Infectious Complications in Patients With Chronic Bacteriuria Undergoing Major Urologic Surgery

Jessica T. Casey, Ronak Patel, Lauren P. Wallner, Bradley A. Erickson, Stephanie J. Kielb, and J. Quentin Clemens

OBJECTIVES To review our perioperative antibiotic management of patients with chronic bacteriuria who underwent urological procedures, and the relationship to postoperative infectious complications.

METHODS Between January 2002 and January 2007, 77 patients with chronic bacteriuria underwent 94 major open procedures, including ileocystoplasty (n = 53), ileal conduit (n = 19), and pubovaginal sling placement (n = 18). Admission urine cultures were classified as "sensitive" (sensitive to admission antibiotics or no growth), "resistant" (resistant to admission antibiotics), and "unknown" (multiple unspeciated organisms present or no admission culture data available).

RESULTS Our rate of multidrug resistance bacteriuria was 46.3%. There were 7 febrile urinary tract infections, 12 wound infections, 1 episode of sepsis, and no intra-abdominal abscesses, yielding an infectious complication rate of 20.2%. There was no statistical relationship between urine culture status and the rate of febrile urinary tract infections or sepsis, but wound infections were less common in patients with "sensitive" urine cultures. Of the patients who had urine cultures that demonstrated multiple unspeciated organisms, 32% were complicated by wound infections. On multivariate analysis, gender, age, and body mass index were associated with the development of infectious complications.

CONCLUSIONS In a medically complex population of patients, those with neurogenic bladder and frequent catheterization undergoing major abdominal surgery, we demonstrate an infectious complication rate of 20.2%. Wound infections were as common in patients whose urine cultures revealed multiple unspeciated organisms as those that were resistant to the perioperative antibiotics, and in this population, further characterization may allow for more appropriate perioperative coverage and a decreased rate of wound infections. UROLOGY 75: 77–82, 2010.

Most patients who use bladder catheterization by either chronic indwelling catheters or intermittent catheterization have chronic bacteriuria.[1,2] It is well recognized that this bacteriuria does not require antibiotics unless it is causing fever or other symptoms signifying a clinically significant urinary tract infection (UTI) or bacteremia.[3] Patients with chronic bladder catheterization commonly undergo urological surgery for either complications related to the catheterization itself or to treat the underlying bladder dysfunction. Such patients may be at increased risk of perioperative infectious complications. Preoperative sterile urine is considered mandatory, as transient perioperative bacteremia during manipulation of the genitourinary tract can lead to postoperative complications such as intra-abdominal abscesses, septicemia, wound infections, or febrile UTIs.[4,5]

Few studies have addressed the optimal use of perioperative antibiotics for urologic surgery in patients with bacteriuria. Hamasuna et al[4] demonstrated a relationship between organisms in preoperative urinary cultures, intraoperative subcutaneous swabs before skin closure, and subsequent surgical site infections and argued that the bacteria in the urine contaminated the surgical field itself. However, a separate study found that preoperative bacteriuria was not a risk factor for surgical site infection and that preoperative antibiotic treatment for bacteriuria was not sufficiency efficacious to decrease the incidence of surgical site infection after radical cystectomy and urinary diversion, especially with methicillin-resistant *Staphylococcus aureus*.[6] The recent Best Practice Policy statement released by the American Urological Association addresses the use of antimicrobial prophylaxis to suppress the bacterial count or to attempt to sterilize the field preoperatively for patients with an existing bacteri-

From the Department of Urology, Feinberg School of Medicine, Northwestern University, Chicago, Illinois; Departments of Epidemiology and Urology, University of Michigan Medical Center, Ann Arbor, Michigan

Reprint requests: J. Quentin Clemens, M.D., Department of Urology, University of Michigan, 1500 E Medical Center Dr, Ann Arbor, MI 48130. E-mail: qclemens@med.umich.edu

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Table 1. Patient demographics

