

PERIOPERATIVE ANTIBIOTIC PROPHYLAXIS IN UROLOGICAL SURGERY: AN UPDATE SYSTEMATIC REVIEW

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ABSTRACT

Background: Perioperative antibiotic prophylaxis (PAP) is provided to avoid local or systemic infections, such as surgical site infections (SSI), urinary tract infections (UTI), or sepsis. However, PAP may not be effective in reducing symptomatic UTI in some procedures, such as extracorporeal shock wave lithotripsy and cystoscopy.

The aim: This study aims to determine the effectiveness of perioperative antibiotic prophylaxis in urological surgery.

Methods: By comparing itself to the standards set by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. So, the experts were able to make sure that the study was as up-to-date as it was possible to be. For this search approach, publications that came out between 2014 and 2024 were taken into account. Several different online reference sources, like Pubmed, SAGEPUB, and ScienceDirect, were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.

Results: In the PubMed database, the results of our search brought up 105 articles, whereas the results of our search on SAGEPUB brought up 6 articles, our search on ScienceDirect brought up 129 articles. In the end, we compiled 9 papers, 7 of which came from PubMed, and 2 of which came from ScienceDirect. We included nine research that met the criteria.

Conclusion: Perioperative antibiotic prophylaxis (PAP) can lower SSI, UTI, and sepsis incidences in urological surgery. In addition, PAP showed a lower positive blood culture. To minimize side effects and lower the risk of drug-resistant organisms, the use of reasonable PAP is advised.

Keywords: Perioperative, antibiotic prophylaxis, urological surgery

INTRODUCTION

The majority of urological therapies can be performed primarily by surgery.¹ The most common complication of urological surgery is surgical site infection (SSI) and urinary tract infection (UTI).² Patients with SSI are at greater risk of experiencing morbidity and mortality. Antibiotic prophylaxis is one of the most crucial methods to decrease the risk of SSI incidence.³ Previous studies showed that patients with SSI had twice the chance of dying, five times the chance of being readmitted, and a 60% increased chance of being committed to the intensive care unit (ICU).⁴

Perioperative antibiotic prophylaxis (PAP) is provided to avoid local or systemic infection, such as SSI, UTI, or sepsis.^{5,6} Antibiotic prophylaxis systematically administers an antibiotic to minimize the risk of surgical site and secondary systemic infections.⁷ Antibiotics should be chosen based on the patient's medical risks and allergies, as they may cause adverse reactions.⁸ According to the European Association of Urology (EAU), antibiotic prophylaxis is not effective in reducing the incidence of symptomatic UTI in some procedures, such as extracorporeal shock wave lithotripsy and cystoscopy. PAP may benefit patients undergoing endourological procedures, such as ureteroscopic surgery and percutaneous nephrolithotomy.¹ The Global Prevalence of Infections in Urology study revealed a 10.5% prevalence of hospital-associated UTIs in urology departments, with 41.0% of patients undergoing open surgery.⁹ EAU advises obtaining a urine culture or performing urinary microscopy before the urologic procedure. UTIs should be ruled out or treated to avoid postoperative infectious problems.¹⁰

The use of minimal antibiotics is recommended to reduce patient infection risk, minimize adverse effects, and reduce the risk of drug-resistant organisms. Current guidelines suggest a single dose of preoperative antibiotics therapy and no postoperative continuation of antibiotics regardless of surgical procedure type. Multiple randomized controlled trials with moderate quality evidence showed no benefit in prolonging AP beyond case completion, with prolonged AP (>48 hours post-incision) significantly increasing antibiotic-resistance risk and no decrease in SSI.⁸ The Centers for Disease Control and Prevention (CDC) categorizes surgical wounds into four groups based on intraoperative microbial contamination: class I (clean), class II (clean-contaminated), class III (contaminated), and class IV (dirty and infected).¹¹

Antibiotic prophylaxis for non-transplant urological surgery has been advised to be administered for a shorter period. According to American Urological Association and EAU guidelines, for class II (clean-contaminated) surgery, a single dose of a cephalosporin (first or second generation), trimethoprim, and sulfamethoxazole, or penicillin with a beta-lactamase inhibitor (BLI) should be administered either preoperatively or within 24 hours after surgery.¹² Antibiotic prophylaxis must be penicillin with BLI, or first/second generation of cephalosporins. At least 30 minutes before the procedure begins, antibiotic prophylaxis should be begun. In the event of transurethral, clean, or clean-contaminated surgery, antibiotic prophylaxis should be given as a single dose or stopped within 24 hours; in the event of contaminated surgery, it should be stopped within 2 days.¹³ The purpose of this study is to compare the perioperative antibiotic prophylaxis in urological surgery.

