Microbiology of infection-related complications after transrectal ultrasound-guided prostate biopsy

Cynthia T. Nguyen[1], Alison Lew[1], Natasha N. Pettit[1], Jennifer Pisano[2], Luke F. Reynolds[3]

[1]Department of Pharmacy, University of Chicago Medicine, Chicago, IL, United States; [2]Department of Medicine, Section of Infectious Diseases and Global Health, Chicago, IL, United States; [3]Department of Surgery, Division of Urology, Chicago, IL, United States

Cite as: Nguyen CT, Lew A, Pettit NN, et al. Microbiology of infection-related complications after transrectal ultrasound-guided prostate biopsy. *Can Urol Assoc J* 2024;18(7):E204-11. http://dx.doi.org/10.5489/cuaj.8553

Published online March 1, 2024

ABSTRACT

INTRODUCTION: The objective of this study was to describe the incidence, microbiology, and risk factors related to infectious complications after transrectal prostate biopsies.

METHODS: This was a single-center, retrospective cohort study of patients undergoing prostate biopsies. Throughout the study period, the institutional recommendation for antibiotic prophylaxis was cephalexin and ciprofloxacin. Due to the desire to limit fluoroquinolone use, the ciprofloxacin duration of therapy was reduced from 48 to 24 hours in the middle of the study period. The primary outcome was the incidence of infection-related complications, defined as a urinary tract infection (UTI) or bacteremia within 30 days post-procedure.

RESULTS: A total of 1471 transrectal prostate biopsies were included. All patients received antibiotic prophylaxis, with 86.1% (1268/1472) of patients receiving both ciprofloxacin and cephalexin. The incidence of infection-related complications was 1.6% (24/1471). Four patients experienced bacteremia, all of which were due to *E. coli,* and all of these patients had received antibiotic prophylaxis with an active antibiotic. The use of ciprofloxacin was associated with a lower risk of infection-related complications (odds ratio [OR] 0.20, 95% confidence interval [CI] 0.07, 0.55). Bacteriuria within one year prior to the procedure was associated with increased risk of infection-related complications (OR 4.77, 95% CI 1.34, 16.93). Four (0.3%) patients experienced an antibiotic-related adverse event.

CONCLUSIONS: We observed a low rate of infection-related complications and antibiotic-related adverse events in the setting of antibiotic prophylaxis with ciprofloxacin and cephalexin for 24 hours, without pre-procedure rectal culture screening. Investigation into procedural or host factors may uncover opportunities to further reduce infection-related complications.

INTRODUCTION

Approximately one million prostate biopsies are performed annually in the United States to diagnose prostate cancer.[1] Infectious complications related to prostate biopsy include bacteriuria, urinary tract infection (UTI), bacteremia, and sepsis.[2,3] These complications lead to hospitalization, prolonged antibiotic therapy, increased healthcare costs[4] and significant morbidity to the patient following a minor procedure.

Antibiotic prophylaxis can prevent infectious complications related to prostate biopsy procedures.[5] Consequently, the American Urological Association (AUA) recommends a single dose of prophylactic antibiotics administered intramuscularly at least one hour prior to transrectal ultrasound (US)-guided prostate needle biopsy.[6] Additionally, in efforts to decrease complications and improve cancer detection, the role of a transperineal prostate biopsy is becoming more important. Transperineal prostate biopsy has the main advantage of decreased infection risk with less antibiotic use, and less rectal bleeding.[7,8] While many academic centers are moving towards a transperineal approach, it is still very common to use the transrectal method.

