephrostomy, or bladder catheter), and nearly the entire cohort had undergone intestinal preparation. Of all patients, 71.9% had undergone incontinent urinary diversion. Median length of hospital stay was 13 days (IQR 11−20). The 30-day readmission rate due to any cause was 16.1%. Of all patients, 74.7% had not been readmitted after surgery, and 9.2% had remained in hospital for more than 30 days.

The most frequently used antibiotic prophylaxis was a combination of metronidazole (98.2%) and cephalosporin (89.9%). Table 2 lists the percentage of antibiotics used. Median duration of antibiotic administration after RC was 7 days (IQR 5−14). After cessation of the first antibiotic therapy (prophylaxis), additional antibiotics had been prescribed for 51.6% of the patients. Fifty-six patients (25.8%) received antibiotic prophlaxis for only 24 hours.

The overall number of culture-positive UTIs treated after RC was 42 (19.4%): 21 patients (9.7%) had pyelonephritis (PN2-3) and 21 (9.7%) systemic SIRS, severe urosepsis, or uroseptic shock (US 4-5-6). The most commonly isolated bacteria in urine and blood cultures are shown in Table 3. *Enterococcus* spp. was the most frequently isolated bacteria in urine (25.7%) followed by *Klebsiella* (15.8%), *Escherichia coli* (13.9%), *Enterobacter* spp. (6.9%), coagulase-negative *Staphylococcus* (CoNS, 5.9%), *Staphylococcus aureus* (5.0%) and *Citrobacter* spp. (5.0%). *Candida* spp. was isolated in 14.9% of the cultures.

Table 1
Characteristics of patients who had undergone radical cystectomy

Number of patients		217
Year of surgery (range)		2009−2015
Men:women (% men)		170:47 (78.3%)
Age (y median, IQR)		72 (64−78.5)
BMI (kg/m^2 median, IQR)		26.1 (23.2−29.7)
	Unknown	1 (0.5%)
ASA	ASA1	14 (6.5%)
	ASA2	103 (47.5%)
	ASA3	92 (42.4%)
	ASA4	7 (3.2%)
	Unknown	1 (0.5%)
pT	pTa−T1	30 (13.8%)
	≥T2	148 (68.2%)
	pTis only	15 (6.9%)
	pT0	24 (11.1%)
Pathologic grade	1-2 (low grade)	27 (12.4%)
	3 (high grade)	177 (81.6%)
	Unknown	13 (6.0%)
Nodal status	pN0	155 (71.4%)
	p ≥ N1	55 (25.3%)
	pN unknown/pNX	7 (3.2%)
Previous radiotherapy	Yes	13 (6.0%)
	No	204 (94.0%)
Neoadjuvant chemotherapy	Yes	15 (6.9%)
	No	202 (93.1%)
Regular glucocorticoid medication	Yes	9 (4.1%)
	No	208 (95.9%)
Continent diversion	Total	61 (28.1%)
	Orthotopic neobladder	53 (24.4%)
	Others	8 (3.7%)
Incontinent diversion	Total	156 (71.9%)
	Ileum	129 (59.4%)
	Colon	16 (7.4%)
	Ureterocutaneostomy	11 (5.1%)
Urinary catheter prior to surgery	Any tube	84 (38.7%)
	Nephrostomy	23 (10.6%)
	Ureteral stent	15 (6.9%)
	Bladder catheter	56 (25.8%)
Intestinal preparation	Yes	207 (95.4%)
	No	9 (4.1%)
	Unknown	1 (0.5%)
Preoperative positive urine culture	Yes	33 (15.2%)
	No	184 (84.8%)
Duration of antibiotic therapy (d) (median, IQR)		7 (5−14)
Length of stay (d) (median, IQR)		13 (11−20)

ASA = American Society of Anesthesia.

Table 4 shows the antibiotic susceptibility. In our cohort, *Enterococcus* was resistant to gentamicin in 90% of isolates. Resistance to levofloxacin was 100%, resistance to trimethoprim-sulfamethoxazole 50% and resistance to ampicillin and sulbactam 40% (Table 4). Univariable logistic regression analysis (Table 5) showed a trend that indwelling bladder catheter before surgery (odds ratio =

Table 2
Antibiotic prophylaxis given at the induction of anesthesia

Total number of patients with antibiotic prophylaxis *N* (%)	217 (100.0%)
Type of antibiotic agent used (%)	
Metronidazole	213 (98.2%)
Cephalosporin	195 (89.9%)
Cefuroxime	87 (40.1%)
Cefazolin	61 (28.1%)
Cefotaxime	46 (21.2%)
Ceftriaxone	1 (0.5%)
Gentamicin	23 (10.6%)
Ampicillin	16 (7.4%)
Clindamycin	5 (2.3%)
Meropenem	4 (1.8%)
Ampicillin/sulbactam, ciprofloxacin	3 (1.4%) each
Amoxicillin/clavulanate, fosfomycin, levofloxacin, TMP-SMX, tobramycin, and vancomycin	1 (0.5%) each

TMP-SMX = trimethoprim/sulfamethoxazole..