METHODS

Protocol

By following the rules provided by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, the author of this study made certain that it was up to par with the requirements. This is done to ensure that the conclusions drawn from the inquiry are accurate.

Criteria for Eligibility

For the purpose of this systematic review, we compare and contrast the perioperative antibiotic prophylaxis in urological surgery. It is possible to accomplish this by researching or investigating surgical site infection rates, urinary tract infection rates, positive urine culture, etiology, and post-operative sepsis. As the primary purpose of this piece of writing, demonstrating the relevance of the difficulties that have been identified will take place throughout its entirety.

For researchers to take part in the study, they needed to fulfill the following requirements: 1) The paper needs to be written in English, and it needs to investigate the perioperative antibiotic prophylaxis in urological surgery. For the manuscript to be considered for publication, it needs to meet both of these requirements. 2) The studied papers include several that were published after 2014, but before the period that this systematic review deems to be relevant. Examples of studies that are not permitted include editorials, submissions that do not have a DOI, review articles that have already been published, and entries that are essentially identical to journal papers that have already been published.

Search Strategy

We used "perioperative"; "antibiotic prophylaxis"; and "urological surgery" as keywords. The search for studies to be included in the systematic review was carried out in March, 16th 2024 using the PubMed, SAGEPUB, and ScienceDirect databases by inputting the words: (("perioperative"[All Fields] OR "perioperatively"[All Fields]) AND ("antibiotic prophylaxis"[MeSH Terms] OR ("antibiotic"[All Fields] AND "prophylaxis"[All Fields]) OR "antibiotic prophylaxis"[All Fields]) AND (("urological"[All Fields] OR "urologically"[All Fields] OR "urology"[MeSH Terms] OR "urology"[All

Fields] OR "urologic"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgeries"[All Fields] OR "surgeries"[All Fields])) AND ((y_10[Filter]) AND (english[Filter])) used in searching the literature.

Data retrieval

After reading the abstract and the title of each study, the writers examined to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilize as sources for their article and selected those studies. After looking at several different research, which all seemed to point to the same trend, this conclusion was drawn. All submissions need to be written in English and can't be seen anywhere else.