Sex*	
Male	41 (53.3%)
Female	36 (46.8%)
Age at surgery (y)	
Median	37.5
Range	17-75
Body mass index (kg/m^2)	
Median	25.06
Range	15-44
Etiology of neurogenic bladder*	
Paraplegic	28 (36.4%)
Quadriplegic	28 (36.4%)
Spina bifida	7 (9.1%)
Cancer metastases or radiation therapy	5 (6.5%)
Cerebral palsy	3 (3.9%)
Spinal surgery	3 (3.9%)
Multiple sclerosis	1 (1.3%)
Imperforate anus	1 (1.3%)
Idiopathic	1 (1.3%)
Bladder management before open procedure†	
Clean intermittent catheterization	30 (31.9%)
Indwelling urethral catheter	30 (31.9%)
Catheterizable stoma	16 (17.0%)
Suprapubic indwelling catheter	15 (16.0%)
Condom catheter	3 (3.2%)
Preoperative risk factors for infection†	
History of organ transplant	4 (4.3%)
Current/recent steroid use	2 (2.1%)
HIV	0
Current cancer	1 (1.1%)
Current chemotherapy	0
Diabetic	9 (9.6%)
Types of individual procedure performed‡	
Ileocystoplasty	53 (56.4%)
Ileal conduit	19 (20.2%)
Pubovaginal sling	18 (19.1%)
Open suprapubic catheter placement	9 (9.6%)
Stomal revision	5 (5.3%)
Urethral closure	4 (4.3%)
Prostatectomy	3 (3.2%)
Open cystolithotomy	3 (3.2%)
Bladder stone removal	2 (2.1%)
Nephrectomy	1 (1.1%)
Cystectomy	1 (1.1%)
Ureteral reimplant	1 (1.1%)
Oophorectomy	1 (1.1%)
Preoperative urine cultures (n = 77)	
No growth	11 (14.3%)
Multiple unspeciated organisms	25 (32.5%)
Speciated organisms (>100,000 CFU/mL growth)	41 (53.2%)
Resistance of speciated organisms (n = 54)	
Resistant to β-lactams	19 (35.2%)
Resistant to aminoglycosides	14 (25.9%)
Resistant to fluoroquinolones	26 (48.1%)
Resistant to trimethoprim/sulfamethoxazole	11 (20.4%)
Multidrug resistance (resistant to ≥2 antibiotic classes)	25 (46.3%)
Identification of speciated organisms (n = 54)	
Escherichia coli	16 (29.6%)
Klebsiella species	8 (14.8%)
Enterococcus faecalis (vancomycin sensitive)	8 (14.8%)
Pseudomonas species	6 (11.1%)
Proteus species	3 (5.6%)
Staphylococcus aureus (methicillin-sensitive)	3 (5.6%)
Achromobacter species	2 (3.7%)
Lactobacillus species	2 (3.7%)
Staphylococcus aureus (methicillin-resistant)	2 (3.7%)
Stenotrophomonas species	2 (3.7%)
Acinetobacter species	1 (1.9%)
Enterobacter species	1 (1.9%)

* Out of 77 total patients.
† Out of 94 procedures.
‡ Total of 120 individual procedures (as 22 patients had 2 individual procedures and 2 patients had 3 individual procedures performed during 1 operative setting); percentage calculated as percentage of 94 procedures.

uria although it does not provide detailed guidelines regarding the length and type of antibiotics.[7] It is clear that the optimum protocol, if one is necessary, for antimicrobial prophylaxis in patients with chronic bacteriuria undergoing urological procedures remains to be determined. Our goal was to determine the relationship between the appropriateness of perioperative coverage of bacteriuria and postoperative infectious complications through a retrospective review to provide more information toward determining the best protocol for this challenging population.