0.329; 95% CI 0.122−0.883; P = 0.027) may be a protective factor against UTI. Continent diversion (OR = 4.364; 95% CI 2.145−8.841; $P < 0.001$) was positively associated with UTI after surgery. Multivariate logistic regression analysis (Table 5) showed only continent diversion to be associated with the occurrence of UTI after RC (OR = 5.027; 95% CI 2.119−11.923; $P < 0.001$). The duration of antibiotic prophylaxis was not a protective factor against UTI after cystectomy.

4. Discussion

Analysis of our cohort of patients showed that 19.4% of the patients had developed UTI after RC in the early (30 d) postoperative period. Nearly 10% of the cases of UTI presented as urosepsis. In our multivariate analysis, continent diversion was the only independent factor associated with a higher risk of UTI (OR = 5.027). The major finding of our analyses was that prolonged antibiotic therapy did not significantly decrease the risk of UTI, which should encourage the use of short perioperative antibiotic prophylaxis. Reducing febrile UTI has clinical consequences because UTI is not only associated with a significantly higher incidence of ureteral stricture (8.7% vs. 1.6%, P = 0.028) in the long term but also increases the risk of urosepsis and readmission rates [12,13]. The existence of a preoperative UTI was not a predicting factor for postoperative UTI. We believe that detection and antibiotic treatment before the surgery helped to avoid further infection afterwards.

The reported UTI incidence after RC in the literature ranges from 8.5% to 39%, depending on the interval of observation and the type of center. The percentage of UTI of 19.4% in our study was higher than that reported by Parker et al. who reported a rate of UTI of 10.3% 90 days after RC in a cohort of 1,248 patients [14]. Their findings corresponded with the results reported by other groups who observed UTI in 46 (19.4%) of 236 analyzed patients with a follow-up of 25 months after RC [12]. Of all the UTI cases, 61.1% had occurred within 1 month after surgery. As in our report, Parker found an OR of UTI of 2.17 (P = 0.001) for patients with an orthotopic neobladder [14]. Van Hemelrijck also reported continent urinary diversion as a potential negative prognostic factor for developing UTI (OR=1.21) [15]. Prolonged presence of indwelling catheters and neobladder irrigation may be one of the causes of the higher rate of UTI and the presence of fungi after orthotopic neobladder reconstruction. Other authors view inflammatory response or the mucosal structure of the bowel segment to be responsible for the early postoperative rate of UTI [16].

Age [14,17], a higher ASA score [18], body mass index [14], and diabetes mellitus [13,14] are other risk factors for developing UTI after RC. We hypothesized that the rate of UTI may also be increased by indwelling preoperative catheters, neo-adjuvant chemotherapy, the administration of steroids, and prolonged hospital stay. However, our analyses did not confirm the hypotheses [19,20]. Diabetes

Table 3
Bacteria isolated from postoperative microbiological cultures

	Urine cultures (n = 101)		Blood cultures (n = 14)	
	N	%	*N*	%
Enterococcus spp.	26	25.7	6	42.9
Klebsiella spp.	16	15.8	−	−
E. coli	14	13.9	4	28.6
Enterobacter spp.	7	6.9	−	−
CoNS	6	5.9	2	14.3
Citrobacter spp.	5	5.0	1	7.1
Staphylococcus aureus	5	5.0	−	−
Pseudomonas aeruginosa	4	4.0	−	−
Others	2	2.0	−	−
Proteus spp.	1	1.0	1	7.1
Candida spp.	15	14.9	−	−

CoNS = coagulase-negative *Staphylococcus*.