The rise in antibiotic resistant *E. coli* and the potential for inadequate antibiotic prophylaxis is thought to contribute to an increase in infectious complications after prostate biopsy.[6,9] Controversy regarding the role of fluoroquinolone therapy, duration of prophylaxis, and targeted antibiotic prophylaxis with pre-

KEY MESSAGES

- In 1471 patients undergoing transrectal prostate biopsy without preprocedure rectal culture screening, there was a low rate of infection-related complications in the setting of antibiotic prophylaxis with ciprofloxacin and cephalexin for 24 hours.
- Among patients with an infection-related complication, defined as UTI and/or bacteremia, 75% received prophylaxis with an antibiotic active against the organism identified. All patients with bacteremia received antibiotic prophylaxis with an active antibiotic.
- Investigation into procedural or host factors may uncover opportunities to further reduce infection-related complications.

biopsy urine or rectal cultures remain. Many factors contribute to infection, including proper sterilization of equipment and host characteristics, such as comorbidities and recent hospitalization. Using broader-spectrum antibiotic therapy may not improve outcomes.[6] This study aimed to describe the incidence, microbiology, and risk factors related to infectious complications after transrectal prostate biopsies in the setting of antimicrobial prophylaxis.

METHODS

This was a single-center, retrospective cohort study of patients undergoing transrectal US-guided prostate biopsies. University of Chicago Medicine is an academic medical center located in Hyde Park on the South Side of Chicago. The Department of Surgery Section of Urology serves patients locally and from the greater Chicago area. All adult patients, 18 years and older, undergoing transrectal US-guided prostate biopsies between December 1, 2016, to September 30, 2020 were included. Patients were identified using procedure charge codes and may have been included multiple times if they received multiple prostate biopsies within the study time frame. Patients receiving antibiotics for the treatment of active infection immediately prior to the procedure were excluded. This was defined as having an antibiotic prescription within two days prior to the procedure and a duration of therapy continuing after the date of procedure.

All patients were instructed to perform an enema the morning of the procedure. Rectal wall washings with antiseptic were not performed. Urinalysis and rectal swab pre-procedure were not obtained routinely for the purpose of the biopsy. All patients underwent a peri-prostatic nerve block with 2% Lidocaine. Patients underwent a standard 12 core biopsy in addition to any MRI targets that were present that would necessitate further passes of biopsy probe. Generally, two or more passes of the biopsy needle were made when a PiRads lesions 3 or higher was present. The biopsy probe was wiped and rinsed in water after each pass of the needle before being re-inserted. All patients are given followup instructions with the phone number to Urology on-call and are instructed to contact the department if there are any concerns of complications, including symptoms of urinary infection, fever, rigors, or feeling unwell.

The institutional protocol for perioperative antibiotic prophylactic included both cephalexin and ciprofloxacin. Oral antibiotics are preferred over intramuscular (IM) or intravenous, for simplicity of administration and to provide time for antibiotic distribution. Intravenous access in the outpatient setting is limited, and administering an IM dose minutes prior to the prostate biopsy may not allow for proper distribution to the tissues.

Prior to October 26, 2018, ciprofloxacin was dosed 500 mg twice daily starting the night prior to the procedure until the morning after the procedure, for a total of four doses. On October 26, 2018, due to the desire to limit fluoroquinolone use and maintain concordance with the AUA recommendations, the ciprofloxacin duration of therapy was changed to 500 mg twice daily starting on the morning of the procedure for a total of two doses. The same dosing regimen of cephalexin (1000 mg three times a day starting on the morning of the procedure for a total of three doses) was recommended throughout the study period.

If either cephalexin or ciprofloxacin could not be given (e.g., allergy or non-adherence), it was recommended to give a dose of IM gentamicin or tobramycin immediately prior to the procedure. Deviations from standard protocols based on the patient's microbiologic history were permitted (e.g., gentamicin for a history of a resistant organism). Pre-procedure rectal cultures were not routinely performed.

Antibiotic adherence was assumed if there was documentation of an electronic or verbal prescription, and confirmed by verbal discussion with the patient during the procedure visit. Throughout the study period, microbiologic and susceptibility data specific to this population was unknown; however, between January 1, 2016,

and December 31, 2020, susceptibility rates for *E. coli* urine isolates obtained in patients who presented to the emergency department were 89% for cefazolin and 82% for ciprofloxacin.