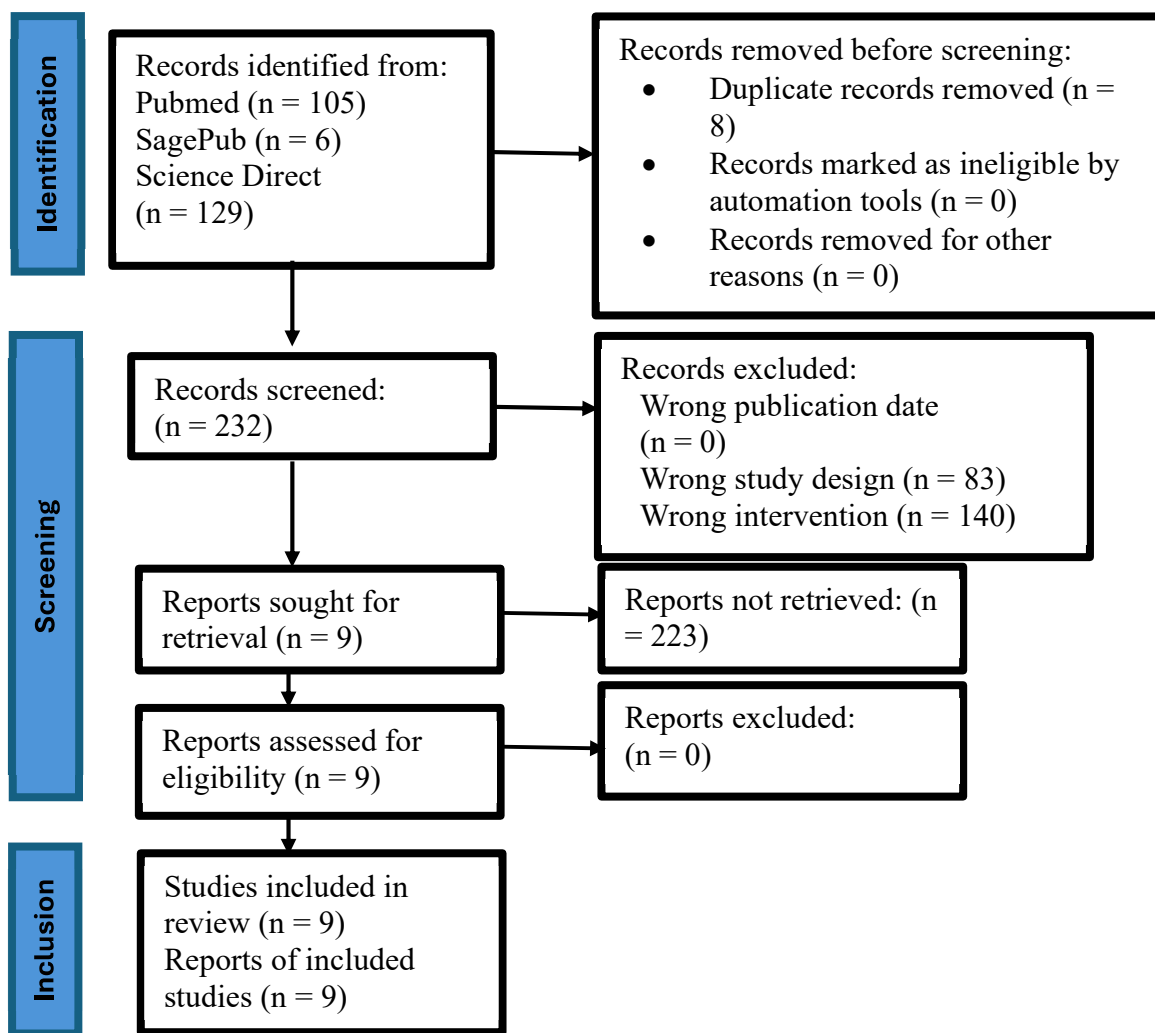


Figure 1. Prisma Flow Diagram

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

Quality Assessment and Data Synthesis

Each author did their own study on the research that was included in the publication's title and abstract before deciding on which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilized in the process of selecting papers for further assessment to simplify the process as much as feasible when selecting papers to evaluate. Which earlier

investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

RESULT

In the PubMed database, the results of our search brought up 105 articles, whereas the results of our search on SAGEPUB brought up 6 articles, our search on ScienceDirect brought up 129 articles. In the end, we compiled 9 papers, 7 of which came from PubMed, and 2 of which came from ScienceDirect. We included nine research that met the criteria.

Table 1. The literature included in this study

Author	Origin	Method	Sample Size	Result
Bachmann, 2019 ⁵	Germany	Retrospective study	212 patients who had renal transplantation	This finding suggested that compared to the prior multi-dose strategy, single-dose cefazolin proved to be similarly effective and more cost-effective.
Berrondo, 2019 ¹⁴	USA	RCT	175 patients who had radical prostatectomy	The result of this study suggested that there was no significant difference in the incidence of C diff enterocolitis or UTIs when oral ciprofloxacin was used as a preventive antibiotic at the time of catheter removal following radical prostatectomy.
Capocasale, 2014 ¹⁵	Italy	Retrospective study	1000 patients who had renal transplantation	Based on its efficacy and safety profile, this study indicates that prophylactic use of universal ceftriaxone is beneficial in preventing UTIs and SSIs.
Davuluri, 2020 ¹⁶	USA	Retrospective study	330 patients who underwent any ambulatory endoscopic urologic surgery	The findings showed a deviation from the AUA recommended practice statement when it came to the prescription of antibiotics following ambulatory urologic surgery, antibiotic overprescription raises expenses, increases the chance of bacterial resistance, and can lead to idiopathic problems such C. difficile.