Table 4
Antibiotic susceptibility according to antibiogramme based on urine culture

Bacteria	Antibiotics % (N sensitive/N tested)												
	Ciprofloxacin	Levofloxacin	Trimethoprim-sulfamethoxazole	Aminopenicillin	Ampicillin/sulbactam	Cefuroxime	Cefotaxim	Ceftriaxon	Ceftazidime	Gentamicin	Piperacillin/tazobactam	Imipenem	Vancomycin
Enterococcus spp.	0% (0/13)	0% (0/16)	50% (5/10)	60.9% (14/23)	60% (6/10)	0% (0/15)	0% (0/15)	0% (0/13)	0% (0/13)	10% (1/10)	71.4% (5/7)	60% (6/10)	90.5% (19/21)
Klebsiella spp.	92.9% (13/14)	75% (3/4)	93.3% (14/15)	0% (0/16)	100% (3/3)	66.7% (8/12)	80% (4/5)	85.7% (12/14)	85.7% (12/14)	100% (13/13)	86.7% (13/15)	100% (8/8)	0% (0/4)
E. coli	91.7% (11/12)	66.7% (2/3)	100% (12/12)	69.2% (9/13)	100% (3/3)	81.8% (9/11)	100% (3/3)	81.8% (9/11)	91.7% (11/12)	100% (12/12)	100% (12/12)	100% (3/3)	0% (0/2)
Enterobacter spp.	100% (6/6)	50% (1/2)	100% (6/6)	0% (0/6)		0% (0/3)		60% (3/5)	66.7% (4/6)	100% (6/6)	100% (6/6)	100% (4/4)	100% (1/1)
CoNS			83.3% (5/6)							16.7% (1/6)			100% (3/3)
Citrobacter spp.	100% (5/5)		100% (5/5)	0% (0/5)		50% (1/2)		100% (3/3)	100% (3/3)	100% (3/3)	80% (4/5)	100% (3/3)	
Staphylococcus aureus	0% (0/3)	0% (0/3)	100% (5/5)	0% (0/3)	33.3% (1/3)	50% (2/4)	33.3% (1/3)	33.3% (1/3)	0% (0/3)	100% (4/4)	33.3% (1/3)	33.3% (1/3)	100% (4/4)
Pseudomonas aeruginosa	100% (4/4)	100% (1/1)	0% (0/1)	0% (0/1)	0% (0/1)	0% (0/1)	0% (0/2)	0% (0/2)	100% (4/4)	100% (3/3)	100% (2/2)	75% (3/4)	0% (0/1)
Proteus spp.	100% (1/1)		100% (1/1)	0% (0/1)		0% (0/1)		100% (1/1)	100% (1/1)	100% (1/1)	100% (1/1)		

CoNS = coagulase-negative *Staphylococcus*.

mellitus [13,14] and incomplete neobladder emptying [21,22] may also be risk factors for developing UTI.

E. coli is generally the most commonly isolated pathogen in urine with a rate of nearly 40%. However, various studies have concordantly reported *Enterococci* as the most frequently isolated organism with a rate ranging between 25% and 54.5% within the first month after RC [7,12,14]. Some authors have suggested that the type of urinary bacteria isolated after RC may be altered by incomplete bowel preparation, which may result in residual microbial flora in the ileal or colonic segment used for urinary diversion [12]. This suggestion contrasts with other findings [22] because colonic neobladder has been associated with lower rates of UTI than ileal neobladder in some reports [21,23]. Moreover, in a series of 105 RC patients with bowel preparation and 75 patients without bowel preparation, Large et al. reported that omitting mechanical bowel preparation did not increase the risk of postoperative UTI (UTI rate of 16.2% vs.12.0% [$P = 0.5$]) [24].

Commonly used antibiotic prophylactic regimens may also play a role in selecting the type of bacterial aetiological agent responsible for the development of UTI after RC. *Enterococcus spp.* is insensitive to cephalosporins, which may lead to a predominance of *Enterococcus spp.* in the early postoperative period. Cephalosporins are the therapy currently recommended for RC by the American Urological Association [8]; hence, our results raise the question whether other regimes such as ampicillin and sulbactam may be more efficacious in reducing postoperative UTI in this high-risk patient population.

Another recent investigation analyzed 207 patients without bowel preparation in the time after enhanced recovery after surgery (ERAS) and the accurate adherence to the most recent perioperative antibiotic guidelines [25]. The incidence of readmission after RC due to infection was still considerable. The 90-day readmission rate due to any infection was 53%; 57% of these patients had positive urine cultures, most commonly with *Enterococcus* faecalis. Readmission rates have not been increased since the introduction of the ERAS protocol (27% in the post-ERAS group vs. 30% in the pre-ERAS group) [25].

In our cohort, the duration of antibiotic therapy was not related to the incidence of postoperative UTI. This finding suggests that strategies for reducing postoperative UTI in RC populations should be more focused on the choice of antibiotics. Other series comparing the duration of antibiotic prophylaxis for RC did also not find any correlation with the UTI rate, although some authors reported prolonged duration of therapy to be correlated with an increased risk of infection with *Clostridium difficile* [26,27].