MATERIAL AND METHODS

Between January 2002 and January 2007, a total of 77 patients with neurogenic bladder dysfunction and a history of chronic bacteriuria underwent 94 major open surgical procedures, including ileocystoplasty, ileal conduit construction, nephrectomy, urethral sling placement, cystectomy, ureteral reimplantation, prostatectomy, and cystolithotomy (see Table 1). All patients were admitted 1-2 days before surgery to receive parenteral antibiotics (typically ampicillin and gentamicin, adjusted for allergies or known recent urine culture with resistant organisms). Urine cultures were obtained at the time of admission, and the antibiotic regimen was changed if needed on the basis of these culture results. Preoperative urine cultures were a voided specimen if the patient was able to do so, otherwise a sterile catheterized specimen was obtained. In an Internal Review Board approved study, patient medical records were retrospectively reviewed to collect the following data points: patient demographics, preoperative inpatient urine culture results, type of perioperative intravenous antibiotics, and postoperative infectious complications. Multidrug resistance was defined as resistance to drugs in at least 2 of 4 antimicrobial classes evaluated: (1) β-lactams (1 or more of the following: cefotaxime, ceftriaxone, ceftazidime, imipenem, piperacillin, and ticarcillin); (2) aminoglycosides (2 or more of the following: gentamicin, tobramycin, and amikacin); (3) fluoroquinolones (1 or more of the following: ciprofloxacin, levofloxacin, and norfloxacin); and (4) trimethoprim and/or sulfamethoxazole.

Infectious complications were defined as clinically evident intra-abdominal abscess, sepsis, wound infection, or febrile UTI within a 30 day postoperative period. Preoperative urine cultures were classified as (1) no growth; (2) "sensitive" (sensitive to perioperative antibiotics); (3) "resistant" (resistant to the intraoperative antibiotic regimen); or (4) "unknown" (culture with growth of multiple unspeciated organisms or no admission culture data available). The relationship between perioperative antibiotic coverage status and postoperative infectious complications was then assessed.

Bivariate associations comparing patients with infectious complications to those without infectious complications across levels of demographic and preoperative characteristics were characterized using χ^2 tests of association. Multivariable-adjusted odds ratios and 95% confidence limits describing the associations between demographic, preoperative, and procedural characteristics with infectious complications were fitted using logistic regression. Backward selection of all significant predictors as identified in the bivariate analyses was used to identify the most parsimonious final model. A P value of $<.05$ was considered statistically significant. All analyses were performed using SAS 9.0 (Cary, NC).

RESULTS

Patient demographics are presented in Table 1. The median age was 37.5 years at surgery. Most patients were paraplegic or quadriplegic from spinal cord injuries (72%), used either clean intermittent catheterization or chronic urethral catheterization for bladder management before surgery (64%), and underwent ileocystoplasty or ileal conduit procedures (76%).

Preoperative urine cultures were available for 77 of the 94 procedures (81.9%) (Table 1). Fifty-three percent (41/77) of the preoperative urine cultures had >100 000 CFU/mL bacteria, and 29% (12/41) of these cultures had >2 speciated organisms. One-third (25/77) of the cultures had >3 unspeciated organisms or minimal growth of multiple nonuropathic organisms ("multiple unspeciated organisms"). Forty-six percent of the 54 speciated organisms were multidrug resistant. Twenty-six percent (14/54) were resistant to ampicillin and gentamicin, and 8 of these 14 were covered perioperatively with other antibiotics to which the speciated organisms were sensitive. Frequency of individual-speciated organisms are listed in Table 1.

In relationship to the perioperative antibiotics used, 6.4% (6/94) of the cultures were "resistant," 47.9% (45/94) were "sensitive" or demonstrated no bacterial growth, and 45.7% (43/94) were "unknown," including 33.3% (26/94) with multiple unspeciated organisms and 18.1% (17/94) without available culture data. In 2 patients, the perioperative antibiotics were changed before the procedure on the basis of admission cultures; these patients were classified as "sensitive." In 1 patient, the perioperative antibiotics were changed on the day after the procedure; this patient was classified as "resistant." None of these 3 patients had infectious complications postoperatively.

There were 7 febrile UTIs, 12 wound infections, 1 episode of sepsis, and no intra-abdominal infections, yielding an infectious complication rate of 20.2% (after 19 of the 94 procedures). Table 2 describes the details of the individual infectious complications. One patient had 2 complications after 1 procedure (febrile UTI and wound infection after augmentation ileocystoplasty with autologous rectus fascia pubovaginal sling). Female gender, older age, higher body mass index (BMI), procedure type, and longer operative time were positively associated with development of infectious complications (all $P <.05$), whereas type of bladder management, preoperative risk factors, and speciated growth type were not (Table 3).