The primary outcome was the incidence of infection-related complications. Infection-related complications were defined as a microbiologically-confirmed UTI and/or bacteremia. UTI was defined as the presence of bacteria in the urine and receipt of antibiotics to treat the urine culture. Secondary outcomes included the incidence of bacteriuria, bacteremia, hospitalization due to infection, emergency department visit due to infection, new resistant organism, and antibiotic-related adverse events. All of these outcomes were evaluated within 30 days post-procedure.

A subgroup analysis comparing infectious complications and causative pathogens before versus after the change in ciprofloxacin dosing regimen was also performed. Outcomes were limited to data available in the electronic health record upon retrospective evaluation, including outside hospital data available through health information exchange (Epic® Care Everywhere). Although it is possible that some patients are treated for post-procedure infection at an outside institution, all patients receive followup communication to review pathology and provide ongoing care. It is exceedingly uncommon to perform a biopsy for a healthcare provider outside of the University of Chicago healthcare network.

UTI symptoms were defined as dysuria, urinary frequency, urinary urgency, suprapubic pain/tenderness, or costovertebral angel (CVA) tenderness. New-onset *C. difficile* or resistant organism was defined as colonization or infection with *C. difficile,* methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), extended-spectrum beta-lactamase (ESBL)-producing *Enterobacterales*, or carbapenem-resistant *Enterobacterales* not documented prior to the procedure. Antibiotic-related adverse events included prolonged QTc interval (QTc >500 ms), tendonitis or tendon rupture, new-onset altered mental status, dermatologic reaction, or acute kidney injury (increase in serum creatinine by at least 0.3 mg/dL within 48 hours or increase in serum creatinine to 1.5 times baseline or more within the last seven days). In order to be attributed to the antibiotic, adverse events had to have no other obvious cause (e.g., sepsis, diabetic ketoacidosis, or dehydration).

Categorical variables were compared using the Fisher exact test or Pearson chi-squared test, as appropriate. A forward stepwise logistic regression including variables with a p-value <0.2 in the univariate analysis (Table 1) was performed to identify factors associated with infection-related complications. No variables were forced into the model. All tests of significance were two-tailed and a p-value ≤0.05 was considered statistically significant. Statistical analyses were performed with SPSS software, version 27 (SPSS, Chicago, IL, USA). This project received a formal Determination of Quality Improvement status according to University of Chicago Medicine institutional policy. As such, this initiative was deemed not human subjects research and was therefore not subject to review by the Institutional Review Board.

Table 1. Baseline patient and peri-procedure characteristics

	Total N=1471	Patients without an infection-related complication n=1447	Patients with an infection-related complication n=24	p
Age, median (IQR)	66 (60, 71)	66 (60, 70)	66.5 (62.25, 71.75)	0.295
Reported beta-lactam allergy	142 (9.7)	140 (9.7)	2 (8)	>0.999
Pre-procedure antibiotics				
Cephalexin and ciprofloxacin	1268 (86.2)	1250 (86.4)	18 (75)	0.129
Cephalexin*	1307 (88.9)	1287 (88.9)	20 (83.3)	0.332
Ciprofloxacin*	1396 (94.9)	1377 (95.2)	19 (79.2)	**0.006**
Aminoglycoside (IM)*	245 (16.7)	236 (16.3)	9 (37.5)	**0.011**
Other*	15 (1)	15 (0.1)	0	>0.999
Bacteriuria within 1 year prior to procedure	44 (3.0)	41 (2.8)	3 (12.5)	**0.033**
E. coli only	16 (36.3) n=44	14 (34.1) n=41	2 (66.7) n=3	0.648
Enterococcus only	9 (20.5) n=44	9 (21.9) n=41	0	
Polymicrobial	6 (13.6) n=44	5 (12.2) n=41	1 (33.3) n=3	
Coagulase negative *Staphylococci* only	5 (11.4) n=44	5 (12.2) n=41	0	
Klebsiella spp. only	4 (9.1) n=44	4 (9.8) n=41	0	
Other†	4 (20.5) n=44	4 (9.8) n=41	0	

Data are number (%), unless otherwise indicated. *Not mutually exclusive; patients may have received more than one antibiotic. †Others included *Actinomyces spp.*, MSSA, *Pseudomonas spp.*, and *Serratia marcescens*. IM: intramuscular; IQR: interquartile range.