Low adherence to recommendations on antibiotic prophylaxis in urology, especially for RC, is well-reported in the literature [8]. According to Liu et al. [27] and Calvert et al. [28], only 49% and 44% of patients, respectively, followed the appropriate guidelines on antimicrobial prophylaxis. When analyzing [29] the use of antibiotic

Table 5
Logistic regression analysis of the development of postoperative urinary tract infection

Variable	Univariable			Multivariable		
	OR	CI 95%	P value	OR	CI 95%	P value
Urological center B ref. A	1.718	0.811−3.639	0.158	–	–	–
C ref. A	0.887	0.334−2.352	0.809	–	–	–
ASA 3−4 vs. 1−2	0.682	0.342−1.360	0.277	–	–	–
Preoperative urine culture neg. vs. pos.	1.146	0.460−2.854	0.769	0.935	0.339−2.577	0.897
pT ≥2 vs. <2	0.803	0.396−1.631	0.544	–	–	–
pN ≥1 vs. 0	1.420	0.677−2.977	0.354	–	–	–
Grade high vs. low	0.662	0.294−1.491	0.319	–	–	–
Prior radiotherapy yes vs. no	1.269	0.333−4.831	0.727	–	–	–
Use of steroids yes vs. no	2.167	0.519−9.045	0.289	–	–	–
Bladder catheter before surgery yes vs. no	0.329	0.122−0.883	**0.027**	0.352	0.114−1.084	0.069
Ureteral stent before surgery yes vs. no	0.623	0.135−2.873	0.544	–	–	–
Nephrostomy before surgery yes vs. no	0.422	0.169−2.109	0.422	–	–	–
Intestinal preparation before surgery yes ref no/unknown	0.958	0.196−4.686	0.958	–	–	–
Urinary derivation continent vs. incontinent	4.364	2.145−8.841	**<0.0001**	**5.027**	**2.119−11.923**	**<0.001**
Sex: women vs. men	1.370	0.628−2.987	0.428	–	–	–
Age: ≥65 vs. <65	0.513	0.252−1.047	0.067	1.465	0.577−3.720	0.421
BMI: ≥30 vs. <30	1.127	0.508−2.497	0.769	1.219	0.509−2.919	0.657
Duration of prophylactic antibiotic therapy 2−5 d vs. 1 d	1.154	0.451−2.952	0.765	1.589	0.573−4.409	0.374
≥ 6 d vs. 1 d	0.899	0.397−2.037	0.799	1.177	0.461−3.003	0.733

Bold means $p < 0.05$.
CI = confidence interval; OR = odds ratio.

prophylaxis in a large community-based population, Mossanen found an overall compliance rate with the American Urological Association best practice statements of 53%; thus, the compliance rate for RC was only 0.6%. Mossanen also reported that patients undergoing RC had a higher probability of receiving prolonged prophylactic therapy (56.3%) for a mean duration of 10.3 days [28]. In our cohort, the median duration of antibiotic administration was 7 days, although institutional guidelines indicate the administration of antibiotic prophylaxis for 1 to a maximum of 5 days. Of all patients, 51.6% received a second antibiotic course as treatment of infection that occurred during their hospital stay.

Our study has the limitations commonly associated with retrospective case series. Although every medical record was reviewed for data collection and the follow-up of patients lasted 30 days after discharge, some cases of UTI may have been missed because patients presented at other centers. In some cases, urine cultures were not collected and could thus not be evaluated. Details of antibiotic resistance reports differed according to the respective laboratory and hospital. Local practice varied in part from standards proposed by the literature such as use of neoadjuvant chemotherapy or certain aspects of enhanced recovery pathways (bowel preparation, extended use of antibiotic prophylaxis). Moreover, due to the retrospective nature of this study, our results may have been influenced by changes in the duration of antibiotic prophylaxis, surgical technique, and perioperative care during the study period. The number of patients who received neoadjuvant chemotherapy was low compared to North American contemporary series but not to European or Canadian studies, still they were too few to assess the association with UTI. With the implementation of enhanced recovery pathways in clinical practice for RC, some of our results might not be able to be generalized to more contemporary series. Nevertheless, our study encourages the short use of antibiotic prophylaxis in RC and the use of an antibiotic therapy active for *Enterococcus* spp. for patients with UTI in the postoperative period.

5. Conclusion

In our cohort, the incidence of UTI after RC was 19.4%, and nearly 50% of patients with UTI had developed urosepsis. Continent diversion was an independent factor associated with a higher risk of developing UTI in contrast to perioperative antibiotic prophylaxis. *Enterococcus* was the most common bacterial etiological agent, which is not covered by the most commonly used antibiotic prophylaxis regimens. For this reason, further antibiotic regimens should be developed, particularly for continent urinary diversion.

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