Of the 20 infectious complications, 14 had a corresponding culture of the urine, wound, or blood, depending on the type of complication (see Table 2). Of the 12 cultures that grew speciated organisms, 58.3% (7/12) had at least 1 organism corresponding to the preceding urine culture. None of these 7 patients had "resistant" urine cultures. The rate of infectious complications was not significantly increased in those patients with multidrug resistant urine cultures (31.8% vs 11.1%, $P = .12$). There was no statistical relationship between urine culture status and the rate of febrile UTIs ($P = .44$) or sepsis ($P = .78$) (see Table 4), but wound infections were less common in patients with "sensitive" urine cultures or those without bacterial growth ($P = .002$). In addition, of the patients who had urine cultures that demonstrated multiple unspeciated organisms, 32% were complicated by wound infections, similar to the percentage of those with resistant cultures that developed wound infections. Urine culture status was also marginally associated with the development of any infectious complication ($P = .08$) (see Table 4).

After adjustment for gender, age, BMI, preoperative culture status, preoperative risk factors procedure type, and operative time, sex (OR 8.48, 95% CI 1.43-50.2), age (OR 1.05, 95% CI 1.01-1.09), and BMI (OR 1.10, 95% CI 1.01-1.20) were found to be significantly associated with the occurrence of any infectious complications and remained in the final model.

COMMENT

Our postoperative infectious complication rate (20.2%) was similar or lower to those previously reported in the published data. In a recent study of 50 patients with neurogenic bladder undergoing ileovesicostomy, 17 (34%) patients had a clinically evident postoperative wound infection and 4 (8%) had postoperative intra-abdominal abscess or peritonitis, giving an infectious complication rate of 42%.[8] In 104 patients undergoing radical cystectomy and urinary diversion for bladder cancer, there was a 33% incidence of surgical site infection, strictly defined as isolation of bacteria from a surgical wound or drain even if there was no obvious infectious state.[6] In another study of 77 patients undergoing radical

Table 2. Individual infectious complications

No.	Age	Gender	Operation	Complications	Preoperative Urine Culture	S/R*	Infectious Culture
1	38	F	Ileal conduit	Febrile UTI	*Klebsiella*	S	*Pseudomonas*, VRE, MSSA, *Klebsiella*
2	49	M	Ileocystoplasty	Febrile UTI	*E. coli*	S	*E. coli*, *Klebsiella*, *Acinetobacter*
3	50	F	Ileocystoplasty, urethral closure	Febrile UTI	*E. coli*, *Pseudomonas*	S	*E. coli*
4	74	M	Ileocystoplasty, prostatectomy	Febrile UTI	*E. coli*	S	*Enterococcus avium*, *E. coli*
5	42	F	Ileocystoplasty, urethral sling	Febrile UTI	Multiple organisms	NA	Not cultured
6	22	F	Ileocystoplasty, urethral sling	Febrile UTI	*E. coli*	S	*E. coli*, *Pseudomonas*
7†	42	F	Ileocystoplasty, urethral sling	Febrile UTI	Multiple organisms	NA	MSSA
7†	42	F	Ileocystoplasty, urethral sling	Wound infection	Multiple organisms	NA	VSE, MRSE, *Pseudomonas*
8	44	F	Ileocystoplasty, urethral sling	Wound infection	*Pseudomonas*, *Klebsiella*	R	Not cultured
9	41	F	Ileocystoplasty, urethral sling	Wound infection	Multiple organisms	NA	No growth
10	31	F	Ileocystoplasty, urethral sling	Wound infection	Multiple organisms	NA	No aerobic growth
11	67	F	Ileocystoplasty, urethral sling	Wound infection	Multiple organisms	NA	1st: VSE, MRSE 2nd: MSSA, VSE
12	44	F	Ileal conduit, oophorectomy	Wound infection	Multiple organisms	NA	MRSA
13‡	26	F	Ileocystoplasty, urethral closure	Wound infection	Multiple organisms	NA	VSE, MRSA
14‡	27	F	Ileal conduit	Wound infection	No culture	NA	Not cultured
15	71	F	Ileal conduit	Wound infection	Proteus	R	Not cultured
16	61	F	Ileocystoplasty	Wound infection	No growth	NA	Not cultured
17	64	M	Ileocystoplasty	Wound infection	Multiple organisms	NA	Not cultured
18	53	F	Ileocystoplasty	Wound infection	*E. coli*	S	*E. coli viridans* streptococcus
19	62	M	Ileocystoplasty	Sepsis	*E. coli*	S	*E. coli*