RESULTS

A total of 1481 prostate biopsy procedure charges were screened and 10 were excluded. Eight patients were excluded because there was no prostate biopsy performed (e.g., due to refusal, intolerability) and two were excluded because the patients were receiving antibiotics for the treatment of active infection prior to and after the procedure. A total of 1471 transrectal prostate biopsies were included in the evaluation. The median age was 66 years old and 9.7% of patients had a reported beta-lactam allergy (Table 1). The incidence of infection-related complications was 1.6% (24/1471) and occurred in 24 unique patients. Four patients experienced antibiotic-related adverse events that could not be attributed to an alternative cause, including two patients with tendonitis, one with acute kidney injury, and one with altered mental status. Additional outcomes are described in Table 2.

All patients received antibiotic prophylaxis, with 86.1% of patients receiving both ciprofloxacin and cephalexin. Among patients who received an aminoglycoside (n=245), 46.5% had a documented beta-lactam allergy and 4.9% had a documented fluoroquinolone allergy. More patients who received an aminoglycoside and fewer patients who received ciprofloxacin had an infection-related complication (Table 1). Upon multivariate analysis, the use of ciprofloxacin was associated with lower risk of infection-related complications [OR 0.20 (95% CI 0.07, 0.55)], and bacteriuria within one year prior to the procedure was associated with greater risk of infection-related complications [OR 4.77 (95% CI 1.34, 16.93)].

Table 2. Outcomes within 30-days post-procedure

	Total N=1471
Infection-related complication	24 (1.6)
UTI*	21 (1.4)
Bacteremia*	4 (0.3)
Infection-related admission	15 (1)
Infection-related ED visit (without hospitalization)	7 (0.5)
New onset resistant organism†	0
New onset *C. difficile* colonization or infection	3 (0.2)
Antibiotic-related adverse events††	4 (0.3)

Data are number (%). *Not mutually exclusive; one patient had a UTI and bacteremia. †Methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), extended-spectrum beta-lactamase producing *Enterobacterales*, or carbapenem resistant Enterobacterales. ††Prolonged QTc interval, tendonitis or tendon rupture, altered mental status, dermatologic reaction, acute kidney injury with no apparent alternative cause. ED: emergency department; UTI: urinary tract infection.

Among the 24 patients with an infection-related complication, 20 patients had a UTI without bacteremia, three patients had bacteremia without UTI, and one patient had a UTI with bacteremia. UTI symptoms were documented in 17 (70.8%) patients and fever (subjective or confirmed) in 12 (50%) patients. Eighteen (75%) patients experienced a complication despite receiving prophylaxis with an antibiotic active against the organism identified. All four patients with bacteremia had *E. coli* bacteremia and received antibiotic prophylaxis with an active antibiotic, including one patient with ESBL *E. coli* bacteremia who had received gentamicin for prophylaxis. Among the 21 patients with post-procedure UTI, *E. coli* (57.1%) was the most common organism, followed by *Klebsiella spp.* (9.5%). Five (23.8%) patients had polymicrobial bacteriuria, including mixed flora with no organisms specified. Most patients with a UTI received prophylaxis with an antibiotic active against the bacteria identified (71.4%). Additional symptom and microbiologic data are in Table 3.

A subgroup analysis among patients receiving two days of ciprofloxacin (n=744) compared to one day of ciprofloxacin (n=649) was performed. There were no differences in outcomes, including infection-related complications, infection-related readmission, and infection-related emergency department (ED) visits (Table 4).