Haider, 2019 ⁹	Germany	Retrospective study	330 patients who had undergone open radical cystectomy	The finding showed urinary tract infections are substantially more common in patients who have continent urine diversion following RC. Extended use of antibiotics during surgery does not appear to lower the incidence of urinary tract infection. Individuals who pose a higher risk should be prescribed varying antibiotic regimens.
Nayyar, 2023 ¹⁷	India	Cross-sectional	1538 patients who underwent endourological procedures	The results suggested that antibiotic prophylaxis during endourological procedures, whether single-dose, combination, or post-discharge, is very common in India. This audit demonstrates the enormous potential to lower the excessive use of antibiotics during endourological treatments that deviates from guidelines.
Schneidewind, 2021 ¹⁸	Germany	Prospective clinical trial	30 patients who had undergone open radical cystectomy	This study demonstrated that starting on day 12, bacterial colonization of IC urine from the skin flora does happen. Additionally, it is likely safe to evaluate the reduction of perioperative antibiotic prophylaxis, possibly with additional single-shot coverage during the stent removal procedure.
Sharma, 2019 ¹⁹	India	Cohort study	277 patients who underwent elective major urological surgeries	The findings of this study suggested that urological surgery can benefit from protocol-based perioperative antibiotic prophylaxis. To reduce the overuse of antibiotics and stop the emergence of antibiotic resistance, comparable protocols ought to be created and checked at other important institutions.

Shin, 2017 ²⁰	Korea	Retrospective study	313 patients who underwent laparoscopic prostatectomy	These findings showed that advanced age, a brief duration of antibiotic administration, and a prolonged Foley catheterization all influence the outcome of postoperative infection problems. While a longer course of antibiotic administration and a longer length of Foley catheterization are linked to a lower incidence of SSI, prolonged drain installation is linked to SSI.
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Antibiotics Used

Penicillin, cephalosporin, and ciprofloxacin antibiotics are the most frequently prescribed perioperative antibiotic prophylaxis.

Surgical Site Infection (SSI)

Four studies include SSI as the main outcome after using perioperative antibiotics prophylaxis. SSI still occurred in patients given antibiotics.^{5,15,18,20} Capocasale, et al. (2014)¹⁵ showed that twenty (2%) of the 1000 recipients of kidney transplants had an SSI diagnosis (9 female subjects and 11 male subjects). Patients undergoing living-donor transplants did not have any SSIs. Schneidewind, et al. (2021)¹⁸ showed that SSI with *E. faecium* occurred in two patients (6.7%).

Bachmann, et al. (2019)⁵ compared 107 patients (group SD) who were supposed to receive prophylactic treatment in a single dosage with 105 patients (group MD) who were supposed to receive prophylactic treatment in numerous doses. In general, the frequency of bacterial SSIs was low (2.8%) and did not vary between the groups (p = 0.40; group SD vs. MD: 1.9% vs. 3.8%). 24.7 (15–31) days was the average time to SSI. Every single SSI was an incisional, superficial SSI. Shin, et al. (2017)²⁰ showed that patients who took a second-generation cephalosporin for two days had a substantially higher incidence of SSI (5.2%) than patients who took antibiotics for longer than two days (0.6%) (P = 0.018).

Urinary Tract Infection (UTI)

Seven of nine studies reported UTI rates in their research.^{5,9,14,15,17–19} Overall, studies showed lower incidences of UTI in patients receiving antibiotic prophylaxis following the urological surgery. In addition, Nayyar, et al. (2023)¹⁷ showed in comparison to patients who got a single-dose antibiotic, postoperative UTI rates were considerably lower in patients who received short-term (1, 2, or 3 days) per-operative prophylaxis. Capocasale, et al. (2014)¹⁵ showed that UTIs were substantially more common in female subjects than in male subjects (17.1% vs. 4.6%; P <.0001).

Etiology

Five studies reported the most common etiology of UTI,^{5,9,15,16,18} included *Escherichia coli*, *Enterococcus faecalis*, *Klebsiella species*, *Staphylococcus epidermidis*, *Enterobacter spp.*, *Staphylococcus aureus*, *Beta streptococcus*, *coagulase-negative Staphylococcus (CoNS)*, *Citrobacter spp.*, and *Staphylococcus haemolyticus*.