E. coli indicates *Escherichia coli*; MRSA = methicillin-resistant Staphylococcus aureus; MRSE = methicillin-resistant *Staphylococcus epidermidis*; MSSA = methicillin-sensitive *Staphylococcus aureus*; No. = procedure number; R = resistant; S = sensitive; UTI = urinary tract infection; VSE = vancomycin-sensitive *enterococcus*.
* S/R—preoperative urine culture organisms sensitive (S) or resistant (R) to preoperative intravenous antibiotics.
† Same patient with 2 different complications after 1 procedure.
‡ Same patient with 2 complications after 2 different procedures.

cystectomy and ileal conduit diversion for bladder cancer, clinically evident surgical site infections occurred in 20.5%, and febrile UTIs in 5.9%.[9] Hamasuna et al[4] reported a 25% infectious complication rate in 137 patients after open or laparoscopic urologic operations. Therefore, despite differences in perioperative antibiotic management and definitions of surgical site infections, our data show similar, if not decreased, rates of postoperative infectious complications in an even more medically complex population.

Interestingly, of the patients who had urine cultures that demonstrated multiple unspeciated organisms, 32% were complicated by wound infections. As this culture result is a frequent occurrence in this population, given their chronic bacteriuria and frequent use of antibiotics, it is important to understand how best to manage this result. In our study, empiric use of broad-spectrum antibiotics (ampicillin, gentamicin) did not decrease the risk of wound infections in comparison with patients with cultures that were clearly resistant to the perioperative antibiotics. Further characterization of this culture result is needed, especially in this high-risk population.

Bacterial isolates from urine culture of spinal cord injured patients varies from study to study on the basis of local microbial patterns and use of antibiotics; however, generally in comparison with non–spinal cord-injured patients, there is an increase in *Pseudomonas*, *Proteus* and *Serratia* and a decrease in *E. coli* and *Klebsiella*.[10] In our study, the most common bacterial isolates were *Escherichia coli* (29.6%), *Enterococcus faecalis* (14.8%), *Klebsiella* species (14.8%), and *Pseudomonas* species (11.1%). Our rate of multidrug resistance bacteriuria was 46.3%. This is slightly higher than the 33% rate of multidrug resistance reported by Waites et al.[11] This may be explained by the fact that our sample consists of preoperative patients, whereas those in the Waites study were obtained at the time of routine outpatient visits. As a result, our patients may have additional risk factors for bacterial resistance (eg, frequent antibiotic use, recent hospitalization).

Multivariate analysis determined that female sex, older age, and higher BMI were associated with an increased risk of any infectious complication. Tan et al[8] demonstrated an increased risk of overall infections (including