DISCUSSION

We observed a relatively low rate of infection-related complications (1.6%) compared to the 1–12% described in previously published literature.[10-12] Several sources may account for this lower rate. Our use of cephalexin in combination with ciprofloxacin for prophylaxis may contribute to reduced rates of complications, as cephalexin may remain active for ciprofloxacin-resistant organisms. The use of oral antibiotics may have also contributed to the low rate of infection-related complications, though details regarding antibiotic prophylaxis (agent, route, and timing) is not well described in previously published reports.

Additionally, we defined a UTI as microbiologic confirmation and the receipt of antibiotic therapy, which ultimately relies on the prescriber's clinical judgement, since post-procedure cultures were only obtained when there was concern for infection; not routinely. Other studies have defined infectious complications as fever, any

Table 3. Symptoms and microbiology of infection-related complications

	Prostate biopsy prophylaxis	Complication	Documented symptoms*	Organism	AM	SAM	CZ	CRO	MEM	GM	CIP	SXT
1	Cephalexin† Ciprofloxacin† Gentamicin†	Bacteremia	Fever	*E. coli*	S	S	S	S	S	S	S	S
2	Cephalexin Ciprofloxacin Gentamicin†	Bacteremia	Fever Dysuria Frequency Urgency	*E. coli* (ESBL +)	R	R	R	R	S	S	R	R
3	Gentamicin†	Bacteremia	Fever Dysuria Urgency	*E. coli*	R	I	R	S	S	S	R	R
4	Cephalexin Ciprofloxacin†	Bacteremia UTI	Fever Dysuria	*E. coli*	R	I	I	S	S	R	S	R
5	Cephalexin Gentamicin	UTI	Suprapubic pain	*E. faecalis*	S	NA	NA	NA	NA	NA	S	NA
6	Cephalexin Ciprofloxacin	UTI	Fever	Mixed flora	NA	NA	NA	NA	NA	NA	NA	NA
7	Cephalexin† Ciprofloxacin	UTI	None	E. coli	R	I	S	S	S	R	R	S
8	Cephalexin† Ciprofloxacin†	UTI	None	*E. coli*	R	S	S	S	S	S	S	R
9	Cephalexin† Gentamicin	UTI	Suprapubic pain CVA tenderness	*E. coli* *Aerococcus urinae*	S NA	S NA	S NA	S NA	S NA	S NA	S NA	S NA
10	Cephalexin† Ciprofloxacin	UTI	Dysuria Urgency	*E. coli*	R	I	S	S	S	S	R	S
11	Cephalexin† Ciprofloxacin	UTI	Suprapubic pain	*Streptococcus agalactiae*	NA	NA	NA	NA	NA	NA	NA	NA
12	Cephalexin† Ciprofloxacin	UTI	Dysuria Suprapubic pain	*E. coli*	R	I	S	S	S	S	R	S
13	Cephalexin† Ciprofloxacin	UTI	Fever Dysuria Frequency	*E. coli*	R	I	S	S	S	S	R	R
14	Gentamicin†	UTI	Fever Dysuria Frequency Urgency CVA tenderness	*E. coli*	R	I	S	S	S	S	S	S
15	Ciprofloxacin† Gentamicin†	UTI	Fever Frequency Urgency	*K. pneumoniae*	R	S	S	S	S	S	S	S
16	Cephalexin Ciprofloxacin†	UTI	None	*S. hominis* *S. epidermidis*	NA NA	NA NA	R S	NA NS	NA NA	S S	S S	S R

*Symptoms evaluated include fever, dysuria, urinary frequency, urinary urgency, suprapubic pain/tenderness, CVA tenderness. Notes active antibiotic against organism(s) causing the complication, based on the organism and/or confirmed susceptibilities (if available). AM: ampicillin; CIP: ciprofloxacin; CRO: ceftriaxone; CVA: costovertebral angel; CZ: cefazolin; ESBL: extended-spectrum beta-lactamase; GM: gentamicin; I: intermediate MEM: meropenem; NA: not applicable; R: resistant; S: susceptible SAM: ampicillin-sulbactam; SXT: trimethoprim-sulfamethoxazole; UTI: urinary tract infection.