Positive Urine Culture

Berrondo, et al. (2019)¹⁴ showed that there were 65% of patients in the control group demonstrated growth of at least one organism compared to 29% of patients in the antibiotic group. Between three and twelve months following surgery, urine cultures were taken from 124 (74.3%) of the patients during their normal follow-up sessions. Compared to 16.7% of patients in the antibiotic prophylaxis group, 27% of patients in the control group exhibited growth of at least one organism.

Davuluri, et al. (2020)¹⁶ showed that antibiotics prescription following surgery was significantly predicted by a positive urine culture within 30 days of the procedure (B = 1.620, P =.003) and a positive urine culture within a year of the procedure (B = 1.123, P =.027).

Sepsis

Three studies reported urosepsis events.^{5,9,19} Bachmann, et al. (2019) reported twelve cases of urosepsis. Haider, et al. (2019) reported 21 cases (9.7%) of systemic SIRS, severe urosepsis, or uroseptic shock. Sharma, et al. (2019) reported 16 cases of urosepsis as the commonest reason for failure of antibiotic prophylaxis. Schneidewind, et al. (2021)¹⁸ reported none of patients who experienced sepsis.

DISCUSSION

The most frequent post-operative issues following urology surgery are SSIs and UTIs can be prevented with antibiotic prophylaxis. Due to the widespread use of various types of catheters, urological surgery has a higher risk of postoperative urinary tract infection than other procedures. CDC categorized classes of surgical wounds became 4 categories: (1) Class I - clean wounds: these wounds are clean, uninfected, and typically closed, with closed draining recommended for drainage if needed. They don't involve the respiratory, alimentary, genital, or urinary tracts, and can be repaired like inguinal hernia or thyroidectomy; (2) Class II - clean contaminated: involving entry into the respiratory, alimentary, genital, or urinary tracts under controlled circumstances, ensuring low contamination levels; (3) Class III - contaminated: resulting from sterile breaches or gastrointestinal tract leakage, and include incisions from acute or nonpurulent inflammation; (4) Class IV - dirty or infected: often caused by surgery or perforated organ microorganisms, result from inadequate treatment, gross purulence, and evident infections, leading to tissue loss. Postoperative risk of surgical site infection (SSI) varies among classes, with scores ranging from 1% to 5%, 3% to 11%, 10% to 17%, and more than 27%. SSIs are defined by the CDC as an infection that occurs within 30 days post-surgery, which can be categorized into three levels of severity, that are superficial incisional, deep incisional, and organ or space infection.²¹⁻²⁴

The standard of treatment for preventing surgical site infections is antibiotic prophylaxis (AP) before surgery.² Class I surgery may not require single-dose antibiotic prophylaxis. Single-dose AP is recommended for class II surgery, but not recommended for simple cystoscopy or urodynamic studies in healthy patients. Single-dose AP recommended for class III and IV surgery.²⁵

According to the American College of Surgeons (ACS) guidelines 2016 for SSI prevention the recommendations are (1) provide antibiotic before incision, (2) use weight-based antibiotic dosage, (3) give an antibiotic 60 minutes before incision (or 120 minutes if using vancomycin or fluoroquinolones, and (4) redosing antibiotic if necessary.¹⁴ The recommended antibiotic prophylaxis for urologic procedures by the American Urology Association is based on consensus which is Trimethoprim-Sulfamethoxazole (TMP-SMX), amoxicillin/clavulanate, cefazolin, fluoroquinolone, 1st or 2nd generation of cephalosporin, aminoglycoside, aztreonam, clindamycin, cefotetan, ceftriaxone, ertapenem, or aminopenicillin combined with BLI and metronidazole.²⁵

One of the most prevalent nosocomial infections, SSIs significantly increase morbidity, death, and healthcare expenses. Perioperative antibiotics have been proven to reduce the likelihood of postoperative SSI in various surgical fields.¹⁴ Risk factors for developing SSI include age, comorbidity, diabetes, malnutrition, low serum albumin, radiotherapy, steroid use, high BMI, host immune status, smoking, site, and wound contamination. The type and complexity of the surgical procedure, including duration, emergency surgery, non-absorbable suture use, electrocautery, massive bleeding, hypothermia, and surgical approach, also play significant roles.²³