Table 3. Infectious complications by demographics

	Infectious Complication (18 Patients, 19 Procedures)	No. Infectious Complication (59 Patients, 75 Procedures)	*P*
Gender*			.005
Male	4 (22%)	37 (63%)	
Female	14 (78%)	22 (37%)	
Age at surgery (y)†			.002
Median	44.0	35.0	
Range	22-74	17-75	
Body mass index (kg/m^2)†			.036
Median	29.2	25.7	
Range	17-44	15-40	
Bladder management before open procedure†			.75
Clean intermittent catheterization	6 (32%)	24 (41%)	
Indwelling urethral catheter	7 (37%)	23 (40%)	
Catheterizable stoma	2 (11%)	14 (24%)	
Suprapubic indwelling catheter	4 (21%)	11 (19%)	
Condom catheter	0	3 (5%)	
Preoperative risk factors for infection†			.06
History of organ transplant	0	4/4	
Current/recent steroid use	2/2	0	
HIV	0	0	
Current cancer	0	1/1	
Current chemotherapy	0	0	
Diabetic	2/9	7/9	
Speciated bacteria in preoperative culture†			.67
No growth	1/11	10/11	
Multiple unspeciated organisms	8/25	17/25	
Escherichia coli	6/16	10/16	
Klebsiella	2/8	6/8	
Vancomycin-sensitive *Enterococcus faecalis*	1/8	7/8	
Pseudomonas	2/6	4/6	
Proteus	1/3	2/3	
Methicillin-sensitive *Staphylococcus aureus*	0/3	3/3	
Achromobacter	0/2	2/2	
Lactobacillus	0/2	2/2	
Methicillin-resistant *Staphylococcus aureus*	0/2	2/2	
Stenotrophomonas	0/2	2/2	
Acinetobacter	0/1	1/1	
Enterobacter	0/1	1/1	
Type of procedure performed‡			.04
Ileocystoplasty	14/53 (26.4%)	39/53 (73.6%)	
Ileal conduit	5/19 (26.3%)	14/19 (73.7%)	
Urethral sling§	7/18§ (38.9%)	11/18 (61.1%)	
Open suprapubic cathete r placement	0/9	9/9	
Stomal revision	0/5	5/5	
Urethral closure§	2/4§ (50.0%)	2/4 (50%)	
Prostatectomy§	2/3§ (66.7%)	1/3 (33.3%)	
Open cystolithotomy	0/3	3/3	
Bladder stone removal	0/2	2/2	
Nephrectomy	0/1	1/1	
Cystectomy	0/1	1/1	
Ureteral reimplant	0/1	1/1	
Oophorectomy¶	1/1§	0/1	
Operative time (h)†			.03
Median	4.4	3.5	
Range	2.3-6.5	2-7.5	

* Out of 77 total patients.
† Out of 94 procedures.
‡ Total of 120 individual procedures (as 22 patients had 2 procedures and 2 patients had 3 procedures performed at once); % calculated as percentage of 94 procedures.
§ All procedures associated with infectious complication were combined with an ileocystoplasty or ileal conduit.

wound infections and intra-abdominal abscesses) after ileovesicostomy in adults with neurogenic bladder for patients with a higher BMI. Additionally, Kanamaru et al[12] showed an association between surgical site infections after an array of urologic procedures with age, operative time, and history of hypertension on multivariate analysis. Given our small numbers, we were unable to verify our univariate results of the effect of resistant

Table 4. Preoperative urine culture status and infectious complications

	"Sensitive" or No Growth n = 45	"Resistant" n = 6	Multiple Unspeciated Organisms n = 26	No Preoperative Culture n = 17	*P*
Febrile UTI	5 (11.1%)	0	2 (7.7%)	0	.44
Wound infection	1 (2.2%)	2 (33.3%)	8 (32.0%)	1 (5.9%)	.002
Sepsis	1 (2.2%)	0	0	0	.78
Any infectious complication	7 (15.6%)	2 (33.3%)	9 (34.6%)	1 (5.9%)	.08

cultures or those with multiple unspeciated organisms on the increased risk of wound infections through multivariate analysis.

One limitation of this study is that it focuses only on major open urologic procedures. It is possible that the risk of infectious complications is different in procedures which involve direct upper tract instrumentation (eg, ureteroscopy) or for other procedures such as transurethral prostate resection. An additional limitation of this study was its retrospective nature. Also, our infectious complications were defined as clinically evident infections as opposed to more strict criteria. Although this may have lead to a lower rate of infectious complications, it likely does not affect the clinical application of our study. Finally, our study is limited by sample size which prevented a multivariable-adjusted assessment of the more specific complications (sepsis, UTI, and wound infections) because of small numbers.

CONCLUSIONS

In a medically complex population of patients, those with neurogenic bladder and frequent catheterization undergoing major abdominal surgery, we demonstrate an infectious complication rate of 20.2%. Risk factors of female sex, older age, and higher BMI led to a higher rate of infectious complications. Wound infections were as common in patients whose urine cultures revealed multiple unspeciated organisms as those that were resistant to the perioperative antibiotics, and in this population, further characterization may allow for more appropriate perioperative coverage and a decreased rate of wound infections.

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