Table 3 (cont'd). Symptoms and microbiology of infection-related complications

	Prostate biopsy prophylaxis	Complication	Documented symptoms*	Organism	AM	SAM	CZ	CRO	MEM	GM	CIP	SXT
17	Cephalexin† Ciprofloxacin	UTI	Fever Frequency Urgency	*E. coli*	R	I	S	S	S	S	I	R
18	Tobramycin	UTI	Frequency Urgency	Mixed flora	NA	NA	NA	NA	NA	NA	NA	NA
19	Cephalexin† Ciprofloxacin	UTI	Fever	*E. coli*	S	S	S	S	S	S	R	S
20	Cephalexin† Ciprofloxacin	UTI	None	*E. coli*	R	I	S	S	S	S	R	R
21	Cephalexin† Ciprofloxacin† Tobramycin†	UTI	Dysuria Frequency Urgency	*K. pneumoniae*	R	S	S	S	S	S	S	S
22	Cephalexin Ciprofloxacin	UTI	Fever Dysuria Frequency	Mixed flora	NA	NA	NA	NA	NA	NA	NA	NA
23	Cephalexin Ciprofloxacin	UTI	Fever Urgency	*E. coli* (ESBL +)	R	R	R	R	S	S	R	S
24	Cephalexin Ciprofloxacin	UTI	Frequency Suprapubic pain	*S. aureus*	NA	NA	S	NA	NA	S	S	S
				S. maltophilia	NA	NA	NA	NA	NA	NA	NA	S

*Symptoms evaluated include fever, dysuria, urinary frequency, urinary urgency, suprapubic pain/tenderness, CVA tenderness. Notes active antibiotic against organism(s) causing the complication, based on the organism and/or confirmed susceptibilities (if available). AM: ampicillin; CIP: ciprofloxacin; CRO: ceftriaxone; CVA: costovertebral angel; CZ: cefazolin; ESBL: extended-spectrum beta-lactamase; GM: gentamicin; I: intermediate MEM: meropenem; NA: not applicable; R: resistant; S: susceptible SAM: ampicillin-sulbactam; SXT: trimethoprim-sulfamethoxazole; UTI: urinary tract infection.

post-procedure antibiotic use, or the presence of urinary symptoms, without the bacteriuria requirement, which are less specific than our definition.[10,11] We opted for a more conservative UTI definition to avoid the potential overdiagnosis of UTI in the setting of non-specific urinary symptoms post-biopsy. Additionally, many of these studies were large, prospective, and multinational, which may contribute to a higher rate of detection compared to our single-center retrospective study. Still, although some patients reside outside the catchment area of the University of Chicago, it is exceedingly uncommon that a patient undergoing a prostate biopsy is not being managed by a urologist or medical/radiation oncologist at the University of Chicago. It would be unlikely for a patient to experience a complication that is undocumented in the electronic medical record due to review of pathologic results and continuity of care of patients undergoing this procedure. Finally, over 90% of the procedures included in our study were performed by the same surgeon, and increased surgeon volume has been associated with a decreased risk of infection.[13]

Table 4. Subgroup analysis among patients receiving 2 days or 1 day of ciprofloxacin for prophylaxis

	Ciprofloxacin 2 days n=744	Ciprofloxacin 1 day n=649	p
Infection-related complications	10 (1.3)	11 (1.7)	>0.999
Infection-related admission	8 (1.1)	3 (0.5)	0.237
Infection-related ED visit (without hospitalization)	3 (0.4)	4 (0.6)	0.711
New onset *C. difficile* colonization or infection	1 (0.1)	2 (0.3)	0.601
Antibiotic-related adverse events*	3 (0.4)	1 (0.2)	0.628

*Prolonged QTc interval, tendonitis or tendon rupture, altered mental status, dermatologic reaction, acute kidney injury with no apparent alternative cause. ED: emergency department.