Choosing antibiotics for surgical procedures is crucial, considering their pharmacokinetics and distribution to incision tissue. These antibiotics target specific bacteria, disrupting vital processes like cell wall synthesis and protein production, thereby eliminating or inhibiting SSIs while preserving beneficial microorganisms. Mechanism antibiotics prevent SSIs is through (1) reducing bacterial load: Antibiotic prophylaxis reduces bacterial populations at surgical sites, creating a less favorable environment for infections, especially during wound healing, making it crucial during the initial stages, (2) Minimizing local spread: Antibiotics act as a barrier against bacteria spreading beyond surgical incisions, preventing severe infections in deeper tissue layers or body cavities. They contain bacteria at the incision site, preventing the development of deep tissue and organ/space infections, (3) Immune system support - Antibiotics help the patient's immune system fight infections by reducing bacterial burden in the surgical area, enhancing the body's natural defense mechanisms and allowing it to focus on clearing remaining bacteria and expediting healing.²⁶

Ferroni et al study (2016) showed that are no significant impact of extended antibiotic prophylaxis on the UTI rate for patients who underwent minimal invasive pyeloplasty with ureteral stent placement in children. The majority of this study patients had UTI because had another risk factor. This study concluded that the regular use of antibiotic prophylaxis may not be necessary following these procedures.²⁷

Similar to our study, a study by Vermandois et al (2019) found that 3 patients were diagnosed with superficial incisional SSIs and 4 patients developed space /organ SSIs after an open urology surgery. All patients received antibiotic prophylaxis which is piperacillin/tazobactam 4.5 g within 1 hour before surgery. All three superficial incisional SSIs are caused by *Candida albicans*. This study also showed that there are no UTI events after urology surgery.²³ This study also supports our findings that there is a lower incidence of UTIs after receiving antibiotic prophylaxis.²³

Similar to our study, Viers et al (2014) study showed that patients underwent percutaneous nephrolithotomy (PCNL), 6 patients experienced UTIs, 11 patients (systemic inflammatory response syndrome) SIRS and no one had sepsis. Antibiotic prophylaxis used in this study were nitrofurantoin, trimethoprim /sulfamethoxazole, fluoroquinolone, and others. This study also showed that patients receiving extended perioperative antibiotics experienced adverse antibiotic events such as the development of *Clostridium difficile colitis* and drug resistance.²⁸ The primary cause of the rising antimicrobial resistance (AMR) is antibiotic misuse, either excessive or incorrect. AMR has increased during the last few decades for

some reasons.²¹ Antibiotic misuse has been linked to *C. difficile* colitis by suppressing natural bacterial flora, increasing patient morbidity, bacterial resistance, and higher healthcare expenditures. Increased antibiotic usage is a primary factor contributing to the rising incidence of *C. difficile* infection, which is on the rise globally.²⁹

A retrospective analysis study by Bhojani et al (2023) found that 5.6% of patients from 109496 patients were diagnosed with sepsis, including 4.1% was non-severe sepsis and 1.5% was severe sepsis after ureteroscopy. Ureteroscopy was a surgical treatment for stone disease. When sepsis is not identified or treated quickly, patients may die, have septic shock, have fast organ function decline, or stay in the intensive care unit (ICU) for an extended period.³⁰ Urosepsis is a severe and potentially life-threatening condition resulting from urogenital tract infection. Urinary tract infections (UTIs) are caused by pathogenic microbes, with *Escherichia coli* being the most common uropathogenic, responsible for approximately 80% of uncomplicated UTIs or pyelonephritis.³¹

Urosepsis is caused by the presence of intact bacteria or bacterial cell wall components in the urogenital tract, which may be present during ureteroscopy or after stent placement. The formation of biofilm on urinary drainage devices like stents and foley catheters is believed to contribute to the genesis of urosepsis. Biofilm, a thin layer formed by microbes and bacterial cell wall components, exacerbates urothelial irritation and leads to an inflammatory response. It may also attract further bacterial adhesion, potentially leading to infection or predisposing patients to subsequent ureteroscopic intervention. Urosepsis is a complex disease characterized by an initial inflammatory response, followed by an anti-inflammatory response, ultimately leading to overwhelming immunosuppression.³¹

CONCLUSION

Perioperative antibiotic prophylaxis (PAP) can lower SSI, UTI, and sepsis incidences in urological surgery. In addition, PAP showed a lower positive blood culture. To minimize side effects and lower the risk of drug-resistant organisms, the use of reasonable PAP is advised.

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