Most patients in our study received ciprofloxacin in combination with cephalexin for prophylaxis. Ciprofloxacin use was independently associated with a lower risk of infection-related complications. This is unsurprising, due to the high concentration fluoroqui-

> “ We found low rates of infection-related complications with antibiotic prophylaxis (ciprofloxacin & cephalexin) in the absence of pre-procedure cultures. ”

nolone antibiotics achieve in the urine and prostatic tissue. Still, this finding is interesting given the relatively high rate of *E. coli* fluoroquinolone resistance in our local outpatient population (~20%) and that among the 15 patients with *E. coli* infection, 60% were resistant to ciprofloxacin and only 4.6% were resistant to cephalexin (Table 3). Importantly, our study was not designed or powered to compare antibiotic regimens, and we cannot conclude that ciprofloxacin is preferred over other antibiotics. Prior bacteriuria was associated with a higher risk of infection-related complications and has been established as a risk factor in prior studies.[11,14] Additionally, all four patients with post-procedure bacteremia had received antibiotic prophylaxis with a susceptible antibiotic. Together, these findings suggest that factors outside of antibiotic prophylaxis and antimicrobial susceptibility, such as procedural or host factors, are more important.

During the study time frame, the standard duration for ciprofloxacin prophylaxis was reduced from two days to one day. Prolonged antimicrobial use has been associated with negative consequences including the increased risk of *C. difficile* and the development of resistant organisms.[3,4] A study evaluating other surgical procedures describes an increased risk of *C. difficile* with each additional day of antibiotic prophylaxis ($p<0.01$). Specifically, fluoroquinolone and clindamycin use was found to be associated with increased risk of *C. difficile* [OR 1.519 (1.063–2.169)].[5] Consequently, the AUA recommends against a three-day or longer duration of fluoroquinolone prophylaxis regimen, as it has also shown to have no benefit to the patient. Our subgroup analysis comparing a two- versus one-day duration of ciprofloxacin demonstrated no differences in outcomes and supports the use of shorter courses of antibiotic prophylaxis.

Limitations

There are several limitations to this study. First, we were unable to routinely capture data from outside facilities. This limitation was mitigated by close prospective followup to identify complications (as previously described) and the use of the health information exchange, which identified 33% of the complications.

Second, we made assumptions regarding pre- and post- procedure characteristics and outcomes when data were unavailable or missing. For example, if urine or blood cultures were not obtained, we assumed that the patient did not have bacteriuria or bacteremia. This may have contributed to our low incidence of UTIs, as our definition required a positive urine culture (described above).

Third, this single-center, single-surgeon experience may reduce the external validity of the study; however, it may also improve the internal validity by reducing variability and controlling for potential confounding related to surgical technique. Additionally, these findings may not translate to centers performing transperineal biopsies.

Finally, we collected a limited data set and are unable to account for procedural or host factors (e.g., rectal preparation, needle disinfection, immunosuppression, prosthesis, etc.) that likely play an important role in infectious complications.

CONCLUSIONS

We observed a low rate (1.6%) of infection-related complications in the setting of antibiotic prophylaxis with ciprofloxacin and cephalexin and the absence of pre-procedure rectal culture screening. Furthermore, there was no difference in outcomes with a longer two-day duration of antibiotic prophylaxis. Similar to other studies, we found pre-procedure bacteriuria to be associated with a higher rate of infectious complications. Interestingly, ciprofloxacin prophylaxis was associated with a lower rate of infectious complications, and we observed a low rate of antibiotic-related adverse events overall. Despite the rise in fluoroquinolone-resistant *E. coli*, these data support our current practice of using oral ciprofloxacin and cephalexin prophylaxis for 24 hours in the absence of pre-procedure rectal culture screening. Additional investigation into procedural or host factors may further reduce infection-related complications.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

This paper has been peer-reviewed.

REFERENCES

1. Wojno K, Hornberger J, Schellhammer P, et al. The clinical and economic implications of specimen provenance complications in diagnostic prostate biopsies. *J Urol* 2015;193:1170-7. https://doi.org/10.1016/j.juro.2014.11.019
2. Abughosh Z, Margolick J, Goldenberg SL, et al. A prospective randomized trial of povidone-iodine prophylactic cleansing of the rectum before transrectal ultrasound guided prostate biopsy. *J Urol* 2013;189:1326-31. https://doi.org/10.1016/j.juro.2012.09.121
3. Williamson DA, Barrett LK, Rogers BA, et al. Infectious complications following transrectal ultrasound-guided prostate biopsy: new challenges in the era of multidrug-resistant *Escherichia coli*. *Clin Infect Dis* 2013;57:267-74. https://doi.org/10.1093/cid/cit193
4. Adibi M, Pearle MS, Lotan Y. Cost-effectiveness of standard vs. intensive antibiotic regimens for transrectal ultrasonography (TRUS)-guided prostate biopsy prophylaxis. *BJU Int* 2012;110:E86-91. https://doi.org/10.1111/j.1464-410X.2011.10768.x
5. Zani EL, Clark OA, Rodrigues Netto N Jr. Antibiotic prophylaxis for transrectal prostate biopsy. Cochrane *Database Syst Rev* 2011;CD006576. https://doi.org/10.1002/14651858.CD006576.pub2
6. Liss MA, Ehdaie B, Loeb S, et al. An update of the American Urological Association white paper on the prevention and treatment of the more common complications related to prostate biopsy. *J Urol* 2017;198:329-34. https://doi.org/10.1016/j.juro.2017.01.103
7. Bennett HY, Roberts MJ, Doi SA, et al. The global burden of major infectious complications following prostate biopsy. *Epidemiol Infect* 2016;144:1784-91. https://doi.org/10.1017/S0950268815002885
8. Xiang J, Yan H, Li J, et al. Transperineal vs. transrectal prostate biopsy in the diagnosis of prostate cancer: A systematic review and meta-analysis. *World J Surg Oncol* 2019;17:31. https://doi.org/10.1186/s12957-019-1573-0
9. Roberts MJ, Williamson DA, Hadway P, et al. Baseline prevalence of antimicrobial resistance and subsequent infection following prostate biopsy using empirical or altered prophylaxis: A bias-adjusted meta-analysis. *Int J Antimicrob Agents* 2014;43:301-9. https://doi.org/10.1016/j.ijantimicag.2014.01.008
10. Alidjanov JF, Cai T, Bartoletti R, et al. The negative aftermath of prostate biopsy: Prophylaxis, complications and antimicrobial stewardship: Results of the global prevalence study of infections in urology 2010-2019. *World J Urol* 2021;39:3423-32. https://doi.org/10.1007/s00345-021-03614-8
11. Wagenlehner FM, van Oostrum E, Tenke P, et al. Infective complications after prostate biopsy: Outcome of the Global Prevalence Study of Infections in Urology (GPIU) 2010 and 2011, a prospective, multinational, multicenter prostate biopsy study. *Eur Urol* 2013;63:521-7. https://doi.org/10.1016/j.eururo.2012.06.003
12. Borghesi M, Ahmed H, Nam R, et al. Complications after systematic, random, and image-guided prostate biopsy. *Eur Urol* 2017;71:353-65. https://doi.org/10.1016/j.eururo.2016.08.004
13. Shoag JE, Gaffney C, Pantuck M, et al. Risk factors for infection after prostate biopsy in the United States. *Urology* 2020;138:113-8. https://doi.org/10.1016/j.urology.2019.12.023
14. Roberts MJ, Bennett HY, Harris PN, et al. Prostate biopsy-related infection: A systematic review of risk factors, prevention strategies, and management approaches. *Urology* 2017;104:11-21. https://doi.org/10.1016/j.urology.2016.12.011

CORRESPONDENCE: Cynthia T. Nguyen, Department of Pharmacy, University of Chicago Medicine, Chicago, IL, United States; CynthNguyen@gmail.com